Skyranger UK Build Manual
Issue 4.0

Not to scale.
All dimensions in millimeters.
Drawing: 04 01 2002.
Copyright: Skyranger UK Limited 2002
Figure 1; tube numbering scheme.
Figure 2; Skyranger frame.
Figure 3; uncovered frame.
Figure 4; uncovered forward fuselage.

Figure 5; simply assemble thus...
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Introduction

1.1 How to Build Your Aircraft

Building the Skyranger is a fairly straightforward process, but it can be made much more difficult than necessary if one basic rule is not followed:

READ THE INSTRUCTIONS!

Figure 6; a rare sight, but essential for successful building (the manual that is, not Rob)!

1.1.1 The Build Manual

Reading the whole manual before starting is suggested. Reading ahead by at least the section being worked upon, as each section is reached, is recommended. Reading the instructions for the components under your spanners is essential! It is remarkable how often the instructions are over-looked or misread, remembering that you are going to fly in your finished aircraft!

Instructions, however, are never as good as they could be, and so corrections and suggestions for improving the instructions are welcome, preferably in writing by email. These can then be included in future updates of the manuals.

If you have errata or receive updates to the manual, mark these immediately in your copy of the manual so that you do not forget them when you reach that stage.

An electronic copy of the build manual is included on the CD in Adobe PDF format, along with the reader software needed. This can be used to print off replacement pages, to zoom in on photographs, and to print colour versions of the wiring diagrams. Updates to the manual will be made available either on CD or via the Skyranger website (www.skyranger.co.uk).

Don’t rush things, work carefully, and don’t forget to enjoy building your aeroplane!
1.1.2 In case of difficulty

If you cannot find a part, ensure that you have determined what it looks like, and that it is not already attached to a sub-assembly in the area you are working on. Often parts are hidden by the packaging, or lurking in the bottom of a box of bits in the corner of the garage, rather than being missing from the kit.

If you have a problem that you cannot resolve by a careful read of the instructions with the appropriate parts in front of you please have a look in the Skyranger internet discussion group, send an email, or if all else fails ring:

   Skyranger Hotline  01604 644222

   Note that most enquiries can be answered by a careful read of the manual, so do give it some thought before calling.

   That way you’ll get through when you really are stuck!

This number should be used rather than Flylight’s lesson booking line. Email is preferred and more convenient than the telephone, as it makes it simple to communicate answers to other builders and allows time for a better reply to your questions.

![Image](image.jpg)

Figure 7; We await your call on the Skyranger Hotline!

1.1.3 Photographs

The manual has lots of drawings and photographs to help you build your aeroplane. The photographs are chosen to illustrate each point, but often include other areas of the aeroplane in the background. However, due to the number of modifications made during the UK certification phase you should be cautious about assuming that background items are shown as they should be on UK specification aircraft.
1.2 The BMAA Homebuilt Aircraft System

Before starting the build of your Skyranger you must register the project with the BMAA. The required forms are downloadable from the BMAA website at www.bmaa.org, go to the Technical Information section, click on Forms, and download form BMAA/AW/022.

An example form for a Skyranger fitted with a Rotax 912UL and standard Kiev prop is shown in Section 0 at the end of this manual.

You will have to find a BMAA Inspector to oversee the project. A list of Inspectors is available from the BMAA if required. Fill in the form with information about your aircraft and Inspector.

Send this form, along with the certificate of conformance for the aircraft, engine and propeller, with the current fee to the BMAA.

The BMAA will then register the project and issue you with a project number. They will send you a pack of paperwork with information about building a BMAA homebuilt, and a stage inspection form to be completed during the build by yourself and your Inspector.

Please read all the paperwork that the BMAA send you when you receive it – this may prevent stress later!

You can also register the aircraft with the CAA and order registration letters (available from Pegasus-Mainair 01706 655134), to save time later.

Your Inspector is required to visit prior to commencing any real building to inspect your workshop and the kit. This forms the first stage inspection.

Your Inspector has to sign off several key stages of the build. Get his signature on the form at the time, just in case! He can be a very useful source of knowledge and advice, and should be your ‘mentor’ during the build. Also, a second pair of eyes and an experienced mind can often solve problems for you in an instant.

Inspectors will vary somewhat in their likes and dislikes, and so requirements may vary from what you may consider to be sensible. It is best to listen to your inspector’s views, but in case of specific queries either you or your inspector may contact Skyranger UK or the BMAA directly to discuss matters.

Please respect the stage inspections and do not present him with a fully built aircraft for the first visit! It is not his fault if you have to undo a lot of building to make right something that should have been checked in a stage inspection before continuing further. If there is a delay in having an inspection it is better to get on with building bits and pieces like wheels and wing frames than to continue adding to the main assemblies.

When your aircraft is complete and to your Inspector’s satisfaction, the completed stage inspection form is sent to the BMAA. Also required to be sent at the same time is the Engine Installation Check Sheet (either the Rotax version or the generic BMAA version for non-Rotax engines). This details tests required to ensure correct installation and set up of the engine, such as the fuel-flow test described in Section 0. Again your inspector has to witness the tests and sign the form.

The BMAA will then process the paperwork and raise a BMAA AW029 giving permission to test fly, along with a draft MAAN (Microlight Aircraft Approval Note) for
specific clearance and flight testing of your aircraft. This will require checking and returning to the BMAA for an authorisation signature to make it valid.

Initially your aircraft must be flown by a BMAA Test Pilot, or a specially authorised check pilot. He/She will fly the aircraft to the flight test schedule to ensure that your aircraft is set up and flying as it should. You can accompany them for the flight tests as observer / secretary. When the aircraft is flying satisfactorily (some trimming / adjustments may be required), then if you have suitable experience you may fly the aircraft. 5 hours of flying are required to prove reliability and debug the aircraft, before an application can be made for a full permit to fly. Whilst waiting for this to arrive you are normally permitted to fly the aircraft, continuing to obey the restrictions of the test flying clearance contained in the AW029.

If you are the first with a new engine or propeller type, or have made any major modifications to your aircraft, then 25 hours of reliability testing are usually required. If you plan any modifications then it is essential that the BMAA is informed at the beginning of the project, so that a technical investigation can be made and approval for you to go ahead can be given.

It is likely that you are keen to begin construction, and are waiting impatiently for the paperwork and your inspector to allow you to do so. However, this short delay can be used very productively to familiarise yourself with the instructions and the components, and prepare them for use.

1.2.1 UK modifications

UK modifications from the original Skyranger build standard are identified in the text by “UKMOD”. The modified parts are included as standard in your kit, and form part of the UK Skyranger build standard, and therefore do not require any additional modification paperwork or signing-off.

1.2.2 Other modifications

You may desire to install equipment such as a radio, strobes etc.. These will constitute modifications to the standard aircraft and therefore must be done in accordance with BMAA procedures. Details of the most common modifications are included in the TIL’s, and Standard Minor Mods (SMM) available on the BMAA website (www.bmaa.org). If these are done at the time of construction it will save time and money later.

For modifications not covered by the TIL’s, or SMM’s, it is probably better to complete the standard aircraft and commence flying before proceeding with the modification. This is because non-standard modifications will introduce complexity and delays into getting you aircraft flying, and so these are best done at leisure when you already have your aircraft in the air.

Note that the Skyranger succeeds in providing a capable aeroplane at an excellent price by following the principle of simplicity. Some areas may look basic at first glance, but meet the stringent requirements of BCAR Section S without adding cost and weight. Any modifications you make must also meet Section S, but it is up to you how much cost you are willing to bear and where you spend your weight. However, increased cost and less fuel carrying capacity are difficult to avoid.

Do not begin any modifications without first speaking to your inspector, the BMAA, or Flylight Airsports.
1.3  **General Assembly Notes**

Before starting to assemble anything, read the whole of this manual to get an overall impression of the order and methods of assembly. The sequence of construction is the one used to build the importer’s aircraft, and should be adhered to. If you wish to change the sequence, you may find difficulty in fitting other parts later, so read ahead carefully to determine the effects of your changes. Flylight Airsports cannot advise on, nor be responsible for, the consequences of not following the instructions, as if we have not tried something we cannot comment upon it with any experience.

1.3.1 **Unpacking**

To familiarise yourself with the kit components it is useful to unpack the kit and sort it into groups for each assembly stage, such as wing parts, fuselage parts, undercarriage etc.. Do this in conjunction with the packing list and the instruction manual to determine that you have all the required parts.

**If you cannot find a part, check under the packaging on related assemblies, and make sure you know what it is that you are looking for, as parts may be rolled up or transported inside other parts.**

Don’t forget to check all the boxes, in case you’ve put a box aside somewhere.

1.3.2 **Initial assembly with plain or wing nuts**

During initial assembly it may be helpful to use wing nuts or normal nuts rather than Nyloc nuts for test fitting pieces, or on pieces which need to be removed later to fit the coverings or other parts. Alternatively, only tighten the Nyloc nuts up to the Nyloc section until ready to apply threadlock and tighten properly.

1.3.3 **Assembly**

If in doubt about a part, or an assembly, read ahead and pay particular attention to drawings and photographs. Note that the direction of bolts (up/down, pointing forwards/backwards) may differ between drawings and photographs. Normally, the bolts will be inserted from the top or the front, unless other considerations apply, such as coverings or access.

Remember to replace any plain nuts with Nyloc nuts before final assembly, and also:

**REMEMBER TO USE LOCTITE 243 ON ALL NUTS.**

This is usually available from your local fastenings company, look them up in the Yellow Pages under “Fixings and Fasteners”, and you will never be stuck for nuts and bolts again!

Loctite should be used very sparingly. A common mistake is to overuse it. Loctite smeared over the outside of fasteners acts as a corrosive agent. Any surplus should be immediately removed with a soft cloth.

A good tip is to paint a red stripe across the nut and bolt end after final tightening. This way it will be easy to inspect and spot any nuts not finally tightened.
1.3.4 Main tools needed for assembly
Spanners: 6, 8, 10, 12, 13, 14, 17mm
Allen keys: 4, 6, 8mm
Metal saw
Drill and bits for metal
Rivet pliers
Cutting pliers
General pliers
Screwdrivers, flat and cross-head
Hammers, metal and rubber/plastic
Mouse tail file with diameter less than 6mm
Flat file
Engineers Rule
Tape measure
6mm reamer (desirable)
Wire-locking pliers (desirable)

1.3.5 Products needed for assembly
Loctite 243, to be used on all bolts
Silicon grease
Oil for general use
Oil for engine and gearbox, see engine documents
Epoxy adhesive (Araldite or similar)
Lock-wire

1.3.6 Holes
All the holes have been drilled to a high accuracy, however it may sometimes be necessary to use a round file or reamer to ease the insertion of some bolts. Be careful not to make a hole too large however, sometimes all that is required is to loosen other bolts nearby, or to apply pressure to some other part. Generally bolts should not be tightened up until all the parts in a particular sub-assembly are assembled, to avoid the common problem of the final bolt not fitting!

1.3.7 Washers
Metal washers should be used to prevent scratching of the surface as a nut is tightened.

Nylon washers, or similar plastic washers, should be used to:
   a) fill spaces between parts, such as between tubes and U-brackets
   b) avoid friction between two moving metal parts, such as the stick and its supporting bracket
   c) avoid contact between parts of different materials, especially stainless-steel and aluminium

The final point above is primarily to prevent the hard steel wearing through the soft aluminium due to vibration, rather than for electrolytic reasons, as the bolt passing through both materials will still complete the electrical connection.
1.3.8 Saddle washers
Normally they are shown on the drawings and photos.
Generally they are used between two crossed tubes or between a tube and a flat bracket.
Take care not to overtighten bolts which pass through plastic saddle washers as you may cause them to split.

1.3.9 Bolts
Important: all bolts should bear on their unthreaded lengths, not on the threaded portions.
It is also important that nuts are not screwed on so far as to become ‘threadbound’ by reaching the limit of the threaded portion. You can use an extra washer or two to adjust the effective length and prevent this where required.
Turn nuts, not bolts, when tightening, as this may damage the plating and encourage corrosion. Washers are only needed under nuts to allow them to be turned, whereas bolt heads should not be turned.
Do not over-tighten bolts, avoid deformation of tubes or brackets.

**IMPORTANT: tubes must not be visibly deformed.**

![Figure 8: bolt tightening.](image)


Every wing nut has to be fastened by a security ring.
Nyloc nuts should be used only once.
When cutting bolts short, a minimum of two threads should protrude from the nut.
Paint the cut end to prevent rusting.
Bolts subject to rotation should be drilled and locked with a split pin. Examples include stick pivot bolt, torque-tube pivot bolt, rudder link bolts.
1.3.10 Wire-locking
Certain parts require securing with lock-wire, such as engine bolts and turnbuckles. If you have not done this before, discuss how to do it with your inspector. A basic guide to wire-locking bolts and turnbuckles is included at the end of this manual.

1.3.11 Stainless-steel parts
A number of tubes have flattened steel end-fittings which may require slight “tweaks” to align them as required. This should be done carefully in a vice, with wooden jaw pieces to protect the surfaces.

Avoid bending the parts back and forth repeatedly, and avoid bending them at the hole position.

The finish on the stainless-steel parts is quite varied. If desired these parts can be polished to a shiny finish, although those positioned in the pilot’s line of sight may be covered in anti-reflection black coatings or plastic sleeving if desired. Scotchbrite pads can be used to provide a pleasing, even, cosmetic finish.

1.3.12 Coverings
Handle the coverings with care, pay attention to the risk of bolt heads, corners and reinforcements/stiffeners damaging the covering as it is put on.

Dacron coverings need care to avoid getting dirty and becoming stained. Keep your hands and tools clean and oil-free when working with or near these coverings.

You can remove most dirty marks on dacron with a sponge soaked with tepid water and a mild detergent, followed by rinsing using only tepid water.

1.3.13 Part numbering
Numbers in bold italics refer to a part number, either as shown on the relevant drawing or a universal part number with a prefix. Prefixes refer to the following:

- **tu** tube
- **tual** aluminium tube
- **tuac** steel (acier in French) tube
- **u** U-bracket
- **ual** aluminium U-bracket
- **me** metal plate piece
- **meal** aluminium metal plate piece
- **meac** steel (acier) metal plate piece
- **ca** cable, wire rope

The material-type part of the number is not always used.

During assembly follow the drawings and photographs corresponding to the text.
1.3.14 **Drilling and cutting**

When drilling holes or cutting parts be very careful to measure and mark the correct positions. Check these a second time before proceeding to cut or drill.

**The old adage of measure twice, cut once still applies!**

Otherwise, you won’t be the first to ring up to order a new bit, having chopped something too short!

If you find a part which you think is wrong, in terms of size etc., be very sure that this is so before cutting or drilling etc. to correct the problem. For instance, over-long bolts may have extra parts to be fitted later. Leave irreversible actions until the end of the build!

When drilling holes in metal, use a centre punch to prevent the drill wandering, and start with a small pilot drill working up to the required hole size.

It can be useful to use masking tape on fibreglass gel surfaces to help prevent cracking, and to reduce the risk of marking the surface if the drill should slip.

1.4 **Finish**

All Aluminium parts are supplied anodised. Do not be alarmed if some marks are present in the finish of the tubular parts, this is a result of the suspension method at the anodising plant. You may also notice areas on tubing that may appear to have fine sanding marks. This is done prior to the anodising process to polish out any small scratches. It is also not unusual to find small areas of silver paint applied at the final stage over any small remaining marks prior to leaving the factory. Some light scuff marks may be present as a result of storage and transit. This is normal. Deep scratches or dents are not acceptable – ask you inspector for advice, and refer the problem to the importer.

Aluminium plate parts may be painted to improve their cosmetic appearance if desired. Use a Scotchbrite pad or lightly sand with fine wet and dry before using a suitable aluminium primer and top coat. Ensure that all painting operations result in a thin covering that will not hide defects from inspection.

Steel components are all supplied plated and / or powder coated, for corrosion resistance. Again they may be painted for extra protection or cosmetic reasons if desired.

Further protection from corrosion can be beneficial for longevity, and to resist the ravages of operation near the sea or storage in damp hangars. Aluminium and steel parts can be treated with corrosion protection products such as the excellent ACF50. This should be squirted in all tube ends and around fittings and applied to the outside with a soft cloth. An initial thorough application before covering is recommended (Xlam or Dacron if not intended to laquer), followed by periodic repeat application.

‘Wax oil’ or similar propriety products may also be used inside tubes and around fittings.

Cowlings and spats are supplied in white gel-coat finish. These may be painted any colour using standard automotive processes. Take care to thoroughly degrease to remove mould releasing agents before commencing this process. Although the cowlings and spats are intended to be painted to match the aircraft colour scheme, typically some light sanding with 1200 grit wet and dry and polishing with T-Cut or
equivalent will result in an acceptable unpainted finish which is not unattractive with most colour schemes.

Dacron coverings may be lacquered with a special process using Automotive Polyester or Acrylic Lacquer mixed with a flex agent. Refer to the importer for more information. Advantages are stronger colours and a sealed shiny finish which allows oil etc to be wiped off without leaving marks. Disadvantages include extra weight and the loss of the ability for the coverings to be re-used in the event of removal for damage repair.
1.5 Weight

The UK prototype Skyranger in standard long wing specification with Dacron coverings, Rotax 912 and standard dash and instrument fit has been found to have an empty weight of approximately 252kg. The Swift airframe is approximately 3 Kg lighter. Options such as Xlam coverings, wheel spats, spinner, carpet, baggage hammock etc will have a weight penalty. Painting metal parts, cowlings and applying lacquer to the coverings will have a weight penalty. Additional avionics or strobes are also surprisingly heavy.

It may be necessary to make choices in these options to ensure that the weight remains inside the maximum permitted Zero Fuel weight (ZFW) for the aircraft. The ZFW will vary according to the fuel burn of the chosen engine option. Refer to the Homebuilt Aircraft Data Sheet (HADS) or the BMAA for further information on the rules regarding weight for this class of aircraft.

Weight is surprisingly cumulative and dividends will be gained by ‘thinking light’ during every stage of the build. The benefits of an aircraft kept well under the maximum permitted weight will be better performance and payload capacity.

Below is an approximate guide to the weight of specific options:

- Xlam coverings +1.5Kg
- Wheel spat kit + 4.0Kg
- Wingtip fairings + 1.5Kg
- Baggage hammock + 1.5Kg
- Carb heat (912 engines) +0.7Kg
- Heater option +2.5Kg
- 2 piece doors +0.5Kg
- Spinner +0.5Kg
- Type 2 (curved top) instrument panel and dash +0.5Kg
- Centre console kit + 1.5Kg
- Quick adjust seat kit (per seat) +0.5Kg
2 Forward Fuselage

Note: During assembly of the fuselage, hand tighten the bolts only as far as the Nyloc section. After the fuselage is complete and you are sure it is correct, you can go back and tighten all of the nuts.

If you wish plain nuts, or even better wing nuts, can be used in the initial construction, to be replaced with Nylocs when the time comes to tighten the nuts up. However, note that it is often beneficial to have the nuts loose anyway, to ease any alignment difficulties.

2.1 Tube Numbering

Refer to these drawings for tube numbers throughout the forward fuselage assembly sequence.

Figure 9; cabin lower and upper triangle tube numbering.

Figure 10; cabin viewed from port side, and rear cabin frame viewed from rear.
Figure 11; forward fuselage from front quarter.

Figure 12; forward fuselage from rear quarter.
2.2 **Lower Cabin Triangle**

2.2.1 **Orienting the main undercarriage cross-beam **\textit{tu9}.

Refer to Figure 13. The main undercarriage cross-beam \textit{tu9} is made of steel, and is fitted with a steel inner sleeve (UKMOD).

a) Flip the beam over until satisfied that the holes are in the correct positions.

\begin{quote}
The holes in the steel main undercarriage cross-beam \textit{tu9} are drilled at an angle through the beam so that the tail section of the fuselage, which attaches to the third set of holes in from the ends, tilts upwards from the beam whilst the lift-strut attachment bolts, nearest the ends, remain horizontal.
\end{quote}

![](image)

Figure 13; starboard end of \textit{tu9}, looking from above, front of aircraft to left.

2.2.2 **Fitting the sides of the lower cabin triangle to the main undercarriage cross-beam.**

Refer to Figure 13, Figure 14 and Figure 15.

a) Assemble the aluminium linking plates \textit{9} onto the pair of lower cabin triangle tubes \textit{tu12}, including the seat support brackets.

\begin{quote}
The linking plates are drilled with three 6mm holes, not at equal intervals. The centre hole is offset away from the single mounting hole. Remember the anti-crush spacers on the bolts (inside the tubes).

The middle bolts have the seat support bracket, an L-shaped piece, on their upper ends, with the upstanding part of the bracket in front of the bolt as per Figure 15 rather than Figure 13. A piece of fuel tube may be slit to fit over the support, and secured with silicone sealant, to make a better rest for the seat base later.

The bolts should pass from bottom to top (contrary to the drawing, but as per the photographs), to clear the undercarriage legs later.
\end{quote}
b) Assemble the pair of lower cabin triangle tubes *tu12* to the main undercarriage cross-beam *tu9* using the fourth set of holes inwards from the ends of *tu9*.

The front ends of the lower cabin triangle tubes *tu12* should have the cut-outs on the inside, visible in Figure 16.

Bolt spacers are not needed in the steel undercarriage tube.

The bolts should pass upwards, to clear the undercarriage legs later.
2.2.3 Fitting the front vertical to the lower cabin triangle.

Figure 16; forward end of the lower cabin triangle viewed from below and above. Note non-UKMOD nose leg lower guide.

a) Fix the lower guide 7 for the nose-leg to the lower part of the front vertical tu14, between the two U-brackets 5.

Note these U-brackets are slightly different from those used elsewhere in the kit, with the holes on the side parts further from the end (16mm from the end to the hole centre).

The front vertical tu14 has a row of three 6mm holes at its upper end (amongst others), and a row of three 8mm holes at the lower end.

UKMOD: a spacer tube is used on the U-bracket and nose leg guide securing bolt as it passes through the front vertical tu14.

UKMOD: The guide 7 has additional webs welded onto it top and bottom, Figure 17.

Figure 17; UKMOD nose leg lower guide.
Figure 18; forward end of lower cabin triangle.

Note: Stud shown may also be supplied as a bolt, and should be fitted head up.
b) With the nose-leg lower guide 7 parallel to the front vertical \( tu_{14} \), if the top or bottom webs on the guide 7 touch the front vertical tube \( tu_{14} \) in this position they should be filed back to allow around 2mm of clearance to allow for flexing.

c) Apply threadlock to the bolt securing guide 7 to the front vertical \( tu_{14} \) and tighten firmly, but take care not to distort or crush the tube.

\[
\text{This should be done at this stage as the bolt holding this bracket is not easily accessible later.}
\]

\[
\text{Whilst the spacer should prevent crushing of the tube, it is better not to rely on it. It is permissible for the spacer to remain slightly loose, as under load it will still prevent excessive deformation of the tube.}
\]

\[
\text{Do not distort the tube.}
\]

d) Mount the U-brackets 5 to the lower cabin triangle tubes \( tu_{12} \)

\[
\text{Note the use of a sleeve in the tubes.}
\]

\[
\text{The studs should be long end downwards to mount the bottom of the firewall and the front of the fuselage covering later.}
\]

\[
\text{Support the upper end of tu14 with one of the wooden seat bases while fitting it to the U-brackets.}
\]

e) Mount the steel diagonal-brace \( tu_{43} \) to the bottom of the stud through the port tube. Use thin plastic washers 26 and steel washers 25.

\[
\text{The other end of the brace will be attached to the rudder pedal mounts later. The brace may be supplied attached to the mounts, have a look under the packaging.}
\]

\[
\text{Thin plastic washers may be used to take up any slack between the tubes and U-brackets.}
\]

\[
\text{Ignore the small tube shown in the drawing as 14,,SKR.00.1.05, as this is part of the covering to be fitted later.}
\]
2.3 Upper Cabin Triangle

2.3.1 Fitting the sides of the upper cabin triangle to the upper rear cabin cross-piece.

Refer to Figure 19 and Figure 20.

a) Fix the aluminium linking-plates 2 on the upper rear cabin cross-piece tube \textit{tu7}, which links the trailing-edges of the wing.

These linking plates are drilled at one end with an 8mm hole and at the other with two 6mm holes.

The row of small holes where the rear fuselage covering will be secured should point forwards, whilst the bolts point rearwards.

The bolts will be tilted down and backwards compared to the vertical bolt holes for the cabin upper triangle and tail cone tubes, as the rear cabin frame is raked backwards.

Figure 19; starboard end of the upper rear cabin cross-piece, looking from above and behind. Note the bolt holding the trailing edge bracket should be reversed, with the nut on the outside.

Figure 20; upper rear cabin cross-piece.
Refer to Figure 19 and Figure 21.

b) Assemble the upper cabin triangle tubes **tu10** with aluminium linking-plates to the upper rear cabin cross-piece **tu7**.

*The drawing shows the lower cabin triangle tubes **tu12**, however the fittings are the same on the upper cabin triangle tubes **tu10**. Note that the tubes themselves are not the same.*

*The cut-outs at the front of the upper cabin triangle tubes **tu10** should face outwards.*

c) Fit the trimmer cable outer termination bracket to the fore-most of the bolts holding the rear of the starboard side **tu10**, shown in Figure 90.

![Diagram](image_url)

*Figure 21; rear of upper cabin triangle tube tu10.*
2.3.2 Assembling the top of the front vertical tube.
Refer to Figure 23 and Figure 24.

a) Fix the U-bracket 4 and the pair of U-brackets 6 for the leading-edges on the front vertical tube tu14.

The two U-brackets for the leading-edges should be parallel.

The bolts must point rearwards as per the drawing and photos, in order to clear parts of the wing fold kit if one is to be fitted.

UKMOD: an anti-crush spacer tube should be fitted to the bolt holding the leading edge attachment U-brackets as it passes through the front vertical tu14.

b) Mount the aileron cable pulleys.

Replace the uppermost bolt with a 75mm long plain pin from the aileron connection kit, discarding the spacer, Figure 22. This allows the use of handed connections as per Service Bulletin SKR-SB-002.

If the pin is tight, run a 6mm drill or reamer through the holes to ease the fit. Secure the pin with a nappy pin or split ring in front of the upright tube. Removal of this pin allows the aileron cables to be removed from the pulleys when de-rigging, as otherwise the modified aileron cable ends cannot pass around these pulleys.

Figure 22; replacement pin above pulleys.
c) Temporarily assemble the two upper cabin triangle tubes \textit{tu10}, linking them to the double U-bracket 4.

\textit{Don’t worry about the spacers etc. at this stage, as the tubes will not be lying flat making this difficult. Once the rear ends of the upper cabin triangle tubes are connected the front ends can be fitted properly one by one, at a later stage.}

![Figure 23; forward end of upper cabin triangle.](image)
Figure 24; forward end of upper cabin triangle.
2.4 Rear Cabin Frame

2.4.1 Preparing the rear cabin uprights.

![Figure 25; rear cabin uprights.](image)

a) Fix the steel U-brackets for the trailing-edges with the taper downwards, using an aluminium saddle washer under each, against the rear cabin uprights tu6.

The rear cabin uprights tu6 have inner sleeves at their upper end, and are not handed.

The small holes should be on the front side on the rear cabin uprights tu6 to secure the covering later.

Position the nuts on the outside, against the U-bracket, rather than the inside as shown, with two threads protruding from the nuts. This prevents the nuts fouling the upper rear cabin cross-piece tu7.

A spacer should be used on the bolt inside the tube.
b) Locate the rear cabin frame diagonals tu27 temporarily and check the clearance from the saddle washers, see Section 2.4.3.(d) Rear cabin frame bracing.

Depending on the size of the saddle washers fitted between the Steel U brackets and the TU6 uprights, it may be necessary to file the edges of the saddle washers to clear the upper ends of the rear cabin frame diagonals tu27.

c) Apply threadlock and tighten the bolts holding the trailing edge U-brackets, as they are not easily accessible later, but not so tight as to prevent rotation of the fittings by firm hand pressure.

Do not distort the tube.

2.4.2 Fitting the rear cabin uprights.
Refer to Figure 13, Figure 15, and figure 25.

a) Assemble the rear cabin uprights tu6 to the main undercarriage cross-beam tu9, using the second set of holes from the end.

Remember the bolt spacers on the two bolts at the bottom of tu6.

UKMOD: the small steel pieces 14 on figure 25 are replaced by canted aluminium U-brackets, and the bolts securing them are longer than the others. Do not tighten these bolts yet, as the brackets will require filing to clear other parts when the undercarriage is fitted.

These U-brackets are shown for identification in Figure 26. Filing to clear the undercarriage is carried out in the section on fitting the undercarriage.

Note that the brackets are handed, with the mounting hole offset in order to minimise the amount of filing which will be required later.

The bolts should all point rearwards through the main undercarriage cross-beam tu6.

Figure 26; side member attachment bracket and undercarriage leg outer clamp, starboard side.
Refer to Figure 19.

b) Lift the upper triangle into position on the rear cabin uprights \textit{tu6} and temporarily secure with an 8mm diameter bolt.

\textit{Do not worry about the spacers etc, as it is tricky to support the frame and include all the spacers without dropping them down the tubes!}

c) Secure the bolts through the rear cabin uprights \textit{tu6} and the upper cabin triangle tubes \textit{tu10} including the proper spacers etc..

\textit{This is easier now the upper cabin triangle is in place, although it is still worth leaving all the accessible bolts loose until more of the fuselage is assembled.}

\textit{Don’t forget the bolts at the front of \textit{tu10}.}

\textit{The 8mm bolts securing the rear cabin uprights \textit{tu6} are fitted with spacers and the nut must not be done up yet as there are more pieces to fit to it.}

**2.4.3 Rear cabin frame bracing.**

Refer to Figure 10, Figure 27 and Figure 29.

\textbf{Figure 27; lower and upper ends of rear cabin frame diagonals.}

a) Assemble the steel end pieces into the rear cabin frame diagonals \textit{tu27}.

\textit{The one with the 8mm hole goes at the upper end and the one with the 6mm hole goes at the lower end.}

b) Install the bolt and spacer to support the seat a short distance above the lower ends of the rear cabin frame diagonals \textit{tu27}, Figure 28, or alternatively the small bracket pieces shown in Figure 29 (kit may be supplied with either option).

\textit{These should be oriented with the supporting part towards the front of the aircraft. Note that the spacer tube is also shown on Figure 29 as well as the small bracket piece. Only one or the other is required!}
c) Stiffen the cabin back with the two rear cabin frame diagonals $tu_27$.

These are positioned behind the rear cabin uprights $tu_6$, with the seat supports pointing inwards and upwards, and their supporting part towards the front.
d) Fit the upper ends to the end of the 8mm bolts at the top of the rear cabin uprights \textit{tu6}.

\textit{It may be necessary to flatten or file the upper ends of the rear cabin frame diagonals \textit{tu27} to clear the rear cabin uprights \textit{tu6}. A steel washer may be placed between the steel end piece on the rear cabin frame diagonals \textit{tu27} and the part they rest against in order to increase the clearance between the rear cabin frame diagonals \textit{tu27} and the rear cabin uprights \textit{tu6}.}

Attach the lower ends to the rear of the main undercarriage cross-beam \textit{tu9}. Refer to figure 27 and Figure 28.

e) Assemble the rear cabin frame cross-tube \textit{tu40} and attach to the rear of the rear cabin uprights \textit{tu6}, but in front of the rear cabin frame diagonals \textit{tu27}.

\textit{The bolts should point rearwards, and pass through the upper ends of the steel drag link braces \textit{tu144} before the rear cabin uprights \textit{tu6} and finally the attachment plate on the rear cabin frame cross-tube \textit{tu40}.}

\textit{Include a thin plastic washer between the steel drag link brace and the aluminium rear cabin uprights. Don’t do up yet as these bolts are removed when fitting the coverings.}
2.4.4 Fuel tank upper mounting pieces.
Refer to Figure 31

a) Where the rear cabin frame cross-tube \textit{tu40} crosses the rear cabin frame diagonals \textit{tu27} they should be connected with a bolt, pointing backwards, Figure 31.

\textit{The holes should be 6mm diameter, if not then drill them out to 6mm. Suitable 6mm bolts are included with the wooden spreader bar pieces.}

b) Paint the wooden tank spreader pieces with fuel-proof paint.

\textit{Fuel proof paint is available from model aircraft shops, an enjoyable but potentially expensive visit!}

c) Assemble the wooden fuel tank load spreading pieces on the rear end of these bolts and tighten, but do not crush the wood excessively.

\textit{Ensure that the end of the bolt is below the level of the rear surface of the wooden pieces.}

Figure 31; fuel tank with wooden tank spreader pieces.
2.5 **Engine Supports**

2.5.1 **Rotax 912.**

![Figure 32; Rotax 912 engine mounts.](image)

![Figure 33; Rotax 912 mounting bracket.](image)
2 Forward Fuselage

Refer to Figure 32, Figure 33 and Figure 34.

a) Locate the two central cabin tubes $tu_{19}$ onto the front vertical $tu_{14}$ including the steel engine mounting bracket 98 between them. Loosely bolt in place using the washers and saddle washers, Figure 34 and Figure 163.

It is worth trial fitting the central cabin tubes to the underside of the main undercarriage cross-beam to allow the stainless steel brackets to be bent in a vice to align properly, see point (j).

Before fitting the steel engine mount it saves time later if you drill a 6mm hole near the front to fit an earth connection, see Figure.

If the pulleys are already in place on the central cabin tubes $tu_{19}$, they can be carefully removed and placed to one side for ease of handling the tubes if desired, noting the positions of the spacers etc.

The two tangs projecting from the rear of the central steel bracket which connect with the bolt through $tu_{14}$ may have a slight curve, which can prevent the washers from seating flat against them. This causes the washers to be a tight fit. If this is a problem then insert the thicker washer from the underside against the inside of the tangs and file it to fit flat against it.

The two plastic rings which form the aileron stops may be slid over the tubes at this stage (see the section on the ailerons in the Wing chapter), although they may require removal later by cutting them off if adjustment of the aileron movement is required.

b) Loosely fix the two stainless-steel upper triangulation tubes $tu_{24}$ to the top of the front vertical $tu_{14}$, including saddle washers, Figure 23 and Figure 35.
c) Loosely attach the upper and lower stainless-steel triangulation tubes to the central cabin tubes and the engine mounting brackets, including the alloy side pieces 298, Figure 39 and Figure 33.

It will be necessary to tweak the ends of the steel triangulation tubes to position them flat against the engine mount and the front vertical tube tu14.

UKMOD: the front pair of mounting bolts should have a spacer tube fitted as they pass through the two central cabin tubes tu19. This allows them to be done up reasonably tight, without ovaling the tubes. This should result in thread protruding from the Nylocs.

If no thread is showing, the washers shown under the bolt-heads may be omitted.

Check the alignment of the stainless-steel parts, and tweak as necessary to get them to all lie flat against each other. This will reduce the space they occupy along the bolts.

Note the presence of the steel diagonal brace tu310 on the port side, and a corresponding additional thick plastic washer on the starboard side.

One of the holes in tu310 may require drilling out to 8mm to fit the port mounting bolt. The other end, 6mm diameter, attaches to the starboard side of the mount, but should not be drilled until the engine is in-situ.

Figure 35; upper engine mount triangulation tubes.
d) Leave the bolt holding *tu310* slack enough to rotate it out of the way when fitting the engine.

![Figure 36; lower engine mount triangulation tubes.](image)

![Figure 37; lower engine mounts and braces.](image)

e) Loosely fix the two stainless-steel lower triangulation tubes *tu23* to the front vertical tube *tu14*, including saddle washers, Figure 37 and Figure 36.

*It may be necessary to apply some weight to the engine mount to fit the bolt holding the lower triangulation tubes *tu23* to the front vertical tube, or to use a twisted rope as shown in Figure 38.*
f) The bolts around the engine mount may now be tightened, starting with those on the mount itself before tightening the bolts holding the top and bottom ends of the triangulation tubes.

*Leave the bolt holding tu₃₁₀ loose enough to turn it.*
g) Bend the steel diagonal brace *tu310* to fit between the engine mounting plates, Figure 39.

   *This should be done to set the distance between the plates at 175mm, measured at the front set of holes where the rubber engine mounts fit. Leave drilling the starboard engine mounting plate until the engine has been fitted.*

h) Trial-fit a rubber engine mount and check the clearance between it and *tu310* held roughly in position.

   *tu310* may be filed to clear the mount, or this may be left until fitting the engine when a definite position will be found.

i) Bolt the steel end pieces into the bottom ends of the central cabin tubes *tu19*, including the plastic sleeves.

   *Orient the bolts with the nuts to the outside, to leave clearance on the inside for the flap handle detent lever.*

---

Figure 39; Rotax 912 engine mounts, front view.
j) Attach the two central cabin tubes **tu19** onto the main undercarriage cross-beam **tu9**.

Note the bolts through **tu9** should point upwards, and should pass through the stainless-steel under-seat diagonal tubes **tu42** (refer to Figure 27 and the tube numbering drawings at the start of this chapter) before passing through the central cabin tubes **tu19** and the main undercarriage cross-beam **tu9**.

The steel end pieces on the central cabin tubes **tu19** may require bending slightly to allow them to sit flat against the underside of the main undercarriage cross-beam **tu9**.

It is useful to temporarily insert the long bolt which forms the pivot for the elevator cable pulleys, as this passes through both of the central cabin tubes, Figure 108. This will ensure that the tubes remain well aligned, otherwise this bolt will prove very difficult to insert later.

k) The lower engine mounts, Figure 40, should be attached to the front vertical **tu14**, visible in Figure 37.

![Figure 40; Rotax 912 lower engine mounts.](image-url)
2.5.2 Rotax 582

a) Loosely fix the two stainless-steel upper triangulation tubes \textit{tu24} to the top of the front vertical tube \textit{tu14}, including saddle washers, Figure 23 and Figure 35.

It is worth trial fitting the central cabin tubes to the underside of the main undercarriage cross-beam to allow the stainless steel brackets to be bent in a vice to align properly, see point (g).

If the pulleys are already in place on the central cabin tubes \textit{tu19}, they can be carefully removed and placed to one side for ease of handling the tubes if desired, noting the positions of the spacers etc.

The two plastic rings which form the aileron stops may be slid over the tubes at this stage (see the section on the ailerons in the Wing chapter), although they may require removal later by cutting them off if adjustment of the aileron movement is required.

b) Position the steel engine mounting bracket \textit{800} between the central cabin tubes \textit{tu19} and the front vertical \textit{tu14}.

c) Loosely bolt the rear end of the mount in place using the washers and saddle washers.
d) Loosely fit the upper and lower stainless-steel triangulation tubes between the central cabin tubes and the steel engine mounting bracket.

e) Loosely fix the two stainless-steel lower triangulation tubes $tu_{23}$ to the front vertical tube $tu_{14}$, including saddle washers, Figure 37 and Figure 36.

   It may be necessary to apply some weight to the engine mount to fit the bolt holding the lower triangulation tubes $tu_{23}$ to the front vertical tube, or to use a twisted rope in a similar manner to that shown in Figure 38.

   It will be necessary to bend the ends of the steel triangulation tubes to position them flat against the engine mount and the front vertical tube $tu_{14}$.

f) Bolt the steel end pieces into the bottom ends of the central cabin tubes $tu_{19}$, including the plastic sleeves.

   Orient the bolts with the nuts to the outside, to leave clearance on the inside for the flap handle detent lever.

![Figure 42; Rotax 582 engine mount.](image)

  Figure 42; Rotax 582 engine mount.

g) Attach the two central cabin tubes $tu_{19}$ onto the main undercarriage cross-beam $tu_{9}$.

   The bolts through $tu_{9}$ should point upwards, and should pass through the stainless-steel under-seat diagonal tubes $tu_{42}$ (refer to Figure 27 and the tube numbering drawings at the start of this chapter) before passing through the central cabin tubes $tu_{19}$ and the main undercarriage cross-beam $tu_{9}$.

   The steel end pieces on the central cabin tubes $tu_{19}$ may require bending slightly to allow them to sit flat against the underside of the main undercarriage cross-beam $tu_{9}$.

   It is useful to temporarily insert the long bolt which forms the pivot for the elevator cable pulleys, as this passes through both of the central cabin tubes, Figure 108. This will ensure that the tubes remain well aligned, otherwise this bolt will prove very difficult to insert later.
2.5.3 Jabiru 2200

Refer to Figure 34 and Figure 43

a) Locate the two central cabin tubes $tu19$ onto the front vertical $tu14$ including the steel engine mounting bracket $98$ between them. Loosely bolt in place using the washers and saddle washers, Figure 34 and Figure 163.

*It is worth trial fitting the central cabin tubes to the underside of the main undercarriage cross-beam to allow the stainless steel brackets to be bent in a vice to align properly, see point (h).*

Before fitting the steel engine mount it saves time later if you drill a 6mm hole near the front to fit an earth connection, see Figure.

*If the pulleys are already in place on the central cabin tubes $tu19$, they can be carefully removed and placed to one side for ease of handling the tubes if desired, noting the positions of the spacers etc.*

*The two tangs projecting from the rear of the central steel bracket which connect with the bolt through $tu14$ may have a slight curve, which can prevent the washers from seating flat against them. This causes the washers to be a tight fit. If this is a problem then insert the thicker washer from the underside against the inside of the tangs and file it to fit flat against it.*

*The two plastic rings which form the aileron stops may be slid over the tubes at this stage (see the section on the ailerons in the Wing chapter), although they may require removal later by cutting them off if adjustment of the aileron movement is required.*

b) Loosely fix the two stainless-steel upper triangulation tubes $tu24$ to the top of the front vertical $tu14$, including saddle washers, Figure 23 and Figure 35.

c) Loosely attach the upper and lower stainless-steel triangulation tubes to the central cabin tubes and the engine mounting brackets, including the Jabiru engine mount.

*It will be necessary to tweak the ends of the steel triangulation tubes to position them flat against the engine mount and the front vertical tube $tu14$.*

*UKMOD: the front pair of mounting bolts should have a spacer tube fitted as they pass through the two central cabin tubes $tu19$. This allows them to be done up reasonably tight, without ovaling the tubes. This should result in thread protruding from the Nylocs.*

*If no thread is showing, the washers shown under the bolt-heads may be omitted.*

*Check the alignment of the stainless-steel parts, and tweak as necessary to get them to all lie flat against each other. This will reduce the space they occupy along the bolts.*
d) The upper piece should be positioned either side of the central cabin tubes tu19, to attach to the two forward pairs of holes.

The sequence on the forward pair of bolts is:

- Bolt head
- Mount
- Upper triangulation tube
- Lower triangulation tube
- Aluminium saddle washer
- Central cabin tube tu19
- Aluminium saddle washer
- Steel centre piece
- Washer + Nyloc nut.
The sequence on the aft pair of bolts is:

- Bolt head
- Mount
- Plastic washer(s) to fit
- Aluminium saddle washer
- Central cabin tube tu19
- Aluminium saddle washer
- Steel centre piece
- Washer + Nyloc nut.

e) Apply weight as required, or tension using a twisted rope, to locate the lower ends of the stainless-steel lower triangulation tubes on their bolt through the front vertical tu14.

f) Tighten the bolts, applying threadlock.

g) Bolt the steel end pieces into the bottom ends of the central cabin tubes tu19, including the plastic sleeves.

   Orient the bolts with the nuts to the outside, to leave clearance on the inside for the flap handle detent lever.

h) Attach the two central cabin tubes tu19 onto the main undercarriage cross-beam tu9.

   Note the bolts through tu9 should point upwards, and should pass through the stainless-steel under-seat diagonal tubes tu42 (refer to Figure 27 and the tube numbering drawings at the start of this chapter) before passing through the central cabin tubes tu19 and the main undercarriage cross-beam tu9.

   The steel end pieces on the central cabin tubes tu19 may require bending slightly to allow them to sit flat against the underside of the main undercarriage cross-beam tu9.

   It is useful to temporarily insert the long bolt which forms the pivot for the elevator cable pulleys, as this passes through both of the central cabin tubes, Figure 108. This will ensure that the tubes remain well aligned, otherwise this bolt will prove very difficult to insert later.

i) The lower engine mounts, Figure 40, should be attached to the front vertical tu14, visible in Figure 37 (Jabiru version is slightly different but fits in the same manner).

j) Tighten the nuts, applying threadlock.
2.6 **Floor**

a) Fit the seat front support tube *tu15*, above the lower cabin triangle tubes *tu12* with a pair of saddle washers per bolt between the two tubes, Figure 44.  
*Note the tapered ends of the tube taper towards the front.*

b) The forward ends of the steel under-seat diagonal tubes *tu42*, which were attached to the main undercarriage cross-beam, should be attached to the bottom of the bolts securing the seat front support tube *tu15* to the lower cabin triangle tubes *tu12* with a thin plastic washer or saddle washer between the steel tube and the aluminium tube.  
*Once fitted it is worth cutting off the protruding bolt end beneath the fuselage, to prevent it rubbing on the covering. Leave at least 1.5 threads showing, and coat the exposed end with a dab of paint to prevent rusting.*

c) Fit the four eyebolts to mount the seats.  
*The outermost tubes in the picture are fitted later, with the main undercarriage.*
d) Cut a hole in the floor for the battery box.  

    The hole is located on the centreline, approximately 1cm back from the rudder pedal mounting bar **tu18**. The hole is 15cm long by 9cm wide, Figure 45.

e) Prepare the floor as required: vinyl or thin carpet may be used, or varnish with some sugar or sand to provide grip. Keep it light.  

    It is recommended that the entire floor be lightly varnished to seal the surface and prevent absorption of moisture, oil etc. even if carpet is to be fitted.
f) Position the floor against the front of the seat front support tube \textit{tu15}.

\textit{It should butt up against the underside curve of the tube, but not actually pass beneath it, thus preventing the floor from lifting upwards along its rear edge in negative-g situations. This can be seen in Figure 47.}

![Figure 47; rear of floor against tu15.](image)

\textit{Figure 47; rear of floor against tu15.}

g) Mark through from the bottom the positions of the holes for the rudder pedal mounting bar, and drill the floor to suit.

\textit{The floor passes beneath the rudder pedal mounting bar.}

\textit{Apply the supplied self-adhesive foam strips along the tops of the tubes which the floor rests on, to prevent it rattling.}

h) To further stiffen the floor in the middle of the cockpit, fit the small piece of L-section aluminium to support the floor, see Figure 52.

\textit{This is attached by the bolts which hold the central bracing pieces, which are fitted later.}

i) Install the battery box, and secure it with four bolts with penny washers.

j) Fit the webbing strap, passing right around the box through the slots in the side of the box, with the buckle at the top.

\textit{Leave fitting the battery until later.}
2.7 Rudder Pedals

Refer to Figure 48.

a) Fit the rudder pedals orientated as shown on the drawing, before attaching the second of the two L-brackets if they are not already in place.

b) Fit the rudder pedal mounting bar *tu18* to the top of the lower cabin triangle tubes *tu12*, over the top of the floor.

c) If a floor is fitted, the saddle washers between the rudder pedal mounting bar and the lower cabin triangle tubes should be omitted.

d) Attach the rear end of the steel diagonal-brace *tu43* to the bottom of one of the bolts, including a plastic washer between the steel brace and the aluminium tube.

e) If no floor is fitted, put pieces of prop-tape on the lower cabin triangle tubes *tu12* beneath the rudder pedals to protect the tubes from abrasion from the pedals when under load.

f) Cut off any protruding ends of the rudder pedal mounting bar bolts beneath the aircraft, to prevent them rubbing on the coverings. Nut caps may also be fitted.
2.8 Control Stick Assembly

Figure 49; UK MOD control stick and torque-tube parts.

a) Attach the aileron horn to the machined ‘top hat’ with 4mm bolts.

Rivets must not be used here, as the fitting carries all the tension loads from the elevator controls. Use the bolts supplied, do not use any unknown strength bolts. Attach the top hat to the front vertical tu14 by the pivot bolt through the aileron horn, inserted from the rear.

The pivot bolt must be assembled in the following order:

- Bolt head
- Large metal washer
- Plastic washer
- Aileron horn
- Thin plastic washer and saddle washer
- Front vertical tu14
- Plastic saddle washer
- Thin plastic washer (if desired)
- Large metal washer
- Small metal washer
- Castle nut and split pin

b) This should be done up tight enough to remove all play but without discernable friction.
c) Fit the stick to the stick pivot fork with thin nylon washers either side of the stick in the stick pivot fork.

d) The pivot bolt should be done up just tight enough to remove any play but allow movement of the stick without discernable friction.

e) Rubber rings are supplied to act as elevator stops. They should be positioned on the stick so as to engage on the edge of the fork jaws,

They may be secured by glue and/or cable ties above and below them.

f) Fit the plastic torque-tube bearing into the rear pivot support.

The bearing is inserted from the front, Figure 50. Then if the forward pivot bolt were to fail, the stick would still be held in place by this bearing.

![Figure 50; torque-tube bearing.](image)

g) The stick pivot fork end should be fitted through the plastic torque-tube bearing and into the torque-tube.

Note that the plastic bearing fits over the fork end and is trapped in position by the torque-tube. This should be an easy fit with 0.5mm free play along the axis of the torque-tube. If this is tight it may be necessary to file the end of the torque-tube a little to prevent binding.

If the bearing is tight on the stick pivot piece when positioned correctly, the bearing should be abraded lightly until a smooth action is achieved.

h) The torque-tube can now be fitted onto the front pivot (attached to the aileron horn), and the rear pivot can be bolted to the central cabin tubes tu19.

Note that the rudder stop cables will be fitted between the rear pivot support and the central cabin tubes, Figure 112. This is done in section 5.5.5. Do not tighten these bolts up without the stops in place.

It may be necessary to slot the holes horizontally in the rear pivot where it attaches to the central cabin tubes tu19 to allow it to take up the exact alignment of the torque-tube, but note the rudder stop cables will have some effect on this alignment.

i) Insert and secure the bolts holding the fittings into the ends of the torque-tube.
2.9 **Finishing the Forward Fuselage**

2.9.1 **Tightening bolts**

At this stage it is permissible to tighten most of the bolts, as the cabin frame now forms a well braced structure. The exceptions are the bolts securing the lower ends of the rear verticals to the main undercarriage cross-beam, as these will be undone when fitting the undercarriage.

Check the basic alignment of the structure as you tighten the bolts, trying not to work in such a fashion as to introduce any unnecessary distortions into the structure (e.g. don’t do all the bolts up along one side and then along the other).

Some slight misalignment is inevitable in a pre-drilled structure of this type, and unless this is severe it is probably best to live with it rather than to open out too many bolt holes. A slightly asymmetrical but well defined shape is preferable to a perfectly aligned shape with sloppy bolts.

Remember to apply threadlock, and do not over tighten the bolts. The tubes should not be visibly distorted. Remember the bolts are not relying on their tightness to stay done-up, they only need to be tight enough to avoid the parts rattling against each other. The Nyloc and the Loctite are responsible for keeping the bolts done-up.

2.9.2 **Central brace**

Refer to Figure 51 and Figure 52.

a) Fit the aluminium angles 2 and 3 linking the central cabin tubes *tu19* to the seat front support tube *tu15*.

*These are not pre-drilled, as the exact hole positions are affected by the general alignment of the rest of the fuselage.*

b) Bolt the angles to the seat front support tube *tu15* first, then drill them to match the holes in the central cabin tubes *tu19*.

*To aid clearance for the rudder and elevator cables, it is recommended that (if supplied) both the lower saddle washers on the seat front support tube *tu15* are omitted. This leaves only the side ones against the central cabin tubes *tu19*.*

*An additional thin plastic washer may be fitted between the central brace and the starboard central cabin tube to increase clearance for the rudder cable.*

*The bolts should pass from the middle towards the outside, to clear the elevator cables.*
Figure 51; central bracing pieces. Note the bolts should be the other way around (as shown in photo fig 53).

Figure 52; central bracing pieces.
3 Rear Fuselage

The rear fuselage is composed of four longitudinal tubes, connected by the vertical fin at the tail end and braced by a single frame half way down. Four steel cables are used diagonally to stiffen the structure, with tension applied by turnbuckles fitted to two of the cables.

*Once again, do not tighten the nuts until the assembly has been completed.*

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**Figure 53**: Rear fuselage. Top left is top view of tailplane attachments, bottom left is rear view of half tailplane and fin.

**Figure 54**: Rear fuselage on uncovered frame.
3.1 Tail End

a) Fit the rudder post (the trailing edge of the vertical fin) between the two pairs of saddle washers shown in Figure 55 and Figure 56.

Do not forget the steel T-piece to which the horizontal stabiliser halves attach, and the extra flat washer on the lower bolt, Figure 56.

Some difficulty may be encountered with access to the various nuts in this area. A useful trick to hold a nut to the end of a spanner is a piece of sticky tape placed over the end of the spanner.

Tighten these particular nuts now using Loctite, as they are very difficult to reach later.

b) Fit the stainless-steel bracket in front of the rudder post, and attach the upper pair of longitudinal tubes tu2 as per Figure 56.

The cables are the ones without the turnbuckles. They have an end where the gap between the swages is purposely long (10cm or more). This end goes towards the lower front of the rear fuselage.

c) Attach the bottom end of the vertical fin to the bracket and longitudinal tubes tu4 in a similar manner, Figure 57.

The cables are the ones fitted with turnbuckles at their forward ends.

If you do not have suitable supports or a helper to hold the front ends of the tubes at this stage it can be helpful to mount the bracing frame (as detailed below) to the lower pair of longitudinal tubes, followed by resting the upper pair of tubes on it whilst they are attached to the bracing frame and the rudder post is attached to the lower pair of tubes.
Figure 56; rear end of upper rear fuselage tubes.

Figure 57; rear end of lower rear fuselage tubes.
3.2 Bracing Frame

a) Fit the rear fuselage bracing frame tu39 to the upper and lower rear fuselage tubes using the holes approximately mid-way down the tubes, Figure 59 and Figure 58.

Check the orientation of this frame against the drawing below, as examples have been delivered assembled the wrong way around.

Figure 58; rear fuselage bracing frame, rear to left of photograph.

Figure 59; rear fuselage bracing frame. Note orientation arrow.
3.3 Front End

a) Prepare the front ends of the lower tubes, Figure 60.

*Use a thin plastic washer between the steel cable tang and the aluminium brackets.*

*Note that the cable ends shown are from the rear end of the upper tubes, and that the cables swap sides. Therefore the cables make diagonals from upper rear starboard to lower front port tube ends, and from upper rear port to lower front starboard ends, Figure 61.*

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Figure 60; forward end of lower rear fuselage tubes.

Figure 61; crossed wires.
b) Prepare the front ends of the upper tubes, Figure 62.

*Use a thin plastic washer between the steel cable tang and the aluminium brackets.*

*Do not fit the turnbuckle centre at this stage, leave the cables slack.*

*The pin holding the front of the turnbuckles to the tang should point downwards, to maintain clearance from the tube above it. Put the turnbuckle end piece in place and rotate the tang before tighten the bolt holding the tang.*

*Note again that the cables shown are from the rear ends of the lower tubes, and that they must cross each other.*

![Figure 62; forward end of upper rear fuselage tubes.](image)

c) Mount the front ends of the upper tubes onto the upper rear cabin cross-piece *tu7* on the forward fuselage assembly.

*Note that the mounting bolt should point upwards as per Figure 63. This is used to secure the rear of the Lexan windscreen later. Check that enough bolt protrudes to fit the rear ends of the cabin uprights / windscreen support tubes *tu34* and the Lexan onto these bolts. If they are too short, a 75mm long bolt should be used.*
d) Attach the lower tubes to the main undercarriage cross-beam, Figure 64.

Figure 63; forward ends of upper tubes, rear to bottom left of photograph.

Figure 64; forward ends of lower tubes, rear to right of photograph.
3.4 Tailplane Front Mounting

a) Attach the aluminium corner section 22, Figure 65, to the upper rear fuselage tubes tu2.

This provides a mounting point for the front of the vertical stabilizer, however do not attach it to the vertical stabilizer at this time as the position will change with the application of cable tensions later.

b) Test fit the tailplane halves between this front mount and the rear mounts.

There should be a thin plastic washer at the rear, and a small saddle washer at the front. If the bolt head at the front of the tailplane contacts the front mount an additional plastic washer may be used.

c) If the fit is too tight, shown by distortion of the metal T-shaped plate which forms the rear mounts, slot the uppermost mounting holes in the aluminium corner section 22, Figure 65, towards the rear to allow the corner section to move forwards slightly.

![Figure 65; vertical and horizontal stabiliser front mounting.](image-url)
3.5 Fuel Tank Support and Flap Handle

a) Fit the fuel tank support **tu20** to the lower rear fuselage tubes **tu4**, with the U-bracket located towards the port side of the fuselage and facing upwards, Figure 66 and Figure 67.

b) The cables have a large gap between the swages which should be placed with one cable each side of the bolt head, visible in Figure 67.
c) Fit the flap handle to the U-bracket, biasing the flap handle tube as far to the starboard side of the bracket as possible, leaving only one saddle washer between the handle and the starboard side of the bracket, Figure 68.

![Figure 68; flap handle pivot.](image)

*Drill and split pin the three flap mechanism pivot bolts to guard against undoing due to rotation (if not already done).*

*Leave fitting the detent lever until the undercarriage and covering have been fitted, as it sticks out the bottom of the aircraft.*

*When it is fitted, to fit into the latching 'slot', which is formed when the pulleys are fitted, the lever must not be attached to the handle. It can then be 'hooked' into position, after which it can be bolted to the handle.*

*Do not space the detent lever away from the handle, use only one thin plastic washer or a single saddle washer between them. It is permissible to bend the lever slightly into a Z-shape to make it align with the flap handle and the latching slot.*

![Figure 69; UKMOD flap detent lever, Z-bend shown on right.](image)

d) Fit the bungee cord from the flap handle to the detent lever, visible in Figure 69. Adjust the tension as required.
This should be inserted through the hole in the flap handle, pulled out of the end, and have a knot tied in it. Pull the knot back into the handle, and attach the other end of the bungee to the detent lever, and tie another knot keeping tension in the bungee.

3.6 Not Tightening the Bolts

Do not tighten the bolts around the rear fuselage at this stage. Lightly tighten the cables to get the rear fuselage to sit approximately squarely, but the final alignment and tensioning is left until section 5.1 Tensioning the Rear Fuselage. This is to avoid building a "set" into the fuselage. If you cannot get the turnbuckles onto the cables, try propping-up the tail end.
4 Undercarriage

4.1 Wheels

All three wheels and tyres are identical, only the hubs differ between the nose wheel and the main wheels, which are fitted with brake discs.

Figure 71; wheel parts.

a) Place an inner tube inside a tyre, Figure 72.

b) Loosely place the tyre onto a wheel half with valve hole, locating the valve through the hole in the wheel half.

Figure 72; tyre and inner tube.

c) Place the other wheel half onto the first wheel half, so that the tyre and inner tube are positioned between the two wheel halves.

d) Take a hub, put a drop of thread lock into each of the six threaded holes, and position it against the wheel half opposite the valve side, Figure 73. Note that the hub has a machined face with square inside corners one side and a radiused face the other. The machined face should sit against the wheel halves. The Do not assemble with hub between wheel halves!
e) Check that the inner tube is not trapped between the wheel halves, and pass all six bolts from the valve side through their washers, both wheel halves, and into the threaded holes on the hub.

f) Tighten the bolts and inflate the tyre to 26psi. If the tyre does not slip easily into position a little squirt of neat washing up liquid around the rim can be used to make it slip more easily.

![Figure 73; placing a hub against the wheel halves.](image)

![Figure 74; a wheel minus the tyre.](image)
4.2 Main Undercarriage

4.2.1 Brake calliper attachments

a) Check that the callipers are bolted together by the correct bolt to leave the other two holes free to mount the calliper offset slightly to the rear of the undercarriage legs. See Figure 87 for the manner in which the callipers are intended to be mounted.

*It will probably be necessary to swap the bolt holding the one of the callipers together to the other hole. This will result in a handed pair of callipers.*

b) If not already done, drill an 8mm diameter hole in each undercarriage leg 18mm above the upper rear stub axle mounting holes, as shown in Figure 75 and visible in Figure 77.

*Mark carefully, and recheck before drilling.* Use a small pilot drill first, and recheck its position. Then drill out to the proper size.

Try to drill squarely. It is permissible to allow a little slop in the hole size, to allow the callipers to find their own alignment.

*Take care to make a handed pair.* The callipers and holes for them are to the rear of the undercarriage legs, and at the narrow end of the legs.

![Figure 75; hole for brake calliper mounting.](image-url)
4.2.2 Undercarriage legs

a) If spats are to be fitted, fit the mounting brackets on the lower pair of stub axle mounting bolts on the wheel side of the stub-axle flange, Figure 77.

*Use the longer bolts supplied in the spat kit. Excess bolt threads can be trimmed off.*

b) Fit the brake mounting piece to the forward upper stub axle bolt, visible in Figure 87, and tighten the stub axle bolts.
c) Fit the undercarriage legs to the main undercarriage cross-beam \( tu9 \) using a pair of U-clamps and spacer pieces per side, Figure 78.

*Use a piece of thin aluminium sheet between the top side of the inner U-brackets and \( tu9 \).*

*Make sure that the legs are on the correct sides to place the brake callipers towards the rear!*

![Figure 77; main gear inner spat mount.](image1)

![Figure 78; main gear leg mounting.](image2)

d) The outer clamp should be positioned as far outboard as possible, against or close to the plates holding the base of the rear cabin uprights \( tu6 \).

*The position of the clamps along \( tu9 \) is quite restricted due to these plates and other fittings on \( tu9 \). It may be necessary to provide a little extra clearance at the lower inside edge of the rear cabin upright tubes themselves, \( tu6 \), for the outer U-clamp. Clearance may be provided if necessary by filing the tube lower edge.*
Figure 79; outer U-clamp position.

Figure 80; side member attachment bracket and undercarriage leg outer clamp, starboard side.

e) The front outer edge of the outer U-clamp spacer piece may need filing to clear the aluminium U-bracket holding the lower fuselage side member, Figure 80.

The corner of the aluminium bracket itself may also be filed to provide the necessary clearance.

Do not tighten the clamps until the drag links have been fitted.
4.2.3 Lower fuselage side members

a) The lower fuselage side members tu16 should be positioned with the inner-sleeved part towards the rear. Slip the padded covers over the drag link upper braces, visible in figure 82.

b) Passing the bolt downwards, connect the end of the front seat support cross-piece tu15 (including a spacer tube in tu15) to the drag link upper brace tu144 (already attached to the rear cabin uprights), the middle of the lower side members tu16, and the aluminium channel section drag link end fitting.

Use thin plastic washers between the steel drag link upper brace and the aluminium tubes above and below it, in order to prevent the steel chafing the aluminium.

The bolt should be secured by one or more steel washers with the sides filed flat to fit within the channel section, and an 8mm Nyloc nut. The number of washers should be sufficient to tighten the nut without binding on the thread. The bolt should only be temporarily tightened at this stage, as it will have to be removed again to fit the covering. When it is tightened properly, do not over-tighten the bolt to the point of distorting the tubes!

Figure 81; fuselage side member tu16 and UKMOD drag link.
c) Temporarily secure the front of 

\textbf{tu16} to the underside of the rudder mounting bar \textbf{tu18}.

\textit{The floor will have to be drilled to allow the bolt to pass through it.}

![Image of side member attachment bolt, port side looking rearwards.]

\textbf{Figure 82; side member attachment bolt, port side looking rearwards.}

\begin{itemize}
\item[d)] With the side member and U-bracket in position the rear end of the side member tube must be drilled in situ.

\textit{The U-brackets are handed and should sit at an approximate angle of 45 degrees, mounted with the single rear fixing hole towards the inner side and the pair of holes in the U-bracket arms in line with the tube.}

\item[e)] Line the tube up with the bracket and mark the hole centres with a pen, and then use a centre-punch. The hole centres should be directly opposite each other on the tube, not offset to one side or another. The fit of the tubes may require a little force, depending on the fit of the rest of the aircraft and floor etc..

\item[f)] If necessary, remove the tube in order to drill it. Starting first with a 4mm bit, drill one side and then the other.

\item[g)] Then open out with a 6mm bit applying any necessary bias to adjust the centre to align with the holes in the U-bracket.

\item[h)] If not already removed, slip the tube out of the bracket and finish with an 8mm bit run through the tube only.

\item[i)] A spacer tube is inserted into the 8mm hole in the tube, which holds the sides of the bracket apart.

\textit{If necessary trim the spacer to fit between the sides of the bracket.}

\item[j)] Secure the bracket and tube with a 6mm bolt.

\textit{Do not tighten until the fuselage cover is fitted at a later stage, as the side tubes are removed again to fit the covering.}
\end{itemize}
4 Undercarriage

Figure 83; drag link end fittings.

k) Fit the drag link into the end fittings, and attach the lower end fitting to the undercarriage leg with an 8mm bolt and washers filed to fit in the channel section.

The stainless-steel drag link tubes are handed to fit and the end with the angle in one side faces forwards.

It may be necessary to file the corner off the ends of the drag link tubes a little more, to allow them to clear the base of the channel sections.

l) When the drag link tubes have been fitted, the main undercarriage U-clamps may be tightened up.
4.3 **Nose Gear**

All UK kits come as standard with a reinforcing sleeve. It may be possible to check this by looking through one of the holes, although the usually slightly visible interface between the inner and outer tubes may be obscured by the hole drilling process.

4.3.1 **Nose leg**

Refer to Figure 85.

a) If no spats are to be fitted apply grease to the inside of the nose wheel lower and upper guides. If spats are to be fitted, then leave this until the noseleg is removed to fit the spat.

This is to minimise the risk of contaminating the rubber washers with grease. It is best to leave fitting the spats until the end of the build, otherwise they are likely to suffer damage during the rest of the build (yes you will drop that hammer on it!).

b) Slide the nose leg up through the lower guide.

c) Put a large steel washer, then 7 rubber washers, then another large steel washer, onto the nose leg before sliding it up through the upper mount.

Check the number of washers supplied, you may receive an extra one or two. Use only the specified number.

It is important that the noseleg should be free to swivel in its guides with little or no perceptible friction.

If the noseleg is stiff to turn due to a slight misalignment between the upper and lower brackets try turning it around 180°.

If the nose leg still does not easily align with the upper bracket in a side-to-side manner, slide it clear of the upper bracket and gently apply a tweak to the lower mount using the nose leg itself as a lever. The aim is to achieve good alignment to remove any friction in the rudder controls. If a small tweak does not suffice, the holes securing the lower guide may be elongated slightly, parallel with the nose leg. Do not elongate them in any other direction, as this will introduce slop into the position of the lower guide.

If the noseleg is still stiff to turn, smooth any protruding weld inside the upper and lower mounts with abrasives. A small file or a flap wheel can be useful.

Do not get oil or grease onto the rubber or metal washers, as this may cause them to slip over each other in a very heavy landing. This can result in the rudder control circuit feeling stiff or binding, due to misalignment of the nose wheel steering bar.
Figure 84; nose leg – use only 7 rubber washers under steel washer, not 9 as shown.

d) Above the upper mount there should be another two large steel washers with one, two, or three rubber washers between them as required, secured by a bolt though the nose-leg.

   *If a nice fit without excessive vertical play cannot be achieved, make a sleeve to go over the top of the nose-leg, and drill it for the securing bolt at the required position to hold the nose-leg firmly in place. Ensure that the fitting is not squeezing the rubbers, as this will increase friction. A little vertical play is no problem and better than an overly tight fit.*

e) Ensure that the lower engine mount triangulation tubes passing either side of the nose leg do not touch it.

   *Use additional washers to space out the lower ends of the triangulation tubes if necessary.*

4.3.2 Nose wheel

a) Assemble the wheel on its axle *tu101* with a spacer tube *tu102* on each side.

   *The spacer tubes are cut to different lengths to centre the wheel on the axle, as the wheel is not symmetrical about the hub."

b) The axle should be attached behind and below the forks.

   *Check that the tyre does not rub against the side of the forks.*
4.3.3 Nose wheel steering

a) The nose leg fits to the steering bar between the two 90 degree brackets.

UKMOD, remove these washers and change for rubber grommets

Figure 85; Nose wheel steering.
b) Temporarily fit the two small steel pushrods $tu44$ and $tu45$ linking the steering bar to the rudder pedals. Use the middle holes at this stage.

One pushrod is longer than the other to account for the offset of the rudder pedal pivot bars.

c) UKMOD: Rubber grommets must be fitted between the box section and steering pushrods and between the pushrods and the pedals to facilitate angle change at steering extremes.

Ensure that you have fitted these, as otherwise the steering will not operate properly.

Do not tighten the bolts so much that you completely squash the rubber grommets!

d) Temporarily fit the pushrods to the rudder pedals, using the middle holes on the pushrods and the second hole from the top of the pedals. The choice of holes on the pushrods is used to set the rudder cable tension later.

e) Note the bolts used at both ends of the pushrods should be fitted with split-pins once adjustments are finalised.

Figure 86; nose wheel steering bar, with rubber grommets between pushrods and box section.
4.4 Brakes

4.4.1 Brake brackets

a) Slide the main wheels into place on the stub-axles. Use a smear of grease.

Sometimes the wheels are a tight fit on the stub axles. If the wheel cannot be slid on and off easily use some fine glasspaper and smooth the exterior of the stub axle, then assemble with a little grease.

b) Slide the callipers over the brake discs, Figure 87.

The callipers must be handed to sit behind the undercarriage legs by swapping the bolt which holds the calliper halves together to the other hole on one of the callipers.

![Figure 87; brake calliper mounting. Note bolts are usually the other way round, heads towards the wheel which keeps the threads away from the axle flange.](image1.png)

![Figure 88; spacers on brake mounts.](image2.png)
c) Bolt the callipers to the undercarriage legs, using spacers as required to centre the callipers on the discs, Figure 88.

The parts to mount the callipers are in the UKMODs kit.

Note there is movement of the wheel available, but the position used should be with the wheel as close to the undercarriage leg as possible.

If the hole through the undercarriage leg is not square, the calliper will not sit correctly. Open out the hole diameter a little to allow the calliper to find its own alignment.

d) Fix the wheels in place with lengths of aluminium tube **tu111** slipped over the axle and drilled to allow a bolt to secure them to the axle.

If spats are to be fitted, fit the 80mm extension tube from the spat kit.

### 4.4.2 Hydraulics

a) Mount the brake lever on the front of the control stick.

It will be necessary to quite considerably open out the inside of the mounting bracket to fit over the tube. A piece of glasspaper wrapped around a slightly smaller tube than the stick is a good method.

b) If the brake lever fouls the instrument panel, when this is fitted, it will be necessary to put a small stop in front of the lever to limit its forward movement.

This may be a small bolt, chopped off and screwed into place, or some other chocking device. An alternative is to saw off the end of the brake lever to remove the ‘bobble’.

c) Use Teflon tape or an appropriate thread sealant on the threads of the end fittings at the callipers and the brake lever, to help seal the fittings to the callipers and lever.

The threads on the bleed nipples themselves should not require any tape.

d) Assemble the hydraulic tubes from each brake to the splitter piece at the brake handle.

The connectors are a firm push-fit on the tubes. Give the tubes a tug to check they are seated properly.

Leave a little slack to allow for movement of the control stick.

Check that there are no high points between the brakes and the lever, as this could trap air bubbles and give a spongy feel to the brakes.
e) Bleed the brake system until the brakes become effective at preventing the plane being pushed. The lever does not have to be very hard to achieve this.

**Ensure that no brake fluid is spilt on anything.** If any is spilt, wash off with copious amounts of water. Use containers / oven trays etc. to catch any fluid dripping off the reservoir or running down the stick. Beware of spurts of fluid out of the reservoir filler or the bleed nipples.

Fill the system from the bottom up through the calliper bleed nipples, using the syringe supplied or a pressurised bottle available from Halfords or similar. This seems the most reliable method and should be used. To get firm brakes it will be necessary to push enough fluid upwards in one go to fill the calliper and the brake lines and flood fluid out of the master cylinder (use plenty of rags and a catch tray to prevent fluid spilling on the airframe). A ‘stop start’ approach will result in bubbles of air being trapped.

If the conventional approach to bleeding brakes is preferred, filling from the handle end and bleeding the callipers through their bleed nipples, it may be necessary to repeat the bleeding procedure a number of times until all the air is expelled from the system. Tricks include: putting a bleed nipple in the lever reservoir to connect another bigger reservoir whilst pumping the brakes with the lever; removing the callipers from the undercarriage legs to allow them to be moved around to clear any trapped air; replacing the reservoir Allen screw with one drilled with a hole and fitted to the end of a filler supplied with some makes of EP90 gear oil to form another reservoir. Take care that when pumping fluid through bleed nipples that you don’t draw in any air as you close them. It is best to close them before you finish your pump.

f) If the brakes leak fluid they will require more sealant tape on the threads.

It may appear that the brake callipers are leaking from the seal between the two halves. This is unlikely to be the case: typically some fluid from a leak on the bleed nipple gets between the calliper halves, and can then be seen as a line when the brakes are squeezed and the callipers flex slightly.

The hydraulic fittings on the brake callipers may need to be tightened up quite a lot to prevent weeping of fluid.

g) Run-in the brakes on the ground before flight testing commences.
5 Tail Surfaces

5.1 Tensioning the Rear Fuselage

a) Ensure that the front of the vertical fin is not yet fixed to its mount.

b) Check that the rear fuselage is sitting approximately squarely, then tighten the bolts around the rear fuselage, remembering to use threadlock.

   *If there is some “set” in the rear fuselage, get a helper to twist it straight whilst you do the bolts up. This will help when the cables are used to correct the “set” as detailed below.*

c) Lift the back end of the forward fuselage off the ground by picking up on the rear of the fuselage under the vertical stabilizer tube.

d) Fit the turnbuckles to the forward ends of the upper cables and tighten firmly.

e) Allow the fuselage to sit on the ground normally again.

f) To check the tension on the cables you can hang a 3kg weight from the centre of the cables with the turnbuckles: it should hang down around 2cm give or take 3mm or so. This is quite tight!

g) Check that the vertical stabilizer is straight up and down relative to the rest of the fuselage. If it is not you can adjust it with the turnbuckle tension, loosening one slightly whilst tightening the other a little.

   *If small adjustments of the cable tension are not sufficient to correct the symmetry of the rear fuselage, the fixed length cables can be adjusted. To do this, disconnect the slackest of the fixed length cables and give it a couple of twists in the direction of the lay of the wire (twisting it up, not untwisting it). Reconnect the cable and repeat the tensioning and adjustments of the turnbuckles.*

h) Once correctly tightened the turnbuckles should be wire-locked.

i) Check the positions of the plastic anti-chafe sleeves (made of slit fuel tubing if none are already fitted), where the cables cross and optionally where the cables pass the bracing frame, and secure with a small cable tie, Figure 89.

![Figure 89; crossed cables and cable ties.](image-url)
5.2 **Trim Tabs**

5.2.1 **Cable outers**
The action is transmitted from the trim lever via Bowden cables to the trim tab.

a) Fit the threaded cable adjusters into the forward cable outer termination bracket.

*The bracket was fitted earlier to the rear of the starboard upper cabin triangle tube. If this was missed, take care not to lose the internal spacer when fitting the bracket: push the bolt out with another bolt, then push this one out with the bolt holding the bracket.*

b) Secure the cable outers running along the starboard upper rear fuselage tube **tu2** back to the support for the forward tailplane attachment.

*White or grey insulation tape is recommended for this purpose. Whilst cable ties could be used, they will visibly distort the fabric covering.*

![Figure 90; forward end of trimmer cables.](image_url)

The rest of the cable fitment will be done after the fuselage covering is fitted.

5.2.2 **Elevator trim tab**

a) If desired, paint the elevator trim tab.

b) Tap the elevator trim tab hinge pin out about 10mm, and cut this off. Tap the pin back into place.

c) Drill a tiny hole, lockwire size, at each end of the hinge, either side of the hinge pin but not through the hinge pin.

d) Wirelock these holes, to prevent any chance of the hinge pin falling out as it wears over time.
e) Rivet the elevator trim tab hinge to the trim tab and to the lower side of the trailing edge of the starboard elevator half, Figure 91.

Elevator halves are handed, choose the correct one to place the slots for the eyebolt nuts to the underside.

Align the tapered part of the trim tab with the tapered part of the elevator.

Use between five and ten 3.2mm diameter steel rivets, rather than anything larger due to the small diameter of the trailing edge tube.

If desired, leave the actual riveting on of the tab until the elevator halves are mounted on the aircraft, to keep the tab out of the way. However, it is worth drilling all the holes at this stage.

f) Attach the rear cable bracket to the lower forward edge of the elevator leading edge spar.

Drill the 5mm diameter hole 230mm from the inboard end of the elevator leading edge.

Figure 91; trim tab and horns position.

Figure 92; trimmer rear cable bracket.
g) Attach the control horns to the trim tab.

*The horns should be towards the inboard end of the tab, with the flanges for bolting to the tab towards the outboard end.*

They should be positioned in the vicinity of the inboard end of the straight section of the tab trailing edge as per the photographs.

Align the horns to point at the rear cable bracket, and to place the cable attachment holes at the ends of the horn in line with, and erring towards slightly in front of, the trim tab hinge.

*Use two short 4mm diameter bolts, cut down to length if necessary.*
5.2.3 Rudder trim tab

a) Do not fit a rudder trim tab until the aircraft has been test-flown, as it may not require one.

*The rudder centring bungee can be used to trim the rudder instead and is normally sufficient.*

b) Cut out the fixed rudder trim tab from an off-cut of the firewall, using the pattern provided.

c) Rivet the fixed trim tab to the port side of the rudder trailing edge, Figure 94.

*Align the bulge in the tab with the upper internal cross-member inside the rudder, and fix one rivet through this member close to the front of the tab.*

*Use four more 3.2mm diameter steel rivets to secure the tab to the trailing edge.*

![Figure 94; rudder fixed trim tab.](image)

d) Similar tabs can be fitted to the ailerons or the elevator to trim the aircraft.

*Although the aircraft has an adjustable trim tab on one elevator, a fixed tab on the other may be used to provide more bias for low or high speed operation.*

*A tab on one aileron can be used to precisely trim the aircraft for single or two-person operation, or a compromise in between.*
5.3  Tailplane

5.3.1  Horizontal stabiliser

a) Select the four short cables, which brace the tail surfaces.

b) Attach the upper cables to the back of the vertical stabiliser.

   These are the cables without turnbuckles.

c) To make access to the nuts securing the tailplane halves use a soldering iron to cut-out small areas on the underside of the covering, Figure 96.

   This may be done at both the front and rear bolt locations. Those with particularly nimble fingers may not need to cut these holes.
d) Mount the horizontal stabilisers to the forward and rear mounts on the rear fuselage, Figure 97 and Figure 98.

The nut securing the front of the tailplane halves may be tight against the structure of the tailplane. If so, hold it flat against the structure and turn the bolt to tighten it up.

If it is still too close for this to work, try loosening the lacing holding the fabric as this may allow the tubes to spring out of the way.

The forward mounting should be left fairly loose to allow the halves to pivot, and will have to be undone later when the covering is fitted, so do not threadlock it at this stage.

Figure 97; horizontal stabiliser rear mountings.

Figure 98; vertical and horizontal stabiliser front mounting.
e) Attach the lower and upper cables to the back edge of the horizontal stabilisers at the outer eyebolt, Figure 95.

*The upper cables should go on first, against the tailplane trailing edge tube.*

*The turnbuckles should be at the inboard, lower ends of the lower cables, where they can be attached to the tangs already fitted to the lower rudder eyebolt. Tighten evenly by hand. The eyebolts along the trailing edge of the tailplane halves should all line up when sighted through.*

*Make sure the inner eyebolt on the horizontal stabilizer has a saddle washer and one plastic spacer behind it, to match the spacing of the outer eyebolts where the bracing cable tangs attach. There are no saddle washers used on the outer eyebolts.*

*The trick of using either sticky tape or blue-tack to hold washers and nuts to spanners is worth remembering here.*

5.3.2 Elevators

a) Slide on the stainless-steel elevator joiner to each elevator half in turn and mark the fabric around its edge.

*Use a soldering iron to trim the fabric slightly inside your marked line so that the joiner can slide on nearly fully without fouling, Figure 99. The joiner may not have to slide on quite all the way, depending on the spacing of the elevator halves, that is why you should leave a little spare material at this stage. Note: later kits are manufactured for UK mod status and will not require trimming.*

b) Put the port elevator into place and secure with a pivot-pin through each eyebolt.

*As the elevator is likely to be removed for transportation etc., the pivot-pins should not be split-pinned at this stage.*

c) Slide the joiner into place onto the port elevator and fit the starboard elevator.

d) Make sure that the joiner is fully pressed back onto the elevator tubes and fits snugly.
e) Align the elevators with the tailplane, using two wing under-surface battens or similar straight edge and some bungee cord to hold them level, Figure 100.

![Figure 100; elevator joiner and alignment.](image)

f) **Make a final check of alignment!**

g) Ensure that the holes in the elevator joiner are perpendicular to the elevator halves so that the joiner is properly centred, then using the joiner as a jig drill through the tube, Figure 101, in the following sequence.

h) Drill the top side first then underside.

i) Do one hole first in one elevator half, and pop in a bolt.

j) **Recheck the alignment!**

k) Next drill a hole on the other elevator half, and again pop in a bolt.

l) Do another, very final check of alignment and then drill the remaining two holes, one in each elevator half.

m) Secure the bolts holding the port side of the joiner.

![Figure 101; drilling the elevator halves.](image)
5.3.3 Elevator horn

a) Dry fit the elevator horn assembly, Figure 102 and Figure 103, and verify that everything aligns and fits.

*It may be necessary to file the horn a little to ensure a snug fit.*

*Note the longer, forward raked arm goes uppermost.*

![Figure 102; elevator horn.](image)

b) Now rivet the angles to the horn, using the 4 X 10mm steel rivets. Take care to have the correct orientation of angles to horn.

*It may be necessary to ease the holes slightly with a round file to fit all the rivets. It is preferable to ease a few holes a little than one hole a lot.*

![Figure 103; elevator horn braces.](image)
c) Slide the horn into place on the elevator. Verify alignment of the fixing holes, ease if necessary with 6mm reamer or drill.

d) Insert the 6mm securing bolt. This should have one washer under the nut.

e) Melt a hole through the fabric at the rear fixing hole. The horn should sit at a very slight angle inwards to the fuselage so that it aims towards the centre of the aircraft in the cabin area. The bolt should pass to the side of the elevator framework, not through it.

f) Insert the 4mm bolt and tighten it and the other bolt.

5.4  **Rudder**

5.4.1  **Rudder horn assembly**

Figure 104; rudder horn assembly.

a) Remove the fabric over the 6mm holes in the rudder leading edge spar with a soldering iron.

These holes can be felt through the covering, located 300mm from the bottom of the tube.
b) Put in place the bracing angles and secure them lightly with a 6mm diameter, 35mm plain shank length bolt through the hole.

c) Position the angles so that the rear 4mm hole is just in front of the rear tube.  
   *This will be on the trailing edge of the rudder.*

d) Burn a hole both sides of the fabric to accept the 4mm securing bolt.

e) Bolt this end together complete with the sheet U-brace between the aluminium braces and the rudder covering.

f) Temporarily tighten the 4mm rear bolt and the 6mm front bolt.

g) Take the soldering iron and burn a slot in the fabric above the braces to accept the rudder horn.
   *These slots should extend back approximately 80mm measured from the centre of the tube. Use the edge of the braces as a guide and keep the slots tight to their edges, Figure 105.*

![Figure 105; rudder horn fixing.](image)

h) Next insert the horn into position and check the alignment of the rivet holes.

i) Ease the holes with a 4mm drill or reamer if necessary to ensure all rivets fit.
   *Check for excessive tightness or looseness of the securing bolts if alignment is not easy.*
   
   *If the holes are well out, it may be necessary to file away some material from the central part of the horn, where it presses against the rudder leading edge tube, to allow it to be positioned slightly further forwards.*

j) Rivet the horn in position with 4mm diameter steel rivets.
   *Take care to ensure that the head of the rivet gun is flat in relation to the horn. If your gun is too wide the fabric will prevent this and the rivets will not seat correctly – get a narrower gun if this is the case.*

k) Finally tighten the bolts, remembering to use a small dab of threadlock. Don’t get it on the covering!
5.4.2 Mounting the rudder

a) Attach the rudder to the vertical stabilizer using the top two eyebolts on the rudder, Figure 106.

*The third, lower, eyebolt is attached to the ventral fin which will be fitted later.*

The eyebolts fitted to the rudder itself should have two steel washers under their heads to stand off the rudder a little. *Saddle washers should not be used in this position.*

![Figure 106; rudder mounting.](image)

b) Make sure that the rudder is not touching the stainless-steel elevator joiner tube when it is deflected from side to side (±25° or so) and the elevators are moved up and down (±25° or so).

*If it is touching you will need to put an additional spacer washer under the lower two eyebolts on the rudder.*

![Figure 107; lower end of rudder.](image)
5.5 **Control Cables**

5.5.1 **Cables**

a) Identify the rudder and elevator cable pairs.

*The rudder cables are longer than the elevator cables and are not fitted with turnbuckles, but are fitted with long tangs with a number of mounting holes.*

*The elevator cables are fitted with turnbuckles, one at the rear end and one in the middle, and tangs with a single mounting hole.*

*Note that the cables will have to be disconnected later when the covering is fitted, so do not bend the split-pins over at this stage.*

**WARNING!** – *when fitting the cables do not have the battery installed. Otherwise there is a risk that the cables may make a connection across the terminals and melt the cable or set fire to the aircraft!*

5.5.2 **Pulleys**

a) Assemble the single pulley onto the outside of the port central cabin tube *tu19*, Figure 108.

*If the port seat is uncomfortably close to the pulley (trial fit a seat now, or check this later) then the saddle washer between the pulley side plate and the central cabin tube may be replaced by a thin plastic washer. If still too close, and the side plates holding the pulley are the same height as those on the central pulleys, then contact Skyranger UK for shorter side plates.*

*Pass a rudder cable (either one) through the pulley with the tang with lots of holes towards the front before tightening the bolt.*

*A single metal washer should be in position on both sides of each pulley to provide a small amount of clearance from the side plate, not more than 1mm. A spacer tube should be in position on the pivot bolt to keep the side plates parallel.*

*Don’t forget the flap detent lever retaining plate and its spacer tubes mounted on both the port rudder pulley mounting bolt and the main pulleys mounting bolt, shown on the left side of the rightmost, port, central cabin tube *tu19* tube in Figure 108.*

b) Assemble the three central pulleys onto their long 6mm pivot bolt.

*Each pulley wheel sits between a supporting side plate to prevent the cables from falling off the pulley and jamming.*

*A single metal washer should be in position on both sides of each pulley to provide a small amount of clearance from the side plate, not more than 1mm.*

*Spacer tubes are used on the lower mounting bolt to keep the side plates parallel. The spacers may be filed to fit, or padded with additional washers as required.*
c) Pass the other rudder cable through the first, most starboard, pulley with the multi-hole tang to the front.

d) Pass the elevator cable with the turnbuckle at the back end through the second pulley, tang to the front.

e) Pass the short part of the other elevator cable through the third pulley, the one on the port side of the group of three pulleys, with the tang to the front. The turnbuckle will then be closer to the cockpit than the tail.

f) Tighten up the bolt passing through the pulley bearings to help hold the assembly together for the next step.

g) Carefully slide the pivot bolt out of the pulleys, keeping all the spacers etc. in place.
h) Insert the pivot bolt right through the central cabin tubes tu19 including the pulley assembly between them, using the second hole from the rear of the central cabin tubes tu19.

5.5.3 Elevator control cables

a) Attach the elevator cable passing through the port-most pulley of the three pulleys to the lower attachment hole on the port side of the joy stick.

   Use washers to take up any slack in the bolt.

b) Attach the other end to the upper attachment on the elevator control horn. The cable is routed between the horizontal stabiliser and the rear fuselage.

c) The cables route past and over the flap handle as shown in Figure 110, looking rearwards. The rudder cables are the lowest, with the elevator cables passing above them.

   The cables pass close over the top of the tubes. Check the clearance with some tension in the controls, rather than just slack.

   If the cables rub on the flap actuating rod, check that the lever is fitted as per the instructions, particularly on its position to starboard and the spacing of the detent lever. If this does not cure the problem, space the starboard spacer tube at the rear end of the flap handle out with washers and shorten the port spacer tube.

   Figure 110; cable routing past flap handle.

d) Attach the other elevator cable from the top hole on the starboard side of the joy stick, through the pulley second from the starboard side, to the lower attachment on the elevator control horn, again via a turnbuckle.

e) Check that the elevator deflects upward when you pull the stick back toward the rear of the aircraft.

f) Tension the turnbuckles by hand, keeping the elevator central when the stick is at 90° to the cabin central tubes tu19 (not vertically upwards).
g) Check the elevator moves smoothly, without binding.

*It is not necessary to have a lot of tension in the cables.*

The upper elevator horn may need a single, small tweak to align it to allow free movement of the cable between the horizontal stabiliser and the rear fuselage. **Do not bend it back and forth repeatedly!** The cable should just touch the horizontal stabiliser at full up-elevator, which should stop it touching at any other position. In case of difficulty, check that the correct pulley has been used and that the elevator horn has been fitted correctly.

h) Check that the rubber stop-rings on the joy stick act against the edges of the stick pivot, forming the control stops.

*When moving the stick forward or backward you should have around 25° of deflection in the elevator each way. If necessary, adjust this by filing the top and bottom edges of the stick pivot piece where the stop-rings bear. These are somewhat flexible, so set the deflection with some pressure on the stick.*

i) Secure the stop-rings with adhesive such as epoxy or silicone.
5.5.4 Rudder cables

a) Attach the rudder cables to the pedals, using the stainless tangs that have several adjustment holes in them.

The cable from the starboard-side pedal is the one which passes through the starboard-most pulley in the group of three. The cable from the port-side pedal passes through the separate pulley on the port side. Note the cable routing for the starboard cable shown in Figure 114.

b) Make sure the rudder cables pass over the flap handle mount and over the flap linkage at the rear end of the flap handle, Figure 110.

If they pass beneath the linkage the flap handle will push the cables downwards when you deflect the flaps.

c) Attach the rudder cables to the rudder horn, crossing them on the way back in the rear fuselage so that the starboard cable at the pedals attaches to the port rudder horn and vice-versa.

The port pulley is slightly higher than the starboard pulley, so ensure that the port rudder cable passes over the starboard rudder cable where they cross.

Figure 112; Rudder system schematic
d) Connect the rudder centring cables, a pair of steel cables connected together at one end, to the shackles on the rudder horn using the other ends, Error! Reference source not found..

e) Check to make sure that the rudder moves to the left when you push on the left pedals, and to the right when the right pedals are pushed.

f) The tension in the rudder cables is adjusted using the selection of holes in the rudder cable attachment tangs and in the nose leg steering pushrods. 

Try a range of combinations until you achieve a centred nose wheel and a centred rudder together, with just enough cable tension to remove any slack in the cables and prevent them lying against any tubes.

The resulting positions are likely to be asymmetric due to the offset in the rudder pedal pivots.

Fine adjustments can be made by twisting up the cables in the same manner as was used for tensioning the rear fuselage.

The positions of the rudder pedals fore-and-aft can be adjusted together at this stage to bias the aircraft for tall or short pilots if desired. The seats can also be adjusted to suit.

g) Connect the bungee between the centring cable single end and the middle of the rear fuselage bracing frame.

Use three loops of bungee around the tube. Offset the bungee by about 5cm (to port 912 / jabiru engines, starboard 582 engines) of the centreline. Apply a gentle amount of tension, as a starting value. This will be adjusted on flight test.

5.5.5 Rudder stops

h) Fit the rudder stop cables to the rudder pedals.

The forward ends of the cables have a tang with a bend in it. This picks up on the same bolt as the rudder cable tang, fitted outside the rudder cable tang (closest to the centreline of the aircraft), with the bend angled towards the centre of the cockpit, Figure 111..
i) The other end should be fitted to the bolts supporting the rear stick pivot, Figure 112, with the cables crossing: the cable fitted to port side pair of pedals should fit on the starboard side of the rear stick pivot, and vice-versa.

A thin nylon washer should be placed between the tang and the rear stick pivot support, and a saddle washer between the tang and the central cabin tubes. It is not essential to fit the cables between the tube and the rear stick pivot, they can be attached to the other side of the pivot piece (i.e. on the same bolt, but the other side of the metal). However, further spacers will be required to avoid pinching the two central cabin tubes together, and longer bolts may be required.

![Figure 112; rudder stop cables attached to rear stick pivot, standard and optional arrangements.](image)

j) Ensure that rigging the rudder cables and setting up the correct tension/ nose leg alignment etc. has been done before adjusting the rudder stop cables.

k) Deflect the rudder until the required maximum deflection is achieved (see current HADS), and then adjust the stop cable to match.

This is done by lightly clamping the cable with the stainless steel wire clamp supplied. Leave it loose enough so that the cable will slide through when the spare end is pulled firmly with pliers/grips. Pull the stop cable until it will go tight to match the rudder deflection. Ensure that the wire grip is slid up tight enough to push the cable ferrule against the cable thimble (the cable ‘eye’), Figure 113.
Figure 113; rudder stop cable adjustment.

l) When happy with the adjustment, clamp up the wire grip to hold the correct position.

   *Do not do this up too tight as it will distort the cable.*

m) If you have access to a Nicopress swaging tool crimp the ferrule, remove the wire clamp and trim the excess cable. Use a hot air gun to shrink the piece of heat shrink supplied in position over the ferrule and cable end for neatness.

   *If you could please return the clamps at your leisure they can be reused to keep costs to a minimum.*

n) If you do not have access to a Nicopress swaging tool then remove the stop cables, send them back to us and we will crimp them for you.

   *Leave the clamps in position so we will know where to crimp them!*

o) The bolt securing the rear tang can be done up tight, but do not crush the tube.

p) The bolt on the pedal end should be loose enough to allow rotation as the pedal is deflected.

q) Secure the middle of the stop cables with a short length of light Bungee looped over the control stick torque-tube just out of sight under the instrument panel, to pull the cables up and prevent sag towards the battery.
5.5.6 Rubbing cables

a) Check both the rudder and elevator cables to make sure they are not rubbing on any tubes.

*Apply some typical tension to the cables, such as feet against the rudder pedals, as this will give a better indication of any problem areas.*

b) Fine adjustments to the pulley positions can be made. The pulleys have to be carefully shimmed with thin washers between the starboard central cabin tube \textit{tu19} and the first pulley plate to ensure that the rudder cable just avoids rubbing on the tube where it runs from the pedal to the pulley, Figure 114.

1mm washer thickness on the starboard side is a good starting point, filing the same off the port-most spacer tube to maintain the \textit{tu19} spacing.

The cable should not quite touch the tube with weight on the rudder pedals. If it is too close for comfort a piece of prop tape can be placed on the tube to act as a fairlead. If it touches the starboard central cabin brace piece this may be shimmed out with plastic washers between it and the \textit{tu19} tube, up to 3mm if necessary. This limit is due to the elevator cable rubbing the central brace at full left aileron.

Any shimming of the pulleys must not be over-done or the elevator cable on the lower end of the stick will rub on the central cabin brace, attached to the port central cabin tube \textit{tu19}, on full right aileron. Wait until the aileron movements are set up later before worrying too much, you may have to adjust the stops to reduce the movement to the correct amount.

Adjustment of the cables and the pulleys will require some fiddling to achieve nice clean cable runs which do not rub, so don’t tighten the bolts up until this is achieved.

![Figure 114; starboard rudder cable routing past central braces.](image-url)
c) Pieces of prop-tape or off-cuts of Lexan from the screen can be used to provide additional protection to the tubes if the cables only rattle against the tubes with vibration.

*They should not be relied on if the cables apply any constant pressure to any tubes they pass over.*

*The brace in the middle of the rear fuselage is a good place to apply such protection.*

d) With the controls centred and the cables properly tensioned, including foot weight on the pedals, the elevator cables will be close to, but not touching, the rudder cables, and there should be 5mm or more between the rudder cables where they cross. With the rudder deflected the rudder cables may touch one another where they cross, but this is acceptable.
6 Co\verb|vering| the Fuselage

Do not cover the fuselage until it has been inspected!

See the inspection schedule in your BMAA paperwork.

Important: Before covering the fuselage, make sure the cables bracing the rear fuselage have been tightened and the turnbuckles have been safety wired.

6.1 Covering

![Figure 115; covering the fuselage.](image)

a) Apply a layer of clear, thin, lightweight self-adhesive plastic film, such as Fablon, to the leading and trailing edge tubes and wing tip tubes where they touch the covering.

*Do not skip this step!* This prevents vibration from abrading the anodising, which can then cause unsightly stains visible through the covering.

To save weight, just apply the film where the cloth can touch the tubes. If desired to increase resistance to corrosion it may be applied to the whole circumference of every tube, which will protect these difficult to clean areas.

*Do not use thick, heavy tape, such as prop tape or gaffer tape, as this adds too much weight, is too grippy, and can look horrible!*

b) Disconnect the rudder and elevator cables at the control surfaces.

c) The flap detent lever and the flap lever itself will need to be moved out of the way whilst the covering is put on, as the lever will bear on the covering at its rear end, and the detent lever needs to have a hole cut for it in the fabric when it is in place and tensioned.

d) Lay the covering over the top of the fuselage.
e) Unbolt the front mounting bolts on the horizontal stabiliser, and make sure the mounts to attach the horizontal stabilizer are sticking through the holes in the fabric. Reattach the horizontal stabiliser.

   Alternatively remove it entirely for now.

f) Only loosely lace the string through the holes in the rear part of the fuselage covering, just behind the vertical tube of the vertical stabilizer, Figure 116.

   **Do not apply any tension yet!**

   Lacing the covering is best done with a single string (rather than two strings shoelace-style) in a simple zig-zag pattern, Figure 121. Settle on a consistent pattern to make the job look neat: out of one hole, into the next is simple and effective.

g) Insert the long straight batten on the top of the fuselage.

h) Insert the side fuselage battens.

   Do not slide the batten too far back: the plastic fitting at the front of the batten should sit against the outside of the rear cabin uprights to maintain a smooth curve in the rear fuselage covering.

i) Rivet or use self-tapping screws to secure the covering in place to the front of the rear cabin uprights.

j) Slip the seat belt shoulder harnesses over the top cabin cross-tube, Figure 117, and then rivet or self-tap the top fabric in place.

   Use at least 4 rivets along the top cabin cross-tube. Additional holes should be melted in the covering, through the reinforcing strip, if required. The two holes already in the covering do not usually line up with any of the holes in the tube, and may be ignored or the tube drilled to match them as desired.
k) Remove the lower fuselage side members *tu16*, insert them into the pockets in the covering, and reattach them to the frame, Figure 118.

l) Insert the battens into the covering below the fuselage.

   *Two run fore-and-aft, with a third crossing below the front of the cockpit.*

m) Lace the string from the front without tightening it at this point. Lace at least 3 feet of the front of the fuselage at this time, Figure 119.

   *Make sure the covering is not caught on any protruding bolts or fittings as it is tensioned.*
n) Stretch the front lower batten over the bolts sticking down under the front of the fuselage. Use screwdriver to pry the batten over the bolts, Figure 120. The front ends of the other two battens should clip onto this batten, through holes on the inside only.

Ensure the covering is not caught on the undercarriage legs or trapped by the drag link attachment brackets.

The holes for the bolts may need slotting laterally to allow the covering to pass over them and then to be tightened up. The coverings may be tightened up somewhat at the front before they are prised over these bolts.

If the alignment of the holes for the lacing falls out of step, causing the two sides to be pulled in a distorted manner, then either miss a hole or melt a new hole with a soldering iron to re-establish the alignment.

The seam located just behind the main undercarriage cross-beam tu9 is a good guide to the alignment between the two sides of the covering. If they are not well aligned wrinkles will result!
o) Tighten the rear part of the fuselage just behind the vertical tube of the vertical stabilizer.

This is the rear part of the fuselage that you already laced.

Make sure the covering is not caught on any protruding bolts or fittings as it is tensioned. Adjust the coverings until the holes for the bolts line up with the bolts.

It may be necessary to make small “ramps” out of bits of plastic or similar to ease the fabric over the bolts securing the lower parts of the rear fuselage brace.

Work the lacing to pull the fuselage covering rearwards. This will require a few repeat tensionings. Failure to do this enough will result in vertical wrinkles down the fuselage sides when the main lacing is tightened under the fuselage.

Figure 121; tighten the lacing.

p) Lace the rest of the fuselage starting from the rear and tightening as you move to the front, Figure 121.

It can be useful to snug-up the covering a little by attaching cable ties through the lacing holes every foot or so before starting to lace properly.

Poke the rudder, elevator and trimmer cables loosely through their holes in the fabric whilst you can still reach them. The trimmer outer cables should pass out through the hole for the tailplane forward mounts.

q) Tighten the entire fuselage up several times to make sure it is very tight.

Use the Velcro gap seal as a guide to the final position of the covering.

It looks impossible at first, but work steadily and it will get there!

The string may seem too short, but as you tighten the covering it magically gets longer!

r) After the covering has been left to settle for a few days, any small wrinkles left in the fuselage can be taken out, carefully, with a heat gun. If there are large
wrinkles, there is something wrong and you need to examine the fuselage very carefully to find the problem.

s) It will be necessary to cut new the slots in the fabric for the rudder and elevator cables using a soldering iron, to allow for the UKMOD elevator control horn.

*The elevator cable slots are located 7cm forwards of the standard ones. The upper elevator cable slot is positioned almost between the tailplane half and the fuselage. The cable should just touch the tailplane half at full up-elevator.*

*The rudder cable slots are located 9cm forwards of the standard ones.*

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Figure 122; cable exits.

t) Remount the cables for rudder and elevator. Secure them permanently at this time, unless they are to be removed for transportation.

u) Melt a hole in the fabric for the flap detent lever to pass out of the bottom of the fuselage between the seats. Do not worry that the flap lever itself touches the fabric of the rear fuselage, as this will alter when the fuel tanks are installed.

v) Secure the front of the vertical fin to its mount with spacers to prevent pre-stressing the fin.
6.2 Ventral Fin

![Image of plane with ventral fin]

**Figure 123; ventral fin.**

a) Offer up the ventral fin alongside the rudder post to determine the point where the front mounting tube will pass through the lacing holding the fuselage covering together.

*The aim is to eventually fit the fin tightly against the fuselage underside.*

b) Cut a slit in the Velcro flap which covers the fuselage lacing to allow fin tube to pass through the fabric. Push the tube roughly into position, Figure 125.

c) Slide the rear mount into the base of the vertical tube supporting the rudder.

*The ventral fin has an eyebolt to match the one on the rudder. Turn these with the slot vertical to allow them to match up, then rotate them back to the horizontal to allow the rudder to pivot.*

*Ensure that the ventral fin is pushed snugly against the fuselage covering.*

![Image of ventral fin rear mounting]

**Figure 124; ventral fin rear mounting.**

d) Use a pair of 4mm steel pop rivets, one each side, to secure the fin, Figure 124.
e) Position the front tube of the ventral fin against the lower cross-piece of the rear fuselage brace.

    *Again ensure that the ventral fin is pushed snugly against the fuselage covering.*

    *Spacer washers may be used between the fin and the fuselage brace.*

f) Drill a 6mm hole through the fin tube and the centre of tube tu39c, angled to pass through the ventral fin tube at 90°.

    *The ventral fin tube curves almost vertically upwards, requiring a horizontal hole.*

![Figure 125; ventral fin front mounting.](image)

    g) Secure the front of the fin with a bolt, Figure 125, using spacer washers if required.

h) Check that all the rudder hinges align and that the rudder will move freely with no residual friction. If friction is present it may be necessary to align the hinges by adjusting the spacers where the lower hinge attaches to the Ventral fin, or in the case of vertical misalignment, filing the holes in the fin tube where the eyebolts fix.
6.3 Trimmer

6.3.1 Trimmer cables

a) Pass the trimmer cable outers through the hole in the covering at the starboard tailplane forward attachment.

b) Cable tie the outers to the horizontal stabiliser lacing, allowing enough slack for the elevator movement and keeping a smooth curve, Figure 126.

\[\text{Figure 126; trim tab cables.}\]

c) Determine which cable outer is the innermost one at the cabin end. This one must be the outermost one at the elevator end.

\textit{Trial fit a cable if necessary to work this out.}

d) To hold the cable ends into their thimbles on the rear cable bracket on the elevator leading edge, cover the cable ends and their thimbles with a piece of heat shrink tubing over each cable/thimble combination.

\textit{Take care not to melt the coverings! Direct the heat away from them, and check they don’t get hot.}

\[\text{Figure 127; aft end of trimmer cables.}\]
e) Melt a hole in the upper surface of the elevator fabric for the upper cable, 230mm forwards of the trailing edge and 130mm away from the tapered edge of the elevator, both distances measured at 90° to the respective edge, Figure 128.

![Figure 128; position of hole in top elevator surface.](image)

f) Melt a hole in the lower surface of the elevator fabric for the upper cable, 140mm rearwards of the centre of the leading edge and 170mm away from the tapered edge of the elevator, both distances measured at 90° to the respective edge.

![Figure 129; position of hole in lower elevator surface.](image)

g) Attach the loops at the end of the trimmer cables to the trim tab control horn with bolts and plastic spacer pieces.

*The cables go on the inboard side of the horn.*

*The plastic washer part with the seat for the cable should go on the side of the cable away from the horn. The other plastic washer is only needed if the cable interferes with the horn.*
Figure 130; cable attachment on trim tab horn.

h) Thread the upper cable through the elevator coverings and then into the outboard-most of the cable outers, and up to the cabin.

i) Thread the lower cable into the inboard cable outer, and up to the cabin.

6.3.2 Trim lever

a) If not already done at the cabin assembly stage, a 6mm hole must be drilled for the lever 350mm rearwards from the centre of the forward fixing bolt for the starboard side \textit{tu10}.

\textit{This hole should be vertical in relation to the cabin structure and perpendicular to the tube. To do this, use a straight edge across the tops and bottoms of the upper cabin triangle tubes to mark the hole positions onto the top and bottom of the tubes. Measure the location for the top hole and use a piece of paper wrapped squarely around the tube to mark the position of the bottom hole.}

b) If the wing fold kit is to be fitted, slip a 25cm length of heat-shrink tube over each of the exposed inner cables before connecting them to the trim lever pulley wheel.

c) Loosen the cable adjusters to almost fully slack and thread the cables through the hole in the pulley wheel.

\textit{The hole in the pulley wheel may need opening out to 5 or 6mm to get the wires through, depending upon your patience and dexterity!}
d) Fit the pulley wheel and trim lever onto their pivot bolt.

   The lever points to port, and is held on to the pulley with a short steel rivet or screw.

   Wrap the cables in opposite directions around the pulley wheel so that each cable runs from the hole positioned towards the rear, around the front of the pulley, then back to the cable adjusters.

   The trimmer lever is bent down at its end, and this provides a full deflection stop as it touches tube \textbf{tu10} at either extreme.

   The sequence along the pivot bolt, inserted from the bottom, is bolt-head, metal washer, saddle washer, \textbf{tu10}, saddle washer, thin plastic washer, trimmer handle, trimmer wheel, thin plastic washer, steel washer, nut, lock nut, and split-ring.

e) Adjust the trim lever friction with the first nut, and lock it with the second nut.

   Movement should be smooth, but tight enough to prevent the lever slipping due to the trim tab loads. This can be checked on flight test.

f) Adjust the neutral position to give the correct movement.

   With the trimmer lever at \(90^\circ\) to the upper cabin triangle tube upon which it is mounted, the tab should be level with the lower surface of the elevator.

g) Join the cable ends together with a solderless nipple, tightening the screw firmly.

h) Adjust the cable tension to achieve a smooth, slop-free action.

i) **Ensure that the trimmer works in the correct sense!** Trim lever forwards, trim tab deflects upwards, pushes elevator downwards, tail goes up, nose goes down.
6.3.3 Fuselage  transverse batten

A batten is fitted inside the fuselage pushing outwards on the fuselage side battens to produce a curve in the fuselage sides.

a) Fit the batten brackets in the fuselage side battens so that its central spigot is 405mm along the battens measured from the rear face of the rear cabin uprights TU6.

Drill and fix with 2 x 4mm aluminium rivets. Take care when drilling the battens as it is easy to slip off and make an annoying small hole in the covering!

b) With the brackets in position fit the batten.

Insert diagonally over a spigot on one bracket. Push sideways to spring the side batten outwards and spring it into position over the spigot on the other bracket.

Transverse batten and curve produced in side of fuselage
7 Engine Installation
Note that the engine is LIVE until the magneto wires are grounded.

7.1 Rotax 912

7.1.1 Preparation

a) Find a clean area to work on the engine, and then give it an even better clean: you do not want any dust or swarf etc. to get into your engine.

b) Read the instructions which came with the engine for details of installation requirements, and for maintenance and operating procedures.

c) Remove the carburettors and air filters by loosening the screw clamping the carburettors into the rubber mounts and sliding them out. Cover the exposed holes with tape or similar.

When reinstalling the carburettors the rubbers should be degreased to remove any oil, and the clamps tightened as specified in the engine instructions.

d) In order to clear the engine mounts, undo the bolt holding the cable clamp and the rear CDI bracket where it attaches to the engine.

Be careful not to let the screw or washers fall into the magnets around the magneto area.

e) Discard the cable clamp and the spacer tube below the rubber part of the CDI mounting.

If the cable clamp is used the cables will be crushed by the engine mount.

f) Shorten the thread on the rubber bobbin by the length of the spacer tube.

g) Replace the L-bracket above the rubber part of the rear CDI mounting with the supplied longer version, Figure 132.

Figure 132; replacement CDI mounting bracket.
h) The mount for the CDI should be put back in place, omitting the cable clamp and the spacer tube as already instructed, and the screw carefully tightened up.

   Leave the bolt securing the top of the mount loose, as it will need to be removed later when mounting the engine.

i) The water pump inlet on the bottom rear of the engine must be turned so that it points to the lower starboard side of the engine, see the engine instructions for the procedure.

   Take care not to lose the O-ring seal and note the torque value of 10Nm (1kgm, 7ftlb) for the fixing screws.

j) Remove the upper rear case bolt located above the starter.

   This bolt will be replaced with a 10mm x 140mm Allen head machine bolt when the engine is fitted.

k) The upper port mounting bolt will not clear the cylinder head fins. The fins must be trimmed with a file, a small Dremmel grinding tool, or similar method.

l) Trial fit the bolt to make sure you have trimmed enough off, including the rubber mount and washers. Ensure an easy fit, to eliminate any risk of cross-threading the bolt.

   ![Figure 133; upper port mounting bolt.](image)

m) Drill a small hole for lock-wire in the heads of all four 10mm diameter engine mounting bolts.

   Use a new, good quality bit, drill slowly, and lubricate with 3-in-1 oil.

n) Push the rubber mounts firmly into their holes in the engine mounts, and secure with adhesive such as epoxy or silicone.
o) The stainless-steel diagonal brace *tu310* will be fixed to the starboard engine mount after the engine is in place. However, as it is difficult to drill in situ it may be drilled now if desired.

To do this the spacing between the inner edges of the engine mounting plates must be held at 175mm at the position of the rubber mounts. Check that the mount is symmetrical, then position *tu310* and drill a fixing hole through the starboard mounting plate. Do not secure it yet. Some fiddling may still be required later.

Check that *tu310* clears the rubber engine mounts, file the end of *tu310* if necessary.

p) Swing the stainless-steel diagonal brace *tu310* up out of the way.

### 7.1.2 Mounting

a) Position the engine on the Skyranger making sure you do not bump the CDI pickups located on top of the flywheel.

![Figure 134: engine mounts.](image)

Support the engine on a bench, such as a workmate, chock it up to the correct height, and offer the fuselage up to it. An engine hoist (which can be hired from your local hire shop), or some other method of lifting the engine may be used as an alternative.

Be careful how you support the engine, do not let its weight bear on any of its many ancillary parts such as the spark plugs, filters etc.

**Warning: do not let the engine tip forwards whilst connecting the upper engine mounts to the mounting plates as damage will occur to the rear of the engine.**

b) Fix the upper starboard rubber engine mount between the two penny washers with the long 140mm bolt.
c) Fix the upper port rubber engine mount between the two washers with a short 60mm bolt.

d) Fix the lower starboard rubber engine mount between the two washers with a short 60mm bolt.

e) Fix the lower port rubber engine mount between the two washers with a short 60mm bolt.

f) Tighten the bolts to a torque of 38Nm (3.8kgm, 27ftlb).
g) Check that the engine mount is square, then fit the front end of the stainless-steel diagonal brace tu310 to the starboard engine mounting plate by drilling a hole for a 6mm diameter bolt.

   *It will be necessary to undo the two rear mounts on the ignition unit to allow the brace to pivot past it.*

   *It may also be necessary to remove the starboard intake manifold to drill the hole. Check the engine instructions, and remember to cover the all holes before drilling and scattering swarf around. When refitting the manifold, use a torque setting of 10Nm (1kgm, 7ftlb) on the 6mm diameter bolts.*

   *The hole position will require careful marking, as you will probably have to drill from the opposite side from the brace.*

   *If necessary file the end of tu310 to clear the rubber engine mount.*

h) Wire-lock the engine mounting bolts.
7.2 Rotax 582

The Rotax 582 engine is mounted in the inverted position, suspended from the engine mount by 4 rubber mounts and a pair of intermediate plates which also support the exhaust.

7.2.1 Preparation

a) The gearbox should be rotated so that the propeller axis is above the crankcase of the inverted engine.

First remove the cover from the gearbox, complete with the propeller flange, taking care not to damage the gasket.

Then undo and remove all of the gearbox mounting bolts, some of which are on the outside of the gearbox, some on the inside.

Rotate the gearbox through 180°.

Reassemble the gearbox, taking care that the lower gear in the gearbox is correctly meshed before refitting the cover.

The torque setting for the gearbox bolts is 24Nm and for the cover bolts is 10Nm. No threadlock is required.

Remember to fill the gearbox with the oil specified in the engine manual before operation.

b) Reposition the breather cap to the top of the gearbox.

c) The electric starter must be mounted at the magneto end of the engine, on the starboard side.

The crankcase will need to be cut away as per Figure 138, as the starter needs to be mounted in the 3 O’clock position rather than any of the standard positions.

Take care to contain any swarf. Do not cut through any of the internal components!

Remember the engine is going to be inverted, so cut away the correct side, see Figure 197.

d) Remove the rotary intake valve reservoir from the engine.
e) Undo the pipes from the rotary valve reservoir and swap them over.

*Reposition the reservoir above the inverted engine, Figure.*

f) Undo the pipes from the engine and swap them over.

*The reservoir will be mounted properly later, but for now temporarily tie it up out of the way.*

g) Drill out the 5mm exhaust mounting hole in the intermediate engine mounting plate to 6mm.

h) Drill the heads of the M10x55 hex-head engine mounting bolts for lockwiring.

*Cap-heads are too deep to fit between the mounting plates and the mount itself.*

i) Fit the intermediate plates to the engine using the M10x55mm bolts, large steel washers above the plates, and the 28mm long spacer tubes between the plates and the engine, Figure 41 and Figure 144.

*Ensure that the exhaust mounting holes in the intermediate plates are on the exhaust side of the engine.*

*Tighten the bolts to a torque of 38Nm (3.8kgm, 27ftlb).*

j) Lockwire the bolt heads together.

![Figure 139; 582 engine mounting.](image-url)
7.2.2 Mounting

a) Position the engine on the Skyranger.

Support the engine on a bench, such as a workmate, chock it up to the correct height, and offer the fuselage up to it. An engine hoist (which can be hired from your local hire shop), or some other method of lifting the engine may be used as an alternative.

b) Insert the rubber vibration mounts into their large holes in the intermediate plates, and Figure 139.

c) Fit the M10x55 mounting bolts from the top down.

Use a small washer beneath the bolt head.
Use large penny washers on both sides of the rubber mounts.
Secure with a Nyloc nut and Loctite.
7.3 Jabiru 2200

a) Remove the engine from its shipping box.

To get the lid off undo the 4 screws on the sides, not the large number of screws on the top.

The engine sits upside down on a framework. Remove the screws holding this framework into the box.

Tape a piece of wood to the sump ready for the engine to rest on, otherwise the exhaust stubs may touch the ground.

Get a friend to help to lift the engine out of the box and place it upright on the bench.

b) Fit the ring shaped pieces of the standard Jabiru rubber mounts to the upper mounts on the aircraft, and fit the other, larger part of the standard Jabiru rubber mounts to the lower engine mounts on the aircraft.

The drawings in the Jabiru manuals vary on this arrangement, but the text describes this arrangement. If the top mounts are the other way around the front half of the mount tends to get squeezed out by the engine thrust, whereas with this arrangement the central part passing through the engine mount hole prevents this happening.

c) Fit the engine to the mount, Figure 140.

Support the engine on a bench, such as a workmate, chock it up to the correct height, and offer the fuselage up to it. An engine hoist (which can be hired from your local hire shop), or some other method of lifting the engine may be used as an alternative.

Be careful how you support the engine, do not let its weight bear on any of its many ancillary parts such as the spark plugs, filters, exhausts etc.

d) Fit the other rubber mount parts followed by large steel penny washers between the rubber parts and the securing nuts.

Discard the internal spacers supplied by Jabiru, they are not required with this design of mount.

e) Check that the flattened parts of the lower engine mounts lie flat against the saddle washers on the front vertical tu14.

If they do not then support the engine and remove them, and carefully tweak them to get them to lie flat.

f) Remove the support from beneath the engine.

g) Tighten the castellated nuts until they reach the end of their thread, then back off if necessary to secure with large split pins.
Figure 140; Jabiru engine mountings.
8 Wings

The wings are built at this stage to allow them to be fitted to the fuselage to permit accurate positioning of the parts supporting the windscreen. Use these instructions for both long and short (Swift) wing versions. Remember to make a handed pair of wings!

8.1 Wing Frame

Figure 141; overview of wing structure. Ignore the cable numbers.

a) Set the leading edge tube **tu49** and the trailing edge tube **tu50** across two supports at a comfortable working height, or lay a piece of carpet or similar on the floor to work on.

b) Tighten the fittings already attached to the tubes except for the aileron eyebolts (the outer 3 eyebolts) as per the rest of this section.

   Remember to include the leading-edge tip extension tubes. These may need to be fitted first, if they are not already in place (N/A for Swift version).

   **Important:** Do not over-tighten the bolts, and remember the Loctite! You should not be able to see any deformation of the tubes when you have finished tightening the bolts. If you can see any oval-ing of the tubes, you have tightened them too much.

   The saddle washers shown in Figure 155 over which the tensioning tube fits often foul the edge of the rear spar attachment bracket on the fuselage. It is worth filing 2-3mm off the side closest to the wing root before the saddle washer is fitted to the spar.

c) Join the leading and trailing edge tubes with the oval tube **tu37** at the tip, Figs 142,143,144.
Shortwing (Swift) version does not have this extension sleeve, SKR 49

Figure 142: Front of tip

Figure 142: rear of tip.
d) Use a round *tu37* tube to join the leading and trailing edges at the jury strut location, Figure 146, Figure 147, Figure 144 and Figure 145.

*The orientation of the bracket that holds the jury struts should be long side downwards and towards the tip, Figure 145.*

*The orientation of the bolts should be head downwards, to maximise clearance from the jury struts when they are fitted at the very end of this manual. They must not be fitted sooner, as their length depends upon the exact alignment and tension of the airframe.*

*Note: The Aerofoil section jury strut option (Skyranger Swift) uses a different upper mounting, replacing the bolt and L bracket with an eyebolt.*
Figure 146; front jury strut attachment.

Figure 147; rear jury strut attachment.
e) Rivet the small aluminium strips, located on the top of the tu37 tube attachments at the tip and the jury strut locations, onto the top of the leading edge tube, pointing towards the wing root.

*Use 4mm aluminium rivets. These plates hold the tubes from turning.*

*Check that the jury strut attachments are vertically downwards, and that the flattened part of the tip tube is approximately horizontal, as per the drawings.*

d) Use another round tu37 tube to join the leading and trailing edges at the lift strut location, , Figure 149, Figure 151 and Figure 148.

*Don’t forget to attach the bracing cables at the lift strut ends: the one with the turnbuckle to the trailing edge, using the end without the turnbuckle; and the one without the turnbuckle to the leading edge.*

*Note the altered arrangement of the aileron pulleys, Figure 149. A spacer tube has been incorporated between the top and bottom parts of the U-bracket, with the lower pulley bracket held between the spacer and the upper part of the U-bracket. The upper pulley sits on top of the U-bracket, with a thin plastic washer between it and the bracket.*

*Leave the bolt securing the pulleys loose at this stage, to allow the aileron cables to be passed through later.*

![Figure 148; lift strut attachments.](image)

![Figure 149; UKMOD aileron pulleys.](image)
Figure 150; front lift strut attachment. And UK MOD pulleys

(The bolts holding the pulleys and the tu37 should point upwards to avoid pressing against the coverings. Alternatively they may point downwards, but then nutcaps must be used to protect the coverings from the protruding bolt ends.)
Figure 151; rear lift strut attachment.

Attach the bracing cable without a turnbuckle to the fuselage end of the trailing edge tube,

Refer to figure 153 and Figure 154.

g) Attach the bracing cable with the turnbuckle to the fuselage end of the leading edge tube, with the turnbuckle at the fuselage end.

Make sure that the cables cross and run over tube tu37. The cable with the turnbuckle must be over the other cable. If the sleeving on the cables is not in the correct location it may be slid along the cable by heating it first with a heatgun. If this does not work, protect the tube where the cables cross with some prop tape.

Do not tighten the turnbuckle yet, as the compression tubes are not yet fitted.

The split pins can be secured now, but do not wirelock the turnbuckle until the covering has been fitted.

To protect the coverings the bolt securing the turnbuckle should be cut off leaving only a couple of threads showing above the Nyloc. File to remove any sharp edges.
Figure 152; front of tensioning tube.

Figure 153; rear of tensioning tube.

File edge of this saddle washer 2-3mm to clear U bracket on fuselage.
Figure 154; tensioning tube fittings, front in left photo (note bolt through compression tube), rear in right photo.
8.2 Aileron Horn Assembly

Figure 155; aileron horn parts.

a) Find the hole in the aileron leading edge spar.
   *This is located 480mm from the inboard end of the spar.*

b) Burn through the fabric with a soldering iron at this point to uncover the hole.

c) Lightly bolt into position the upper and lower angles.
   *Use the 6mm bolt with 45mm shank length.*
   *The long brace goes underneath with horizontal edge facing the inboard end of the aileron, placing the horn towards the wing tip.*

Figure 156; aileron horn, top and bottom.

d) Temporarily mount the aileron onto the wing, and line up the long brace to point at the aileron pulleys.
   *This will put the brace at around 90° to the trailing edge of the aileron.*
e) If the aileron movement feels at all stiff, the holes for the eyebolts on the trailing edge may need to be eased slightly to achieve good alignment and thus easy movement. Once satisfied tighten the eyebolts, remembering the Loctite, and do not over-tighten (as a guide they should still be able to turn with only moderate finger pressure).

f) Burn a small hole in the fabric at the trailing edge through the 4mm hole at the rear of the brace.

g) Burn a hole in the same position on the upper surface fabric.

h) Remove the aileron from the wing.

i) Insert a 4mm bolt to hold the angle in position and using the angle as a guide burn a slot 70mm long on the under surface measured from the centre of the leading edge spar, Figure 157.

j) Use the long brace from the opposite aileron against the upper surface as a guide to melt the upper slot.

This slot should be 60mm long measured from the centre of the leading edge spar.

Figure 157; slot for the aileron horn in the undersurface of the aileron,

k) Put the braces back in their correct positions and secure the trailing edge with a 4mm bolt passing through the thin sheet aluminium U-piece, the spacer tube and the lower brace, the sequence shown in Figure 155.

Note that the U-piece edges should be bent up slightly so that the edge does not cut the fabric over time.

l) Tighten this assembly, and also tighten the 6mm bolt holding the front of the top and bottom braces.

m) Insert the aileron horn.

If it is a tight fit through the fabric you may have to lengthen the slots a little.

n) Check the alignment of the rivet holes.

These may have to be gently eased with a 4mm drill or reamer.

o) Insert all rivets, from the horn side, to ensure they all fit, then pull up the rivets.
8.3 Attaching the Wings to the Fuselage

Note this is a temporary fitting, before removal for covering and transportation. However, it should be performed in order to allow easy setting up of the controls.

a) Select the front and rear lift struts tu92 and tu91.

b) Lay them on the ground next to the fuselage in the position that they would attach.

   The inboard ends are those fitted with the angled stainless-steel brackets.
   The strut with the angle cut out of its trailing edge is the front strut.

 c) Attach the struts to the main undercarriage cross-beam, tu9.

   The plastic washers between the strut ends and the main beam shown in Figure 158 are not required.

   ![Figure 158; lift strut attachments.](image)

 d) With two people, attach the wing to the fuselage.

   One person should hold the tip up while the other person puts the pins through the U-brackets to secure the leading and trailing edges on the fuselage.

   Put the leading edge pin in first, from the rear, then the trailing edge pin, from the front.

 e) Lift the struts up to the wing and attach them to the leading and trailing edges, Figure 152 and Figure 159

   Do not install the jury struts at this stage, wait until the wing has been covered and the geometry checked. This will happen at a later stage.

   Do not overtighten the upper bolts holding the lift struts to the wings, there is no need to distort the connecting brackets.
8.4 Aileron Control Cables

Figure 159; aileron cable runs.

a) Temporarily fit the ailerons onto the wings.

b) Check the ailerons for unrestricted movement.

If any friction is felt the holes in the trailing edge where the eyebolt hinges attach should be elongated slightly along the tube. This is worth doing on all the hinges, even if no friction is present at this stage, as when the coverings are fitted they tend to build some stress into the wing and cause the ailerons to bind slightly which spoils the feel of the controls.

c) Select the pair of upper aileron cables, those with the turnbuckles on one end.

d) Thread the ends without the turnbuckles around the upper pulleys inside the wings and through the U-brackets at the jury strut attachment locations.

Work from the ailerons inwards towards the fuselage.
8 Wings

Figure 160; cable routed through U-bracket.

e) Pass the cables around the pulleys at the top of the front vertical tube where the leading edges attach, Figure 162.

f) Prepare the fittings for attaching the aileron cables to the driving horn connected to the control stick.

    Attach a pair of the stainless steel plates to the port aileron cable using a shackle pin and two plastic washers on the outside of the plates to take up some of the slack, and permanently secure with a split pin, Figure 161.

    Attach the other pair of stainless steel plates to the starboard side of the aileron driving horn, again using a shackle pin with a pair of plastic washers outside the plates, permanently secured with a split pin.

Figure 161; aileron cable connections viewed from beneath.
g) Attach the starboard aileron cable end to the stainless steel plates on the starboard side of the aileron horn using a shackle pin and a nappy pin or split ring.

h) Attach the stainless steel plates on the port aileron cable to the port side of the aileron horn using a shackle pin and nappy pin or split ring.

i) Attach the turnbuckles to the upper control horns.

Figure 162; aileron cable fuselage pulleys.

j) Select the other aileron cables **ca6** which are connected in the middle by a single turnbuckle.

k) Pass the ends of the cables **ca6** over all the tubes in the wing and the fuselage (except the windscreen supports) and around the lower pulleys inside the wing.

> Loosen the turnbuckle and feed the other ends from the fuselage outwards towards the ailerons.

l) Attach the ends to the lower control horns on the ailerons.

m) Tighten the bolts securing the aileron pulleys in the wings.

> Ensure the pulleys can still move to take up the correct angle to the cables.

n) Check the gap between the pulley and the plates to make sure that it is not more than 1mm or so.

> If it is, there is a chance that the cable could jump the pulley and slip between the plate and the pulley. If there is an excessive gap, check the plate for bends and check for the proper washers between the pulley and the plate.

o) Tension the cables by hand to check that all the cable lengths are accurate.

p) Check the angle of the lower pulley bracket inside the wing.

> This is the bracket for the cable **ca6** that connects to the lower control horn on the aileron. You will need to bend the bracket with a twisting...
motion so that the pulley is in the same plane as the cable, and moves smoothly.

q) A short plastic sleeve should be fitted over each of the central cabin tubes tu19, immediately behind the front vertical tu14, to form aileron horn stops, Figure 163.

These will require cutting to slip over the tubes if not installed earlier, and to allow packing out later to set the aileron deflections.

![Figure 163; aileron stops.](image)

r) Set the levelness of the ailerons with the turnbuckles at the ailerons, whilst the centre turnbuckle simply takes up the slack.

Final adjustments to neutral position and control surface movement will be done when the aircraft is complete.

s) Check the right and left joy stick movements for the proper aileron deflection: stick left, left aileron up, right aileron down and vice-versa.

t) Check for any stiffness and binding.

u) Small pieces of prop-tape can be applied to tubes where the cables may occasionally touch them, but the cables should not be rubbing continuously on any tubes.

v) If the cables are found to “slap” against the leading edge tubes within the cabin area, either apply tape, or position a couple of cable ties or similar around the leading edge tubes to act as buffers for the cables.
8.5 Flaps

a) Temporarily mount the flaps on the wings.

If the pin securing the wing trailing edge to the fuselage touches the leading edge tube of the flap, the pin should be shortened to fit.

The control rod mounting plates at the flap roots face downwards.

b) Attach the push rods for the flaps to the flap handle.

The slightly longer flap pushrod and the longer spacer tube goes on the starboard side of the rear end of the flap handle.

c) Attach the push rods from the flap handle to the plates on the flap roots.

The plates may require a tweak to line them up with the pushrods.

d) If the flap lever rubs the cables, check the fitment of the flap lever and adjustment of the cables against the respective instructions.

If the starboard flap pushrod still rubs the control cables (due to the UKMOD controls) cut a few mm length off the port side spacer tube and add it to the starboard side spacer tube.

e) Adjust the flaps to set the centre of their trailing edges 5cm below the level of the rear fuselage covering, Figure.

Final adjustments will be done when the aircraft is complete.

If the starboard flap push rod runs out of adjustment (too long), turn it 90° and drill another hole 10mm above the original hole at the bottom of the push rod. Use this to secure the push rod end fitting.

f) Check the smooth operation of the flaps, including moving the ailerons to check for any contact between them.

g) If the attachment plates at the bottom ends of the flap pushrods are found to press hard against the coverings they may be rounded off to a radius of 8mm from the hole edge, and a patch stuck onto the covering to further protect it.

The fuel tanks push the covering downwards out of the way of the flap pushrods, so wait until they are fitted before getting too concerned.
Figure 164; flap handle, looking rearwards and flap rods.
8.6 Covering the Wings

a) Do not cover the wings until they have been inspected!

   See the inspection schedule and tick sheet.

b) Select the odd-one-out from the battens: the trailing edge fitting is flat rather than forked, lay this one aside for the cabin roof.

c) Select a typical batten and draw around it onto a large sheet of paper, to make a template for checking the batten profiles later should this be required after repairs etc. .

d) Check the battens and their fittings for any sharp edges which might damage the coverings.

   Smooth the ends with glass paper or similar if necessary.

   Polishing the battens with car wax makes them slide in more easily, but on no account do this for aircraft with Dacron coverings if you intend to paint or lacquer the aircraft, the reaction will not be a pretty sight!

e) With two people remove the wings from the fuselage.

   Remove the lift struts from the wings followed by the fuselage, then remove the wings from the fuselage and lay them down flat in a very clean place.

   Do not place the wings on concrete as it will scuff the cloth when you cover the frame.

f) Apply a layer of clear, thin, lightweight self-adhesive plastic film, such as Fablon, to the leading and trailing edge tubes and wing tip tubes where they touch the covering.

   Do not skip this step! This prevents vibration from abrading the anodising, which can then cause unsightly stains visible through the covering.

   To save weight just apply the film where the cloth can touch the tubes.

   If desired to increase resistance to corrosion it may be applied to the whole circumference of every tube, which will protect these difficult to clean areas.

   Do not use thick, heavy tape, such as prop tape or gaffer tape, as this adds too much weight, is too grippy, and can look horrible!

g) Thicker tape should be applied only to the U-brackets at the wing tips to prevent chafing of the coverings.
h) Lay the wing cloth on the clean surface, next to the frame, with the lower surface of the wing upwards.

*The lower surface is the one with the zips.*

*Take care when handling the coverings to keep your hands (and any tools etc. you may handle) clean at all times.*

i) Remove the turnbuckle from the drag cable.

*Make sure that the cable with the turnbuckle is over the top of the fixed cable.*

j) Remove the compression tubes **tu38**, the innermost cross-tube in the wings.

k) Insert only the upper surface (curved) outermost (tip) batten, but leave an inch or two still poking out of the rear of the batten pocket.

*It will be found to be very tight if inserted later, with a risk of ripping the batten pocket.*
l) Collapse the wing frame using a scissor type motion so that it will slip easily into the fabric envelope of the wing, Figure 166.  

*The trailing edge has the most fittings on it, so scissor the wing to insert the trailing edge first.*

m) Slide the frame of the wing into the cloth taking care not to damage the fabric with any of the fittings attached to the frame.

*Keep track of the turnbuckle, tie a bit of string to it if necessary.*

n) Use the same type of scissor motion to expand the frame back to its original shape.

*Make sure that the fittings for ailerons, and flaps, as well as the strut attachments, exit through their respective holes in the fabric.*

o) Stand the wing up with the trailing edge on the clean surface, and the leading edge up.

p) Attach a small rope through the grommet on the leading edge so that you can use a bar to press against the leading edge of the frame to stretch the fabric into place, Figure 167.

*You may need to use a bar and pry against the leading edge tube, being careful not to damage it. Note the piece of wood to protect the tube end in the photograph.*

*Check that the fabric is properly seated at the tips of the leading and trailing edges. It should be nice and snug, with no wrinkles near the tip. If prop tape or similar has been incorrectly used it is possible that it will grip the fabric and prevent it sliding down the leading edge, causing difficulties later.*
Figure 167; pulling the fabric into place.

q) Tighten the bolts on the compression tubes tu38.

r) Install the compression tube tu38 by placing the end without the bolt over the round spacer on the trailing edge of the wing frame. Put the other end over the aluminium cam, and push the strut into place.

   The cam should pop straight when the tube is pushed into place. It may be necessary to apply a sharp tap, or to use a blunt screwdriver to push the cam straight. There is no need to bolt the cam in place.

   Ensure that the two large holes on the compression tube are facing the fuselage end of the wing.

   The technique shown in Figure 168 may be of use. Or maybe not…!

   Wear a glove to clout the screwdriver, and note the broom handle inserted into the trailing edge being held down by a strategically located foot, whilst the leading edge is lifted upwards by the arm holding the screwdriver.
s) Lay the wing flat on its lower surface.

t) Replace the turnbuckle on the drag cable and tighten by hand until the other cable comes taught, which may require some effort.

The cable with the turnbuckle goes over the other cable.

If the cable without the turnbuckle will not tighten up, check that the covering is properly seated along the leading edge.

u) Install the two large diameter battens (tu186 curved, tu87 straight) at the wing root end of the wing covering, Figure 169.

They are inserted through the holes at the trailing edge of their pockets (look closely, they are there), not through the holes further forwards.

Push the battens in as far as they will go and slip them into the wing root side of the pocket so that they are held securely in place.
v) Install the two wing tensioning tubes (tu32 and tu33) against the outboard side of the large diameter battens.

Cut the ends of the tensioning tubes at an angle, on the sides opposite the holes, and finish them nicely. This prevents them cutting into the fabric.

They will fit into the holes cut in the fabric for this purpose. The longer end of the tensioning tubes goes uppermost. The holes cut into these tubes must clip over the battens, and the threaded rod must enter the holes in the compression tube, Figure 170.

w) Tighten the wing tensioning tubes against the compression tube by turning the threaded rod.

To turn a threaded rod, put two nuts on the end and tighten against each other. Turn the rod with a spanner on the outermost nut, whilst holding the nut behind the tensioning tube with another spanner.

The threaded rod will push against the compression tube and tension the fabric.
x) Tension the fabric to the point that you see the compression tube bowing, Figure 171.

There should be around a 4cm gap between the compression tube and the vertical wing tensioning tubes.

This should result in the bow in the compression tube being no more than the diameter of the compression tube. You can check by placing a straight edge along the compression tube and measuring the space in between.

y) Check that the cables in the wing are still taught, tighten if necessary, then secure the turnbuckle with safety wire.

z) Use the rope that you have attached to the leading edge of the fabric to pull the fabric tight in the same manner as before.

Look for the wrinkles just near the leading edge-root section of the wing. Tension the fabric with the rope until you see these wrinkles pull out. This will require a good firm pull.

aa) Whilst holding the tension on drill a hole through the centre of the grommet and secure the fabric in place with a 4mm or larger steel rivet and a washer.

Alternatively a stainless steel countersunk screw can be used.

Remove the string before the final rivet pull or screw turn.

bb) Leave a nut on the end of the threaded tensioning rods and cut off the remaining thread, then finish nicely with a file.

cc) Measure the distance from the fabric to the end of the leading edge and make both wings the same, otherwise it will look odd when aligned with the cabin doors.

A typical measurement is around 44cm.
8.7 Inserting the Battens

a) Make sure the wing battens are clean, and insert them into the fabric to the point where their rear ends still sit on the trailing edge tube.

*Get someone to steady the wing.*

*Start with the upper surface battens first. Begin at the tip and work your way toward the root.*

*Do not let the battens twist, use two hands.*

*Use one smooth motion to insert the batten all the way into the wing. Stopping in the middle can cause the batten pocket to rip when you try to continue.*

*Wear a glove on your pushing hand.*

![Figure 172; inserting a batten. Use your other hand to prevent the batten twisting.](image)

b) Once each wing batten is in place, use a screwdriver to slip the fabric flap over the end of the batten, then slide the batten sideways into the pocket in order to secure it in position.

![Figure 173; secure the battens in position.](image)
Figure 174; batten end.

c) Next do the same with the lower surface battens.

d) After the fabric has settled for a few weeks, any remaining minor wrinkles can be taken out using a heat gun to shrink the fabric. Great care must be taken not to burn the fabric!
9 Windscreen Frame and Throttles

Before mounting the cowlings and firewall, the windscreen support frames and the throttles should be installed. These parts position the rear edge of the cowlings.

9.1 Windscreen Frame

a) Attach the bottom of the cabin uprights \textbf{tu34} to the middle of the fuselage lower side members \textbf{tu16} using an L-bracket slid inside the slightly flattened bottom end of the tube, with the tube orientated towards the outside of the aircraft, Figure 176 and Figure 177.

b) If a floor is fitted, the saddle washer may be discarded. A hole must be drilled up through the floor, to allow the L-bracket to sit on top of the floor.
c) At the rear of the **tu34** support frame, the tubes are flattened to fit onto the bolt end protruding upwards from the fuselage at the trailing edge attachments, Figure 177.

> These need to be quite flat to fit well, which is best accomplished by cutting off the underside to leave only the upper piece of the end, Figure 178. Drill a small hole either side and hacksaw up to them, then dress the ends with a file ensuring no sharp corners are left.
d) Slip one of the large diameter heat-shrink rings over each leading edge, and fit the covered wings to the fuselage.

e) Ensure that the *tu34* tubes curve around the leading edge with around 3-5mm of clearance, and that the curves of the top tubes match the curve of the large innermost wing battens, maintaining around a 5mm gap, to get a good fit between the Lexan windscreen and the wing.

*It may be desirable to tweak the curve of the top *tu34* tubes to get a good fit. Take care not to kink it, which can happen if you flatten it too much then try to bend it again.*

*It may also be necessary to tweak the curved piece which joins the upright tubes to the curved upper tubes, slide it up or down inside the vertical tube to get the best position, and to re-drill the holes which secure it.*

*In the correct position the tubes should be centred, with the centres of the tops of the tubes around 900mm apart, so that the upper curved tubes are run parallel back to the rear attachments.*

*The cabin uprights will then lean slightly outwards from their bases.*

f) Measure the positions of the *tu34* tubes relative to the centre of the aircraft.
g) Mark the positions for the heat-shrink rings to centre them on the \textit{tu34} tubes.

h) Remove the wings, and heat-shrink the rings into position.

i) Secure the \textit{tu34} tubes at the same positions they held whilst the wing was fitted.

\textit{These can be held in place by a tube, such as a piece of plastic drainpipe or similar, Figure 180. Pieces of string, wood etc. may also be used, the aim is to securely locate the tubes.}

![Figure 180; holding the frame in position.](image-url)
9.2 Throttles

The throttle assembly consists of a torque-tube supported by pivot bolts through mounting plates on either side of the fuselage. Friction is provided by clamping two nylon washers against either side of the plates. Curved levers hook around the bottom of the instrument panel.

Figure 181; dual throttle parts.

Figure 182; port throttle lever assembly.
a) If a Jabiru is fitted the hole for the cable attachment on the port lever should be 40mm from the pivot.
   
   *If not in place then drill a 5mm hole at this location.*

b) If a Rotax 582 is fitted the hole should be at 65mm from the pivot.
   
   *If not in place then drill a 5mm hole at this location.*

c) The standard Rotax 912 hole position is at 85mm from the pivot.

d) The torque-tube should be cut 795mm long.

e) Rivet the port lever pivot into the torque-tube using eight 3.2 x 10mm steel rivets.

   *Do not drill within 12mm of the end of the tube. There should be two rings of four rivets each, Figure 183.*
f) Verify the alignment of the levers before riveting the starboard lever in place.  

The top of the port lever should be very slightly offset ahead of the top of the starboard lever so that when the throttles are mounted to the aircraft the port throttle lever will contact the full throttle stop slightly before the starboard lever. The full throttle stop is formed by the lip of the dash board, not fitted yet, but a line between the cabin uprights will serve to mark its position.

![Image of throttle assembly](image)

Figure 183; throttle torque-tube rivets.

g) Assemble the mounting plates onto the torque-tube pivot bolts and temporarily bolt in position to the cabin uprights **tu34**.

The top two holes line up with holes on the cabin uprights. Check that the right holes are being used – the top hole is 410mm up from the lowest hole in the cabin upright.

This position can be lowered if a deeper instrument panel is desired. However, note the need for the throttle torque-tube to clear the aileron torque-tube, and the effect on clearance between the instrument panel and tall pilots’ knees.

h) Mark the position of the angle stop pieces, Figure 185, which should be cut from one of the lengths of angle included in the kit.

The port lever should contact the stop fractionally before the starboard lever.

On the Rotax 912 and Jabiru the throttle levers should contact these with the forward part of the lever vertical in relation with the cabin frame.

On the Rotax 582 the throttle stop will have to be long enough to leave space for the fittings on the end of the throttle inner cables. Check these now and position the stops accordingly at 90° to the throttle lever.
i) Remove the throttle assembly if necessary and fix the stops in place with two 3.2mm steel rivets.

*Take care that the rear most rivet is sufficiently far forwards to not foul the cabin frame.*

j) If a Rotax 582 is fitted drill a 6mm hole in the port mounting plate level with the hole in the lever for the cable connections.

*The mount for the inner cables will be fitted here later.*

k) If a Jabiru is fitted then file a notch in the port side plate to allow clearance for 5mm bolt through the throttle cable attachment hole when the throttle lever is moved fully rearwards.

l) The portion of the throttle levers above the cable attachment holes and stop positions may be cut off.

m) If required, adjust the end float on the torque-tube using plastic washers.
n) Rivet the plates into position to the cabin uprights \texttt{tu34}, again checking that the correct holes are used.

\textit{If using the standard position, fix rivets in the top two holes on each side, then drill through the lower hole 4mm to accept the lowest of the three rivets.}

o) \textbf{Adjust the throttle friction by tightening the lock nuts on the port side torque-tube spindle.}

\textit{The starboard side should be done up just enough to remove any play.}

p) Once the friction has been set, lock the two friction nuts together at both ends.

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{throttle.png}
\caption{port throttle lever, looking inwards from front.}
\end{figure}

q) The ends of the bolts should be cut off to prevent fouling with the glass fibre fairing, just leave a couple of threads showing.

r) Drill the golf balls to fit over the ends of the throttle levers, but do not glue them on yet.

\textit{A flat, wood type drill works well.}

\textit{The balls will be fitted later, when the levers have been cut to length in situ to match the dash board positioning.}

s) Check that the spacing and centralisation of the parts holding the tops of the cabin uprights has not been disturbed by the fitment of the throttles.
10 Cowling and Firewall

10.1 Cowling

Be careful when handling the cowlings not to scratch them or to stress them, for instance by picking them up by only one corner, as this can result in visible stress crazing.

When drilling holes in the fibreglass, drill very gently to avoid cracking the gel coat. The application of tape around hole positions before drilling is useful to reduce the risk of cracking and scratching if the drill should slip.

Masking tape is useful in any location where a hole needs to be marked and drilled, or where you might slip and scratch the cowlings. Masking all the cowling edges is a good start.

A very useful tool indeed for working the fibreglass parts is a Dremel type mini-drill, fitted with cutting discs or abrasive wheels. Just the excuse you need to go and buy one! For the Jabiru engine, which has quite a bit more fibreglass trimming than the Rotax engines, one of these tools is strongly recommended.

UKMOD: The inside of the cowlings must be painted with the fire resistant intumescent paint supplied. This will require at least two coats. For best results use a small foam roller – such as is found in DIY shops for painting household radiators.

a) The five parts of the cowlings are held together with 5mm pan head bolts.

The threaded clips are used only on the forward upper and lower parts which need to be removable for inspection. The aft parts are secured with plain nuts and threadlock, or Nylocs if you prefer.

Even spacing of the bolts looks best, it is worth determining and marking the bolt positions before drilling any holes.

Do not drill more holes than you have bolts and clips (where necessary) for.

b) First attach the lower front part of the cowling to the side panels.

Use two bolts and threaded clips on each side about 6” apart.

Figure 187; attach side panels to lower front piece.
c) Then attach the upper front part of the cowling, followed by the upper rear part of the cowling, Figure 188 and Figure 189.

   *Space the bolts about 6" apart. Make sure they are evenly spaced.*

   *Use threaded clips on the upper front to lower front join, and on the upper front to upper rear join, but just nuts between the upper and lower rear parts.*

   *On the 912 compare the bolt positions on the front upper to front lower pieces to the carburettor positions. Do not position the bolts over the carburettors, as they will foul them when the cowling is fitted.*

---

Figure 188; attaching upper front piece.

Figure 189; upper rear piece.
d) If you have your propeller hub and spinner fit these to the engine, including the prop-spacer.

Ensure the assembly is fitted with all the parts it will use when it is ready to fly, to get a realistic reference. The blades themselves can be omitted if they do not affect the position of the spinner.

On the Jabiru the spinner will need to be cut to fit around the prop. Fit the prop to the engine, with the spinner backplate on the front of the prop. Protect the prop with masking tape, and carefully shape the holes in the spinner with at least 2mm clearance from the prop. Note that the positions of the predrilled holes for the spinner to backplate bolts set the position of the spinner.

Leave fitting the captive nuts until the engine can be spun on the starter, to confirm the hole alignments.

The spinner will need finishing with filler and sand paper, followed by painting.

e) Otherwise, in the case of the standard 912 installation a wooden disc can be used as a reference.

Cut a disc the same size as your spinner if you know its diameter, or of the standard 225mm diameter for a Kiev prop spinner, from wood, MDF or similar.

Take the propeller spreader plate from the engine box and centre it on the disc. Use the plate as a drilling jig and drill 3 evenly spaced 8mm holes to locate the disc on prop flange.

Mount the disc on the propeller hub, leaving a 35mm space between the front of the prop boss and the rear of the disc, Figure 190.

The disc must be held firmly in position, perpendicular to the prop-shaft. Use spacers or nuts behind the disc to allow the securing nuts to be done up tightly.
f) Fit the cowling over the engine and airframe.

g) Position the cowling with a minimum clearance of 10mm behind the rear edge of the spinner.

    Or for the 912 wooden disc method, pressed against the disc touching the disc at the top. This will result in the top of the front of the cowl being 35mm forwards of the engine prop-boss and leave clearance for the spinner.

h) Support the cowling with packing materials on the engine to centre the cowling on the spinner or disc, both horizontally and vertically.

    Foam packaging wrapped repeatedly around the hub or prop-spacer can be used to get a well-centred cowling, allowing the cut-out in the front of the cowling to fit over the packaging.

    The cowling will tend to sag a little, so it should be well supported whilst aligning it.

i) Use spring-clamps or similar to hold the rear cowling edges in position against the cabin uprights tu34.

    Protect the cowling from marking by the clamps, using tape or similar.

j) If the bolt holding the bottom of the cabin uprights tu34 to the angle bracket forces the side of the cowling outswards, the bottom of the cabin uprights tu34 should be pinched a little flatter, or the bolt changed for one with a thinner head. Alternatively a hole may be drilled in the cowling when the alignment has been finally determined to allow the bolt to pass through and help secure the cowling.

    Note that the door hinges will increase the space available for this bolt head.

k) If the floor prevents the cowling from fitting, or distorts the cowling when it is being fitted, the floor edges should be sanded to fit.

    Remember to varnish them when fitting is complete, before the final fitting of the cowling.
l) Make sure the cowling is not touching any part of the engine. If it is you must reposition the cowling.

m) Manipulate the cowlings until satisfied with the symmetry and the fit at the propeller spinner and the positions where the lower rear parts of the cowling attach to the airframe.

   *Spacer washers may be helpful on these attachments and those slightly further forward where the cowlings will attach to the bolts through the ends of the rudder pedal support bar.*

   *Note that on the Jabiru the cooling ducts will need to be fitted to the engine. These can be trimmed at the front, but try to leave some clearance between the front starboard cylinder and the cowling. Also, ensure that the cowling does not sit too low for the ducts to fit beneath it: if the prop is centred in the hole in the upper cowling it should be about right. Another guide is to ensure that the lower edge of the upper cowling is no lower than 5cm below the top of the outermost cooling fin on the front starboard cylinder*

n) With the final position determined, mark and drill out the holes in the lower rear cowling for the bolts holding the cabin uprights to the horizontal tubes, using a 6mm drill bit, Figure 192. Secure temporarily.

o) If necessary, make small adjustments to the positions of the two rear mounting holes to achieve a nice, symmetrical cowling. Try to avoid strange distortions.

p) Once the alignment is correct, drill the holes for the bolts at the end of the rudder pedal support bar, forward of the rear mounting holes at the cabin uprights.

   *Use the tube as a guide and drill down from the top, through the fibreglass side panel.*

q) Ensure that the lower ends of the cabin uprights are installed in their final configurations, including floor etc., as this will affect the positions of holes drilled up the side of the cowling.

r) If door sills are to be fitted, check their fitting now as they fit between the cowling and the cabin uprights.
s) Drill holes through the cowling through the existing holes in the cabin uprights tu34. Temporarily bolt in place.

*If a better bolt spacing is desired it is permissible to drill new holes through both the cabin uprights and cowling sides.*

*At least one more bolt or rivet should secure the top half of each side, and at least two more each side should be used on the bottom half.*

*If using rivets, do not rivet them yet! The cowlings may need to be removed while fitting the firewall.*

t) Cut the fibreglass behind the cabin uprights tu34 so that it is even with the back side of the tube. Sand to finish, but protect the tubes with plenty of tape first.

![Figure 193; cut the cowl and sand flush with the cabin uprights.](image)

u) If using 2-piece doors, position the lower door hinges between the rear cowling edges and the cabin uprights tu34.

*These should be fitted so that the top edge is level with the bottom of the dash board lip. The position is usually correct when the hinge rests against the top of the bolt holding the bottom of tu34.*

*Remember that the doors open outwards and forwards, so the hinge “bulge” needs to be on the outside when finished.*

v) Mark the hole positions on the hinges through the holes in the cowling side and drill the hinges to suit.
10.2 Firewall

Note that for the Rotax 912 / 912S engine installations the main sides firewall panels are supplied pre cut, and only requiring slight trimming / filing to fit.

For the Rotax 582, Jabiru 2200 and other engines the firewall will be different, including the outline as the cowlings are positioned differently depending on the engine type. For these other engine types, a rough paper pattern is supplied. Transfer this oversize to cardboard and use this to determine the actual shape required.

A pattern for the Jabiru firewall upper part is supplied, but may need extending towards the rear depending upon the precise location of the cowlings.

The standard pattern for the main firewall part is close to that required for the Jabiru, but the holes for the lower engine mounts and lower engine mount braces will require enlarging downwards for the Jabiru.

Figure 194; firewall from front, with oil tank mounts.

a) Use the paper template, supplied with the kit, to draw the shape of the lower parts of the firewall onto a piece of cardboard.

b) Use the cardboard as a template to check the fit of the firewall, before transferring the final pattern to the piece of 1mm aluminium sheet supplied with the kit.

See below for fitting the firewall pattern before fitting the firewall material itself.

c) Cut the firewall out of the aluminium sheet using a tin snips.

A round file and/or a flap-wheel are useful tools for shaping the firewall.
d) Carefully bend the firewall over the edge of your workbench, or similar, as indicated on the paper template. The main bend in the fire wall should be 75 degrees. Bend the bottom 1" at a 45 degree angle in the same direction.

Figure 195; mark and cut out the firewall.

e) It may be necessary to remove at least some parts of the cowling to fit the firewall.

As the cowling is still relatively unsupported and flexible, take care to ensure that the firewall and cowling are positioned together properly. This will require replacing the parts of the cowling which are removed, in order to ensure that they all fit together properly. What you are trying to avoid is building in any unsightly distortions or asymmetry into the finished cowling shape.

Figure 196; firewall halves in position, cowl removed for clarity.
f) Temporarily fit the firewall to the fuselage.

The firewall halves should overlap in the middle.

Apply tape to the tubes etc. where the firewall will touch, to prevent it scratching them.

The firewall should fit snugly behind the top engine mounts, and the upper bend should be level with the bottom of the lower engine mount supports.

g) Position the firewall in front of the fibreglass angles on the cowling.

The fibreglass angles have proven awkward and may have been omitted on your cowlings. If the angles are supplied separately, they may be glued to the cowling after the firewall has been fitted.

Ideally the firewall should be tight against the fibreglass angles. However, if this causes distortions in the cowling the angles may be removed by scoring and breaking them off, and repositioned using Epoxy adhesive or fibreglass to glue and/or reinforce the angles.

If no angles are supplied, or as a better method if desired, a thin fibreglass strip (glassfibre kits are available from Halfords) may be used to secure the firewall edge to the cowling when fitting is complete. Three small bolts or rivets should be used each side through the firewall and the glassfibre to provide a mechanical link. The glassfibre will bond very securely to the glassfibre cowling.

h) Slide the firewall halves apart until they are against the fibreglass cowlings.

Refit the cowlings if they have been removed.

i) Trim any high points until a good fit is achieved.

Note that the rubber edging strip should be applied around the firewall where it touches the central tubes, so remember to allow for this when trimming the firewall to fit. Glue it on with super-glue. Edging is not required between the firewall and cowling if glassfibre and RTV sealant are going to be used to fix the firewall in place (see below).

Note that for the Rotax 582 engine a hole will be required to clear the electric starter motor, Figure 197. The hole should be covered with an aluminium cover, which can be made by cutting up an aluminium baking tray.
j) Mark the overlap of the two halves of the firewall with a marker.
k) Remove the firewall.
l) Drill holes in the overlap for rivets. Do not rivet it at this point.
m) Reinstall the firewall halves on the airplane, in front of the fibreglass angles, and rivet the halves together.
n) The bottom of the firewall attaches to the two bolts protruding beneath the covering, Figure 199.
o) Attach the fibreglass angles to the firewall using 4mm bolts.

As mentioned above, the angles can be relocated if they cause visible distortions in the cowling.

The angles on the port side bear some of the loads applied by the throttle cables. It is advisable to reinforce them with epoxy adhesive or similar.

p) Locate a piece of light gauge aluminium angle from the kit and cut it to the same width as the top of the firewall.

q) Attach it to the rear of the top of the firewall with five or so rivets.

The top of the angle piece should be facing to the front of the aircraft.

r) The firewall support bracket (UKMOD) should be used to brace the firewall to the engine mount immediately in front of the top of the nose-leg, Figure 200.

s) The firewall on UK spec aircraft continues upwards and forwards to meet the upper cowling, Figure 200.
t) Use the template to trial fit a cardboard template, then cut out the upper part of the firewall from the aluminium sheet.

   Rubber edging should also be used around the upper firewall to prevent chafing against cowling, glued on with super-glue.

u) Drill and rivet (5 rivets are adequate) the upper part of the firewall to the aluminium angle, with the front of the firewall tucked under the upper cowling.

   If desired, a pair of jubilee clips can be placed on each of the engine mount braces where they pass through the upper firewall, and used to hold it up against the cowling.

v) Rivet or bolt the central covering plate to the upper firewall.

   Tweak the tab on the front part to lie flat against the underside of the upper cowling.

w) Once satisfied with the fit of the upper firewall and the cowling, secure the tab at the front of the upper firewall to the cowling with a couple of small countersunk rivets, installed from the top.

x) Additional small plates should be made from the off-cuts of the aluminium sheet to cover the remaining holes in the firewall. Secure each with rivets or bolts as required.

y) For a nice finishing touch the edge of the firewall can be sealed to the cowling using high temperature RTV silicone sealant.

z) Apply a thin layer of fire resistant acoustic foam to the top surface of the upper part of the firewall, where the forward part of the dashboard will sit on it.

aa) When the aircraft is complete, apply the thicker fire resistant acoustic foam behind the firewall on the cockpit side.

   This will reduce the noise and heat from the engine. A good way to fit it is to first cut it into strips.

   Do not install it at this stage, as you will have to cut it away to fit other parts later.
11 Engine Ancillaries

11.1 Rotax 912

11.1.1 Standard Exhaust welding
If the aircraft has been supplied with the engine package, then the exhaust will be supplied pre manufactured for fitting in the Skyranger. If you have sourced the engine yourself and the exhaust has standard Rotax components, then you may follow the procedure below:

a) A pre-cut and welded system is available if you do not want to weld it yourself.

b) The front upper and lower parts of the cowling should be removed for fitting the exhaust, however they must be refitted to check that the exhaust maintains a good clearance from them, before the exhaust is finally welded.

c) Read the engine installation manual for advice and requirements for the fitting of the exhaust.

d) Use a bungee cord or similar to temporarily secure the muffler below the engine and insert a piece of wood 10mm thick to set the proper spacing.

    The muffler is located 10mm below the oil line connection on the bottom of the crank case, and 10mm in front of/beneath the lower engine support tubes.

    The exhaust outlet should be downwards, on the left side of the aircraft.

    Figure 201; exhaust suspended in position, viewed from front.

e) With the muffler held in place you will be able to make measurements for the exhaust tubes.

f) Weld the exhaust pipes that come from the engine in place, taking care not to let them interfere with the radiator lines that will be installed in the future.

    Use a competent welder, you need accuracy and good technique.

g) Secure the exhaust with exhaust springs.

    Use string to pull the springs on, not pliers which damage the springs.

h) With the firewall and fibreglass cowling installed to position the slot in the cowling correctly you can weld the exhaust outlet onto the muffler. You may need to elongate and/or enlarge the slot to maintain a good clearance.
11.1.2 Standard Exhaust fitting

a) If you have a Rotax mild steel exhaust (rather than the Rotax stainless or optional CKT exhaust system) paint it with high temperature paint before fitting.

b) Insert the exhaust pipes into the muffler and secure with springs.

   *A touch of Copaslip high temperature grease should be applied to the ball joint ends of the exhaust pipes.*

   *Use string to pull the springs on, not pliers which can scratch and severely weaken the springs.*

c) Offer the exhaust up to the engine and bolt on loosely.

d) Centre the muffler side-to-side by reference to the engine mounts and the ridges on the muffler.

   *Note the oil line fitting is off-centre.*

e) Check that the muffler is 10mm clear of the oil line connection.

f) Check that the exit pipe is 10mm clear of the cowling, trim the cowling if required.

g) Tighten up the exhaust mounting bolts.

h) If any part of the exhaust can be touched by, or get too close to, the cowling it may be protected by a piece of aluminium sheet riveted to the inside of the cowling.

Figure 202; engine viewed from starboard and port sides.
11.1.3 CKT Exhaust system fitting

The CKT exhaust is fitted in the same manner as the standard exhaust, but a couple of points should be observed:

a) Position the cabin heater jacket towards the port side, with the angled outlet towards the rear.

b) Position the exhaust itself biased towards the port side of the aircraft.

c) Use the adjustable manifold pipe on the forward starboard cylinder.

d) Adjust the exhaust pipe to point downwards and slightly rearwards, and trim the lower lip of the cowling to clear it if necessary.

![Figure 203; stainless steel exhaust with cabin heater jacket.](image-url)

e) The CKT exhaust is a little wider than the standard Rotax. It is important that the placing of the oil tank, cooler and pipes does not give rise to a ‘bottleneck’ where the starboard water pipe has to pass around the edge of the exhaust can. If so it can give rise to the exhaust being positioned to port of the optimum position and can in the extreme give rise to interference between the starboard rear down pipe and one of the rubber water pipes that runs under the engine. This in turn can cause the water pipe to burn through and loss of coolant. There should be a minimum clearance between the starboard rear downpipe and the rubber water pipe of 10mm.

![Figure 208; Exhaust / water pipe interference.](image-url)
f) If this cannot be achieved without interference with the oil tank / oil cooler hoses, starboard metal water pipe, then they may require some repositioning. For maximum clearance the oil tank should be as far to starboard as possible – if necessary the ‘cheek’ on the cowling may need to be trimmed. The tank should sit high in the brackets. The oil cooler should be positioned far enough to starboard so that the fitting and flexible hose tucks under the corner of the oil tank. The following pictures illustrate a good installation with more than enough clearance.

![Figure 209; Starboard hose CKT exhaust](image)

**Figure 209; Starboard hose CKT exhaust**


g) On 912S engines fitted with the CKT exhaust it is possible for the exhaust to move slightly due to the high acceleration experienced when the engine is started or shutdown. To prevent the possibility of this causing the above problem the fitment of a spacer bracket is recommended, as illustrated in the pictures. Use one of the M10 bolts that come with the engine to secure it to the transit bracket in the box, to secure the spacer bracket to the engine. See picture below.

![Figure 210; CKT exhaust steady](image)

**Figure 210; CKT exhaust steady.**
11.1.4 Oil cooling

Note that the engine may contain some oil, be prepared for this when removing caps etc. Ensure that all oil hoses are properly rated for use within an engine compartment.

a) Mount the oil tank on the starboard side of the firewall by a pair of clamps, Figure.

Trim the cowl lip a little to allow the oil tank to be tucked into the side of the cowling as much as possible without touching it.

The lower clamp mounts onto the firewall along the top of the fold line. A piece of aluminium angle should be mounted (and riveted or bolted) to run from the fold line up to the angle piece along the top of the firewall at the position of the bolts holding the inner ends of the two oil tank clamps. This stiffens the firewall.

Use penny washers on the bolt ends behind the firewall.

b) Mount the oil cooler onto the firewall at the bottom of the starboard side, Figure, using two long lower brackets and one shorter upper bracket, Figure.

Ensure that the oil pipes will not foul the oil tank or anything else where they stick upwards from the oil cooler. On the stainless steel exhaust the cooler may need to be positioned quite low and away from the centreline to keep the oil pipes clear of the oil tank and the exhaust.

Trial fit the brackets and mark the positions for the rivets.

Note that the top and bottom plates of the oil cooler do not contain oil: check that this is the case by inspection. Drill the rivet holes very carefully, using a depth stop on a pillar drill, or a very slow speed on a hand drill. Do not slip and drill into the next cross-bar down in the oil-cooler!

Rivet the brackets to the oil cooler and the firewall, using 4mm diameter steel rivets.
c) Install the hose from the port side of the oil cooler to pass under the starboard cylinders to fit onto the oil pump inlet at the front of the engine.

d) Install the hose from the starboard side of the oil cooler straight up to the outlet side of the oil tank (the almost vertical one which curves over, closest to the filler cap), Figure.
e) Install the hose from the sump connection beneath the engine passing beneath the lower cylinder head water pipes, but above the exhaust pipes, to connect with the inlet on the oil tank (the angled one towards the side of the tank, furthest from the filler cap).

f) Check that the oil pipes do not come close to or contact any part of the exhaust, or anything else which may chafe or otherwise affect them.

> Use cable ties to secure them to the water pipes etc. when these have all been fitted.
11.1.5 **Water cooling**

a) The water radiator should be fitted to the lower cowl, keeping it as low as possible, Figure 215.

![Figure 215; water radiator position.](image)

b) The radiator is secured by four simple angle brackets, Figure 216. The brackets are bolted to the front of the cowling, 2 above and 2 below the radiator.

*The two lower ones are fitted with the cowling bolt highest to keep the radiator low (exactly the same orientation as the upper ones in fact!)*

![Figure 216; radiator mounting bracket.](image)

c) Fit the starboard water pipe assembly as shown in Figure 217.

*The rubber elbows are supplied loosely fitted. Adjust their position by rotation and sliding the tubes in and out as required.*

*The rearmost bend should have even clearance between the oil tank and the exhaust, and be clear of the firewall.*

*An anti-chafe rubber ring is supplied fitted to the aluminium pipe. Position this as required to prevent contact with the closest structure during starting, when engine shake is at its greatest.*
d) Remove the port-side carburettor inlet manifold, Figure.

e) Remove the rubber water hoses between the expansion tank and the elbows on the port-side cylinder heads.

f) Remove the elbows from the port-side cylinder heads and swap them over between the front and rear cylinder heads.

This will change the outlet angles and allow the expansion tank to be rotated clockwise a little.

Figure 217; starboard water pipe.

Figure 218; water pipe attachment elbows to left of, and under, inlet manifold.
g) The water temperature gauge should be installed in the front port water pipe on top of the engine, Figure.

*The sensor for this is actually the CHT sensor from the front port cylinder head. Unscrew this and screw it into the water temperature fitting, using a touch of sealant on the threads.*

![Figure 219; water temperature sensor.](image)

h) Refit the hoses.

*The hoses may have to be repositioned slightly to effect maximum rotation of the expansion tank.*

i) Fit the rubber elbow on the port water pipe assembly to the expansion tank, passing between the carburettor and the upper engine mounting plate.

*Trial fit the inlet manifold and carburettor to check the positioning of the rubber elbow.*

*The elbow may touch the engine mounting plate. In this case position an additional piece of rubber hosing to prevent wear.*

j) When satisfied with the positioning, refit the manifold using a torque setting of 10Nm (1kgm, 7ftlb) on the 6mm diameter bolts.

k) The intake manifold balancing tube, crossing the engine in front of the carburettors, must be curved forward more than its standard position to allow more room for the expansion tank in its new position.

![Figure 220; expansion tank and rubber elbow.](image)
l) Fit the elbow at the front of the port water pipe assembly to the radiator.

   *It is supplied trimmed slightly to give maximum clearance from the exhaust. Make sure it is pushed home fully.*

   *Before tightening the jubilee clips rotate the elbows and piping to ensure best fit/maximum clearance.*

m) Be aware that the fixed pipes running underneath the engine are secured with spring clips that have sharp ‘ears’. Make sure that the water pipe cannot rub against these and fret. Rotate them to move the ears out of the way if required, and stabilise the pipe in the middle of its run with a long cable-tie threaded through a small piece of fuel tubing and attached between the water hose and the fixed hoses beneath the engine.

*Figure 221; port water hose.*
n) The stainless steel exhaust with the optional cabin heater jacket has a slightly different port side water pipe, Figure, although it is still routed between the port carburettor and the port engine mount in the same manner as the standard water pipe.

![Figure 222; water pipe routing for stainless steel exhaust with optional cabin heat jacket.](image)

o) The water overflow tank should be mounted on the port side of the firewall by bending the securing strap around the indent in the tank and securing it to the firewall with two rivets, Figure. An optional different style of overflow bottle may be supplied with integral bracket. Note that either type should have an overflow pipe through the cap. This should be routed down the side of the tank with its end expelling downwards.

![Figure 223; overflow tank.](image)

p) Finally, check the tightness of all the jubilee clips.
11.2 Rotax 582

11.2.1 Rotary valve oil
   a) Mount the reservoir above the engine, Figure and Figure.
      *Use a piece of angle aluminium bolted to the engine.*
      *Secure the reservoir with a cable tie through a hole in the aluminium.*

   Figure 224; rotary valve oil reservoir.

11.2.2 Fuel pulse-pump
   a) Mount the fuel pulse-pump on the starboard side of the firewall, Figure 225204.
      *The pump is spaced off the firewall.*
   b) Connect the pump as per the Rotax 582 Installation Manual.

   Figure 225204; fuel pump mounted on firewall.

11.2.3 Water cooling
Refer to the Rotax 582 installation manual for diagrams of the cooling system.
   a) Mount the radiator on the front of the lower cowling.
      *The cut-out should be slightly smaller than the radiator itself.*
b) Use 4 L-brackets to secure the radiator to the cowling, Figure.

*These are similar to those used for the 912 radiator.*

![Figure 226; radiator in position.](image)

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c) Mount the overflow bottle to the firewall.

*Mount it on the starboard side of the firewall so that it is not more than 250mm below the expansion tank cap.*

*Position the connection on the side.*

*The overflow bottle can be secured with an aluminium strip riveted to the wall on either side.*

*Make sure the small pipe from the overflow bottle cap is led overboard.*

![Figure 227; expansion tank and overflow bottle.](image)

d) The expansion tank should be mounted to the same bolts as hold the rotary valve oil reservoir.

*Use a piece of aluminium strip, attached to the upper bolt, Figure.*

e) Connect the expansion tank to the radiator, cylinder head and water pump as shown in the Rotax installation manual.

*The bottom tube from the tank goes to the cylinder head.*
The large tube on the side goes to the radiator via an aluminium tube. The next tube up on the side goes to the water pump. The little tube on the side of the filler neck goes to the overflow bottle.

![Figure 228; expansion tank and radiator starboard pipe.](image)

f) Connect the other side of the radiator to the water pump inlet, visible in Figure on the front of the pump, opposite to the tube passing around the back of the engine.

11.2.4 Exhaust

Refer to the Rotax 582 installation manual for further details of the exhaust system installation, such as grease, springs and EGT sensors.

a) Mount the manifold to the engine, projecting horizontally.

b) Mount the curved pipe pointing rearwards, held on with exhaust springs, Figure.

![Figure 229; manifold, pointing rearwards.](image)

c) Loosely attach the after-muffler to the expansion chamber using the mounting plate and clamping bands, Figure.

*The after-muffler sits immediately beneath the arms of the mounting points on the expansion box.*

*The outlet should point downwards.*
d) Fit the expansion box to the manifold pipe, and secure the expansion box to the engine mount intermediate plates using rubber vibration mounts with washers and Nyloc nuts.

*Secure all the exhaust connections with exhaust springs.*

e) Arrange the exhaust so that the outlet points downwards and the exhaust is clear of surrounding structure, then tighten the mounting bands and clamps.

11.2.5 Air filters

a) Fit a pair of K&N air filters to the carburettors.
11.3 Jabiru 2200
Read the Jabiru supplied manuals in conjunction with this manual.

11.3.1 Cooling ducts

a) Fit the Jabiru supplied cooling ducts to the engine.

b) Trim them to fit with the top cowling, leaving a gap to be bridged by the rubber strips supplied with the Jabiru.

c) Fit the coil cooling vent pipes as per the Jabiru manuals.

d) Cut a small hole in the front of the lower cowling to match the finned oil sump, Figure.

   Around 100mm wide by 80mm deep is sufficient. Do not make this hole much larger, as it will adversely affect the cylinder head cooling.

e) A grill may be fitted over this hole if desired.
11.3.2 Air Box

a) Secure with epoxy glue or glassfibre the air outlet to the top of the Jabiru carburettor heat airbox.

*This should point inboard and downwards to make an easy curve for the pipework to the carburettor itself.*

*Cut the hole as neatly as possible.*

*The airbox may be painted to improve its appearance if desired.*

b) Fit the Jabiru air box to the port side of the firewall.

*Get it as close to the side of the cowling as possible whilst allowing enough access to the carb heat cable fitting to connect the cable later.*

*Use 8 4mm bolts to hold the airbox against the firewall.*

![Figure 235; Jabiru air box.](image)

c) Fit the NACA inlet duct to the port side lower cowling, Figure.

*Bed the inlet onto the cowling using the RTV sealant supplied for the firewall.*

*Three bolts or rivets will then suffice to hold the duct in place, the number of rivets shown in the photo is very secure!*

*It may be necessary to build up the diameter of the pipe connection to match the supplied SCAT hose using some self-adhesive foam tape or similar.*
11.3.3 Fuel Overflow Vent
   a) Connect the fuel overflow vent pipe to the small connection on the fuel pump.
   b) Direct the pipe out of the bottom of the cowling.

11.3.4 Oil Cooler
   a) Mount the oil cooler onto the firewall at the bottom of the starboard side using spacer tubes on two lower mounting bolts and riveting the upper mounting bracket as shown in Figure.

   Ensure that the oil pipes will not foul the lower engine mounts or anything else where they stick upwards from the oil cooler.

   Drill a hole in the oil cooler upper flange for the centrally positioned mounting bracket and rivet the bracket to the oil cooler and the firewall, using 4mm diameter steel rivets.

   Trial fit the brackets and mark the positions for the rivets.

   Drill the rivet holes in the bracket and firewall and trial fit the cooler.

   Cut spacer tubes for the lower two mounting bolts so that they cause the cooler to stand off the firewall by around 1".

   Drill holes in the firewall for the lower two bolts, note that they may have to be angled up slightly to allow access above the floor inside the cabin.
b) Fit the oil cooler adapter between the crankcase and the oil filter.

This simply screws on in the same manner as the oil filter itself, with the side with the O-ring against the smooth crankcase side.

c) Connect the oil cooler to the oil cooler adapter with two lengths of oil hose.

Route the hose above the intake manifolds on the port side of the engine, then down the port lower engine mount and along the firewall.

Ensure that the hoses are secured with cable ties through short pieces of fuel tube to prevent them chafing against adjacent parts of the engine and mounts.

Use P-clips to secure the oil hoses to the firewall.
11.3.5 Oil Overflow Bottle

a) Mount the oil overflow bottle clamp to the starboard side of the firewall using rivets, and secure the bottle in place with cable ties.

b) Connect the overflow pipe to the dipstick and the bottle.

c) Connect the overboard discharge pipe to the bottle and direct it out of the bottom of the cowling.

*It may be secured with a cable tie through the cowling lip, along with the fuel overflow vent pipe.*

Figure 239; oil reservoir bottle.

11.3.6 Exhaust

a) Fit the hot air intake to the rear of the exhaust muffler using the large Jubilee clips, with the outlet pointing rearwards and biased towards to the port side.

b) Mount the exhaust beneath the engine, secured by exhaust springs.

*Orientate the outlet pipe to exit beneath the aircraft.*

*Interesting angles for the exhaust pipes are standard with the Jabiru exhausts!*
11.3.7 **SCAT hoses**

a) Connect the SCAT hose between the air box top connection and the carburettor.

> Secure all SCAT hoses with Jubilee clips at both ends.

b) Connect the SCAT hose between the airbox middle connection and the hot air intake.

c) Connect the SCAT hose between the airbox bottom connection and the NACA inlet duct when the cowling is fitted.
11.3.8 Cowl Reinforcement

a) Cut out holes in the lower cowl to fit around the exhaust pipes.

   *Note that the Jabiru supplied pipes have an interesting offset as standard. The cutouts should be large enough to prevent any chance of contact between the cowl and the exhaust pipes.*

b) Cut a length of aluminium strip to fit across the rear edge of the lower cowling to stiffen it.

c) Cut another strip to brace the first strip in the middle. Attach it to the firewall with two bolts or rivets, and to the lower cowl using a threaded clip as per the cowling join.

d) Fit self-adhesive reflective foil to the front and bottom of the lower cowl and to the top of the upper cowl.

   *This keeps the cowls cool, which prevents them distorting under airflow loads when hot.*
12 Fuel System
The fuel system is shown for the Rotax 912. For other engines the fuel system will be similar. Consult your engine installation manual. For instance, the Rotax 582 system is the same, but without the fuel return line and its associated fittings. The Jabiru system also does not have a fuel return line, has only one carburettor, but the fuel lines must be fitted with fire-resistant oversleeve in the engine compartment.

12.1 Fuel Piping
Follow the fuel system schematic, 243.

![Fuel System Schematic](image)

**Figure 243; fuel system schematic, Rotax 912.**

12.1.1 Engine compartment
a) Fit a T-piece in the pipe joining the two carburettors, Figure.

*Remember to slip the appropriate pipe clips over the pipes.*

*The fuel pipe joining the two carburettors can be conveniently clipped to the intake manifold balance pipe.*

*Fit a second T-piece with a restrictor into this pipe if a fuel pressure gauge is to be fitted. The T-piece restrictor may be made by fitting a sawn-off self-tapping screw, which allows some flow past its sides.*
b) The standard T-piece is connected to a short length of fuel tube running forwards approximately half way to the fuel pump outlet.

c) At this position a T-piece with a restrictor connects to allow the anti-vapour lock fuel return line to pass neatly behind the gearbox, Figure.

   *This restrictor should be a precision Rotax/Skydrive item.*

d) The front of this T-piece then connects to the fuel pump outlet (the smaller diameter pipe).

e) The fuel supply pipe from the tank connects to the inlet of the fuel pump (the larger diameter pipe).

   *Note that although the fuel pump inlet and outlet tubes are of different diameters, the fuel tube will fit over both of them.*

   *A useful tip: to fit ¼” bore flexible rubber pipe to 8mm metal tubes, such as those on the fuel tanks and elsewhere: tenderise (as per a steak) the end of the rubber pipe, or heat it by dipping into boiling water. This softens the end. If not already done, clean up the end of the metal tube with a file, and wash to remove any swarf. Then with a small drop of light oil (3-in-1) placed on the tube or the pipe, slip the rubber tube over the metal pipe. The pipe clips may also be a tight fit, but will go on with some worrying!*

f) The fuel supply pipe and the fuel return pipe both pass behind the gearbox and back over middle of the engine and under the centre piece of the engine mount, to pass through the firewall beside the rear of the port upper engine mount along with the pipe from the additional restricted T-piece to the fuel pressure gauge (if fitted).

   *Ensure that the tubes cannot chafe against the firewall, using rubber grommets or sheaths of split fuel tube or oil hose.*
12.1.2 Cockpit

a) The fuel supply and return pipes pass down the cockpit side of the firewall in front of the nose wheel steering bar, Figure, and then under the floor.

b) The fuel pipe should be routed under the starboard side of the floor back to the fuel filter attached to the steel diagonal bracing piece under the starboard seat, Figure.

*It is held in position by a pair of cable ties run through short lengths of fuel tube to act as spacers.*
12.2 Fuel Tanks

a) Fit the balance pipe fittings to both tanks, close to the bottom of the inside rear corners of the tanks.

*Drill a 31/64” hole in each tank, high enough to allow the sealing washers to sit on the almost flat area on the bottom corner of the tank, Figure, and use the push-in fittings provided. Note the hole size must be correct, no metric equivalents!*  
*Position them low – in the lower half of the flat corner area.*

![Figure 248; balance pipes.](image)

b) Optionally, a second balance pipe may be fitted above the first, to speed bala

c) Drill three holes (only two for the Jabiru and 582, no fuel return is required) in the top of the starboard tank for the fuel supply, fuel return, and a breather, Figure.

*The fittings should be a screw-fit into the holes.*

*Keep the holes close enough to the cap to allow a bent spanner to be used to secure the internal nuts.*

*The fuel supply is the long aluminium pipe fitted with a filter cut in half to form a strainer, and a plastic olive to seal the pipe into the tank. It should be gently bent if necessary to arrange it to take fuel from the inside rear corner of the tank.*

*The other two pipes should be fitted into the tank, but should not stick very far in.*

*Check that the ends of the metal pipes are clean, dress with a file if necessary.*
In a similar manner fit the breather tube to the top of the port tank.

When all the holes have been drilled and the pipes fitted into place, carefully rinse any swarf out of the tanks and pipes with water, and allow to dry with the tops removed.

It is worth trial fitting the tanks in place to determine the lengths of fuel pipe required, then remove them and fit as much of the piping as possible before actually fitting the tanks to the aircraft. Otherwise it is quite difficult to fit some of the pipes in situ.

**12.2.1 Fuel tank load spreader bars**

Ensure that these were fitted earlier, in the section on the forward fuselage.
12.2.2 Fuel tank securing straps

a) Push fit the tanks onto the cross bar in the rear fuselage, the one supporting the flap handle pivot, with the filler caps forwards.

*Put pieces of tape or similar onto the fuselage covering where the rear lower edges of the tanks push against it, to reduce chafe.*

*You may find it easier to fit the pipework to the tank fittings with the fuel tanks sitting loosely in place, before strapping them down. See the next section for the details of the pipework.*

b) Fit the tank securing straps, which are one-piece with a metal ring slipped over the strap. Start by looping the strap around the lower support on the outboard side of the tank, with the metal grip end as the stationary end.

![Figure 251; metal ring.](image)

c) Take the strap up and over the tank leaving the ring half way up the outboard tank side.

d) Continue down the other side around the lower support and back up over the tank. Pass through the tank handle each time.

e) On the way back down pass through the ring and change direction to encircle the tank. On the way take a turn around tube *tu27*, Figure.

f) Pass back through the ring and then change direction again downwards to engage in the metal grip end.

g) If the ring does not sit flat against the tank side, the straps should be re-routed through the ring from the other side. Look at it long enough, and you'll manage!

h) Pull everything tight, working the tension around the system until even.

i) Finally tie off any loose strap.
12.2.3  Fuel tank connections

a) The fuel drain should be connected to the fuel balance pipe (the lowest if two are fitted). Fit the pipe with a T-piece to connect the fuel drain, which must discharge clear of the aircraft, Figure.

*The fuel drain tap can be secured with a P-clip attached to the undercarriage leg with a small self-tapping screw.*

![Figure 252; fuel drain.](image)

b) The fuel supply pipe should be connected from the pickup dip tube in the starboard tank to the fuel tap.

c) The fuel tap should be mounted between the fuel tanks towards the starboard side, Figure.

*The mount for the fuel tap is a small piece of aluminium angle, riveted onto the cross-tube below it.*

![Figure 253; fuel tap.](image)

d) The tap should then be connected to the fuel filter under the starboard seat.

e) The fuel return pipe from the engine compartment should be attached to its fitting in the top of the starboard tank.
f) Both breather fittings should have individual lengths of tubing attached, routing directly upwards to curve over and into the tops of the rear cabin uprights. This ensures a reasonable static pressure, and that the pipes discharge overboard. Use a short length of bent aluminium tube at the top ends of the plastic tubes, otherwise the plastic tubes are likely to kink where they are bent over to fit into the top of the rear cabin uprights.

![Figure 254; fuel tank breather.](image)

![Image of fuel tank breather.]

g) Secure the pipes at the top of the tanks using pieces of fuel tube with cable-ties passed through them between the pipes and the tank handles, as seen in Figure.

12.2.4 Drainable sump verification procedure

The fuel system is designed to operate with the fittings as low as possible in the tank in order for the fuel drain to be effective at removing water and debris. It is also designed for the fuel supply dip tube to be above the level of the drain to provide a sump area so that accumulations of water / debris between draining does not get ingested into the supply to the engine.

a) Fill the tank with fuel up to the point where the linking / drain fittings are completely covered.

b) Remove fuel from the tank using the drain until no more fuel will come out.

c) Measure in a further 0.25L of fuel.

d) Size the supply dip tube by trimming the end so that it aligns with the level of fuel (important the end of the dip tube must be cut at a 45 degree angle so as to prevent suction causing a seal with the strainer end cap). Check that the dip tube end is in no case higher than the moulding line step viewed from the rear of the tank (otherwise the unusable fuel is greater than that allowed in Section S)
c) Fix the delivery dip tube into position with the retaining gland screwed tight and secured against vertical movement (as illustrated using cable ties and spacers on to the handle on the top of the tank.)
12.3 Choke

12.3.1 Rotax 912

The choke is fitted to the instrument panel, which is not fitted until the next chapter, so fit the other parts now and complete the choke fitting when the panel is installed.

a) The choke is a simple loop of cable covered with plastic tube, passed through the instrument panel on the port side, Figure.

This position is chosen to allow the choke to be operated with the same hand holding the throttle lever.

A pop-rivet with the centre pushed out makes a neat cable guide for the choke cables passing through the instrument panel. Secure the rivets with a small piece of tubing pushed over the rear of them, or with a touch of glue.

b) The cable outers are mounted on a plate riveted to the port side of the firewall, alongside the throttle cables, Figure.

The choke cables are the pair towards the centreline of the aircraft, on the left of the picture.

Figure 257; choke.
12.3.2 Rotax 582

Figure 258; Rotax 582 choke cable and lever arrangement.

a) The choke lever should be mounted to a spare hole on the pilot’s side of the port central cabin tube.

b) The cable outers should be mounted to a plate attached to the bolt holding the central cabin tubes to the front vertical tube.

c) The cable inners, terminated with loops, should be attached together and to a single length of cable to attach to the lever.

12.3.3 Jabiru Choke and Carb Heat Controls

These are fitted to the instrument panel, which is not fitted until the next chapter, but the cable routing should be prepared now whilst access to the rear of the firewall is reasonably easy. Complete the fitting when the panel is in place, noting that the cables need to be fed in from the front of the panel.

a) The choke cable is provided with the Jabiru engine installation kit and should be fitted to the instrument panel close to a support.

*If a panel with a drop-down central part is fitted then this is ideal for the choke and carb heat cables, Figure.*

Figure 259; choke and carb heat knobs for Jabiru.
b) Pass the choke cable through the firewall and loop it around to connect to the choke (the aft-most connection on the carburettor).

c) The outer cable may be cut to fit if required.

d) The cable outer end fitting is attached by slipping it over the outer cable and carefully compressing it with the crimping tool provided in a vice.

   *Remove the cable from the aircraft again for this stage.*

e) The cable inner end fitting should be fitted in situ by locating the small brass tube in the hole in the choke lever (the aft-most one with the small hole).

   *Slip the inner cable through the hole on the side away from the carburettor and solder the inner cable in place in the small tube.*

   *Secure the other end of the small tube into the hole in the lever using the split pin provided.*

   *Spacer washers may be used to take up any slack if necessary.*

f) The carb heat cable should be looped around and passed through the firewall to connect directly to the carb heat actuation lever.

g) Drill the hole in the firewall to line up with the cable outer clamp on the airbox.

h) Clamp the cable outer in place.

i) Attach the cable inner to the actuating lever in the same manner as for the choke cable.

j) With the cables in this position the drop down part of the instrument panel must be braced to the central cabin tubes with a pair of bent aluminium brackets Jubilee-clipped to the central cabin tubes and screwed or bolted to the instrument panel.

![Figure 260; ‘Drop down centre’ Instrument panel centre mounts.](image)

12.4 Throttle Cables

12.4.1 Rotax 912

a) The throttle cable outers terminate at the firewall on a plate riveted to the port side of the firewall, Figure.

*The throttle cables are the pair on the right, towards the outside of the aircraft.*

*Position the plate as close to the edge of the firewall as possible. Ensure that the firewall is securely attached to the cowling at the plate position, otherwise unreliable idle settings and sloppy throttle control will result.*

![Figure 261; throttle and choke cables at firewall.](image1)

b) The cables pass through the firewall to mount onto the lever with swaged loops and plastic washers, one cable to each side of the bolt.

![Figure 262; throttle and choke cables aft of firewall.](image2)

c) On the engine side the cables should be looped around as necessary to achieve nice smooth cable runs, with no sharp bends. They should then attach to the throttle on each carburettor.
d) Take care to ensure that the cables are secured clear of the throttle arms, as it is easy to prevent them from moving to their fully open position if a cable gets caught around them.

*Cable-tie them to convenient fixings.*

**12.4.2 Rotax 582**

a) Mount the cable outer terminations onto the port throttle lever.

b) Mount the inner cables onto the bolt and spacer tube with a large washer at the end, and fit this to the hole in the throttle mounting plate.

c) Pass the cable inners through the outers and connect them to the carburettors.

d) Check the angular movement of the cable outer mount on the lever as the throttle is operated. Determine the central position of this movement and tighten the bolt to secure the outer cable mount in this position.

*This will minimise the bending action on the cables.*

**12.4.3 Jabiru**

a) Connect the loop in the throttle inner cable to the lever on the carburettor using a 6mm bolt fitted with a short 8mm length of aluminium sleeve in the hole in the lever. The bolt passes from the carb side of the lever, through the spacer and then through the white plastic cable piece, to be secured by the nut. Ensure that the spacer tube is long enough so that the whole assembly can rotate in the hole in the lever, rather than being solidly fixed in the hole.

b) On the engine side the cables should be looped around as necessary to achieve nice smooth cable runs, with no sharp bends.

c) Fit the single firewall plate to line up with the inboard side of the throttle lever and slightly below the level of the lever at idle.

d) Connect the inner cable to the lever using a solderless nipple and the aluminium U-bracket with 5mm pivot bolt as per Figure.

*Figure 263; Jabiru throttle lever connection.*

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13 Instruments

13.1 Standard Instrument Panel

(Proceed to Section 19 if you have the Mk2 Curved top instrument panel)

a) Notch the lip on the instrument panel so that it will clear the cabin uprights.

\[ \text{tu34.} \]

The instrument panel is the grey fibreglass part with a 90 degree lip along one edge.

The panel is installed with the lip on the bottom.

b) Hold the panel in place and slide up and down until the throttle levers can come to within 5° of vertical before they contact the bottom edge of the panel.

This is intended to allow the golf balls to contact the curved edge of the dash board as the full-throttle stop, rather than the throttle lever crushing the bottom of the instrument panel.

c) Mark the top of the panel level with the cowling top edge, and trim to this level.

The slope of the cowling should ensure that even with the extra thickness of the dash board on top of the panel, it will be level with the cowling in front of the cabin uprights.

This is the standard position for the panel, however it may be made deeper by either moving the throttles downwards (discussed earlier in the section on fitting the throttles) or by allowing the top of the panel to go higher than the line of the cowling. In the latter case the back of the panel can be hidden by some black plastic if desired. The dash board top can still be fitted, or left off entirely.

Do not be tempted to keep the panel deeper by cutting slots in it for the throttle levers: the panel will be seriously weakened, and long-legged pilots’ knees will bash the panel.

d) Cut a piece of light gauge aluminium angle to fit between the cabin uprights and trim level with the top of the panel.

Figure 264; example of instrument layout, Rotax 912.
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e) Secure the panel and angle in place using two self tapping screws on each side, one at the top (securing the angle as well) and one at the bottom, with the top of the panel level with the top of the fibreglass cowlings.

*The angle can be riveted to the panel to provide additional support if desired.*

f) Make sure the instrument panel does not interfere with the operation of the hand throttles.

g) Trim the panel ends flush with the outer edges of the cabin upright tubes.

h) Mount the instruments, magneto switches etc. in the panel as desired.

*However, note the position of the throttles and their torque-tube and do not mount instruments so that they interfere with them.*

BMAA TILs 7 and 27 may be useful reading regarding the fitting of instruments.

A useful approach to cutting neat holes is to mark out the hole, drill a large number of holes inside this line close together, cut between them with a junior hacksaw, then finish the hole to the line with an abrasive flap-wheel in a power-drill.

13.2 Pitot-Static System

a) The Pitot probe should be mounted at the port forward lift strut to wing attachment using a P-clip, Figure.

*Replace the standard bolt with a longer bolt.*

![Figure 265; Pitot probe location.](image)

b) The connecting tube should be routed down the inside of the lift strut, to a push fit joiner tube at the fuselage to lift strut bolt.

c) The fuselage piece of tube should enter the cockpit and pass under the floor and up behind the instrument panel to the ASI.
d) The static system consists of a pair of static ports, one on each side of the fuselage, positioned as shown in Figure.

*These ports can be elegantly and simply made with a large pop rivet with the centre pushed out, passed through a hole in the fuselage and secured by the fitment of the tube on the inside.*

*They are located approximately 20cm forwards of the rear edge of the cowling, and 5cm above the join between the top and bottom halves of the cowling.*

e) The two ports join at a T-piece, and must then connect to the ASI.

*It may also be optionally connected to the altimeter and the VSI.*

13.3 Radio Aerial
A suggested position for fitting a radio aerial is shown in Figure. The aerial is mounted on a plate, which is in turn mounted on the rearmost bolt securing the port upper rear fuselage tube.

*If removing this bolt ensure that you push it out with another bolt so as not to lose the internal spacer tube – it’s rather tricky to get it back again!*

Figure 266; static port location.

Figure 267; suggested aerial mounting.
Figure 268; overall wiring schematic, Rotax 912 and standard instruments. (ensure all colours are visible when printed out)
Figure 269; heavy duty power wiring schematic, Rotax 912.
Figure 270; low current wiring schematic, Rotax 912.
Figure 271; instrument wiring schematic, Rotax 912.
Figure 272; overall wiring schematic, Rotax 582 and standard instruments.
(ensure all colours are visible when printed out)
Figure 273; heavy duty power wiring schematic, Rotax 582.
Figure 274; low current wiring schematic, Rotax 582.
Figure 275; instrument wiring schematic, Rotax 582.
Figure 276; overall wiring schematic, Jabiru 2200 and standard instruments.  
(ensure all colours are visible when printed out)
14 Electrical System

Figure 277; heavy duty power wiring schematic, Jabiru 2200.
Figure 278; low current wiring schematic, Jabiru 2200.
Figure 279; instrument wiring schematic, Jabiru 2200.
14 Electrical System

14.1 Wiring General Points

A ready-made wiring loom is included with the engine installation package for the Rotax 912, Rotax 582, and the Jabiru 2200 with standard instruments. The instructions on wiring assume you have either bought this, or are wiring it yourself in the same manner.

If you do not have a basic understanding of electrical systems it may be advisable to buy an introductory text on electrics, especially if you are not using the ready-made loom, or are adding extra equipment. This will serve you well throughout your flying career, not just whilst wiring your Skyranger!

When making connections, crimping is generally the quickest and best method. Soldering may seem attractive, but introduces fatigue points and so is not generally recommended.

Crimp tools: you get what you pay for. This is a good moment to spend as much as you dare, your crimps will be better for it! Alternatively, you may be able to borrow or hire a decent tool.

Keep all wiring neat, and ensure that no bare metal connections are visible which may lead to short circuits. Heat shrink tubing is neater than insulation tape for this job! It is available from Maplins, electrical and car accessory shops etc..

Secure the wiring with cable-ties, P-clips or similar, ensuring that it remains clear of all moving and vibrating parts, and is protected from chafing against sharp edges.

Also ensure that the wiring cannot be accidentally damaged or disturbed by pilots’ feet, baggage etc..

14.2 Low Current and Instrument Wiring

The low current wiring consists of that for the instruments, master switch and magnetos, plus other ancillaries such as a radio.

a) Read the instructions which come with the engine and the instruments.
   
   *BMAA TILs 7 and 27 may be useful reading too.*

b) The wiring loom should pass through the firewall alongside the central cabin tubes.

   *On the 912 installation the port side is the clearest, close to the fuel lines. On the Jabiru installation the starboard side is the clearest.*

   *The yellow solenoid starter wire plus others sprouting from the main harness should be positioned in front of the firewall.*

c) The wires from the 912 magneto should also pass through the firewall in this position, one set to the instrument panel for the tachometer, and one set to the regulator.

   *See the engine instructions and wiring diagram for wire colours.*

d) The ignition switch wires must also pass through the firewall, but keep them away from the others. Amongst other (safety) reasons, this should reduce electrical noise which may be audible in headsets and on the radio.
e) The fuse box can be riveted to the starboard central cabin tube behind the instrument panel, Figure.

   *The contacts can be conveniently connected together, where required, by drilling one hole through each of the protruding contacts in a line and soldering a length of solid wire into the holes.*

![Figure 280; fuse box.](image)

f) The connections on the cabin side should be made according to the instrument instructions and the electrical system schematic.

g) A common earthing bolt can be fitted to the base of the instrument panel to provide a convenient earth point for the instruments and other connections, Figure.

h) All switches in aeroplanes should be UP for ON (in the sense of running, powered etc.).

   *Note* “On” labelled on the switch is actually OFF as far as the engine is concerned, as the magnetos are grounded to prevent operation.

   *On the 912 the master switch is a double-pole single throw (DPST) type, to allow it to turn off the power from both the battery and the regulator, as the regulator draws current even when off. On the Jabiru a single-pole switch is used and the regulator is permanently connected to the battery, as it draws no current when off.*
i) The connections on the engine side should be made according to the engine installation manual and the electrical system schematics.

j) On the 912 the optional capacitor shown in the wiring diagram and the Rotax installation manual may be fitted if desired, although it is rather bulky.

   This has two uses: if you experience interference with your radio through its power supply from the regulator, the capacitor will reduce this by smoothing the supply a little, although the battery already does most of this and a radio power interface does the same thing. The capacitor also provides a fail-safe against accidental disconnection of the battery whilst the engine is running, which would otherwise cause the regulator voltage to rise with possible damage to instruments, radio etc..

   Disconnection would occur either by blowing of the fuse to the battery or if the wire to terminal C on the regulator were to become disconnected.

   A suitable capacitor is available from Rotax/Skydrive. If only protection from disconnection were required, a smaller capacitor could be used at your own discretion.

k) Other optional items are shown on the wiring diagrams: they are an hour-meter, a master-switch warning buzzer, and a start-button warning light.

l) If a master warning buzzer is required on a Jabiru installation the wiring must be altered to disconnect the regulator from the battery in a similar manner to the 912 installation, using a double-pole switch. The buzzer may then be connected between the unused connection on the regulator and earth.

m) Additional systems such as GPS, radio etc. should be individually protected by fuses of the appropriate size.
14.3 Battery

a) All high current cables should be kept as short as possible.

b) The battery should be installed in its supporting box in the hole in the floor between the central cabin tubes, underneath the dash board.

c) Secure with the webbing strap.

d) Ensure that the engine block is well earthed to the airframe, Figure. Here an extra hole has been drilled in the engine mount. Alternatively, attach the earth to one of the existing bolts if enough thread length is available.

e) Attach the earth cable to the battery negative and to a bolt on the engine block.

   Route the cable through the firewall in the vicinity of the other wires.

f) The regulator can be positioned on the front or rear side of the firewall, such as Figure and Figure.
Figure 284; 912 solenoid and regulator on port side of firewall front and rear.

Figure 285; Jabiru regulator and solenoid, starboard front side of firewall.

g) Ensure that the regulator is properly earthed.

912: With the solenoid positioned in front of the firewall and the regulator behind it, this may be accomplished via a common securing bolt. This bolt should then be connected to a convenient earthing bolt on the instrument panel using the separate black wire provided with the standard wiring loom, thus providing a good earth for the instruments etc..

Jabiru: an earth connection is provided on the regulator connector as shown on the wiring diagram.

h) Ensure the battery terminal boots are firmly in place, and that the rudder stop cables are held away from the battery by their bungee restraint.

Failure to do this may result in a short circuit and fire!
15 Dash Board and Windscreen

15.1 Dash Board

a) Re-check the position and symmetry of the cowlings. Use the paper template supplied with the kit to cut the shape of the two dash board parts out of cardboard.

*Cut the templates oversize, except for the straight rear edges on the 912 templates.*

*Templates for other engine types may need to be extended at the rear to accommodate different cowling positions. Cut oversize and trim to fit.*

![Figure 286; fitting using cardboard templates, and the result, a (well used) dash board.](image)

b) Use them to make adjustments so that they fit nicely in place, Figure.

*Use the straight rear edges of the templates as the reference lines. The rear panel reference line should align with the forward edge of the instrument panel.*

*The sides of the dash board towards the rear will have to be left a slightly loose fit, to allow the windscreen to pass down beneath the dash board.*

*Towards the front of the dash board the windscreen will normally be cut to finish above the level of the dash board. However, if the lip for riveting the screen to is rather narrow it will be necessary to allow the windscreen to pass down the sides of the front dashboard piece. This gives more room for the rivets, but will require more trimming of the dashboard.*

*The rear part of the dash board will require slots to be cut to pass the aileron cables through it, as marked on the template.*

*On the Jabiru engine the cowling is further forwards, therefore it may be necessary to use an offcut piece from the sides of the dashboard to extend the dashboard slightly further forwards in the centre.*
c) Use this fitted cardboard template to cut the fibreglass parts, Figure.

The panel without the rounded edge is used to make the front part of the dash board. Lay the panel upside down, mark the template out, and cut. A jigsaw works well, cutting on the upstroke to reduce the chance of damage to the upper surface of the panel. Take care not to damage the central cut-out, as the removed part will be put back in place to cover the hole.

d) It may be desirable to thin the forward edge of the panel to fit more easily between the underside of the cowling and the top of the firewall.

e) With the main panel upside down, draw a line on the flat part 3mm forward of the edge of the curved part above it, to mark the forward side of the instrument panel. Align the template with this line and cut out.
f) Fix the dash board to the aluminium angle behind the instrument panel and to the top of the firewall, Figure,

*Use the light gauge aluminium angle in 50mm lengths to form brackets to fix the dash board to the top of the firewall.*

*Two bolts at the front and two bolts at the rear should be sufficient, although more should be used if you wish to mount any instruments, such as a GPS, on top of the dash board.*

*To fit the dashboard it may be necessary to temporarily undo the instrument panel and allow it to lie against the throttle levers.*

g) Glue, or secure with bolts, the cut-out parts back into their holes.

*Ensure that edges of the glassfibre dashboard and instrument panel do not rub on any of the tubes, as the glass will abrade the tubes in the same manner as glasspaper, damaging them surprisingly quickly!*

h) Sand all edges smooth and use a black felt tipped pen, or paint, to colour the visible edges.
15.2 Windscreen
Do not allow threadlock (Loctite etc.) or other solvents to come in contact with the Lexan as it will damage it severely.

a) Apply the supplied strips of thin self-adhesive foam strip to the tubes supporting the top part of the windscreen.
   *This will reduce noise and vibration.*

b) Cut the Lexan sheet to Figure.

*For engines other than the Rotax 912 do not cut the forward end of the windscreen (the 1720 and 1900 measurements) but leave this full length and cut to fit in situ.*

![Figure 288; windscreen cutting pattern.](image_url)
c) Drill the two rear holes marked on the rear part of the Lexan.

d) Lay the Lexan over the cockpit, locating the holes in the Lexan over the two bolts sticking up at the rear of the cockpit.

Check that you have not left the leading-edge securing pins in place, as if you do, and they are incorrectly inserted from the front instead of their proper insertion from the rear, you will not be able to get them out again when you have fitted the windscreen!
e) Push the windscreen into position behind the cowling lip.

The windscreen must go inside the lip of the cowling and stop above the dash board at the front, and pass down the sides of the dash board towards the rear, Figure.

If there is not enough material along the cowling lip to secure the rivets then the windscreen may pass down the sides of the dashboard even at the front, although the dashboard will need further trimming to allow this.

The windscreen pattern is intended to be oversize at the front: insert the screen and position carefully, then if it is too long mark along the inside a short distance above the dash board (hold a pen flat against the dash board). Remove the screen and trim to this line, and repeat until the windscreen fits nicely above the dash board at the front and passes down the side of the dash board towards the rear.

Take care that the tubes tu34 supporting the windscreen do not get knocked out of position, check them regularly, and check that the shape of the cowling remains as it should be otherwise you may build a strange shape into the windscreen and the cowling!

![Figure 291; windscreen passing down side of dash board.](image)

f) Rivet the Lexan every 15cm or so to the large curved tubes on the top sides of the fuselage.

Use the pre-drilled holes, start at the rear and work towards the front of the Lexan.

g) Get two helpers, one on each side of the fuselage pushing the Lexan tightly into the inside of the curved part of the cowling.

Make sure there are no gaps, and that the Lexan is evenly positioned with respect to the cabin upright tubes tu34 on each side, and that these are in their correct positions too.
h) While the two people hold the cowling in place, drill holes through the cowling and the Lexan to hold it in place with rivets.

Check that the cowling has not distorted, particularly with reference to the minimum 10mm clearance from the spinner – the bonnet must be secured in position before riveting on the lexan, or it may not fit afterwards!

The curvature of the cowling can be increased slightly by lifting it in the middle before fixing the windscreen, to increase space for the carburettors etc. Don’t over-do this however, as you will distort the rest of the cowling.

Use washers on the inside to spread the rivet loads against the Lexan. Space the rivets evenly, every 100mm or so, starting with one rivet in the exact centre (this will be used later for the screen bracing batten).

i) Drill and rivet the sides of the windscreen to the cabin uprights tu34.

The spacing of the rivets should be around 60mm or so, and for best effect it should be matched to the doors.

j) Trim the excess Lexan so that it is even with the rear of the tubes.

k) Drill holes in the windscreen centre batten for rivets, matching the spacing on the adjacent windscreen supports

The batten will need careful bending to precisely match the curve of the windscreen.

While one person holds the batten against the underside of the top of the windscreen, another person can drill from the top, through the Lexan.

l) Rivet it in place with a layer of self-adhesive foam between it and the Lexan.

Note, if the optional Screen centre batten is to be fitted, before riveting in place follow the instructions in 15.2.1
m) With the left over Lexan, cut a triangular piece to fit in the corners of the windscreen and tube tu34. Secure in place with rivets through tubes tu34 and through the cowlings.

The join can be covered with another strip of Lexan riveted in place, if desired, however it looks best left as is.

A pair of vents such as those available from Light Aero Spares may be fitted across the joins if desired.

n) The rear of the windscreen should be secured to the upper rear cabin tube using 3 or more rivets or self-tapping screws and a strip of aluminium between the bolts holding the rear of the windscreen, Figure. Use self-adhesive foam strip between the windscreen and the tube to get a good seal otherwise the rain will blow down your neck!

![Figure 293; strip along rear of windscreen.](image)

o) It is important to get a good seal between the lexan roof panel and the upper surface of the wings. This affects glide performance and stall characteristics. Where the lexan overlaps the upper surface of the wing the gap should be sealed using the self adhesive foam strip supplied. This should be fitted with the self adhesive side against the lexan. It may be necessary to use more than one thickness to close the gap on the front ¼ of the chord. It will be necessary to fit the wings to mark the position to attach the foam, and remove them again to fit it. You can wait for final rigging to do this – but don't forget!
15.2.1 Screen centre batten

At high cruise speeds the windscreen distorts slightly. This can be prevented with the installation of the optional Screen centre batten. This is part of the mandatory build standard for the Swift model, recommended for the standard 912S model, and may be fitted to all models.

a) Cut the end off the roof centre batten to expose the hollow tube end.

b) Fit the small tube plug inside the end of the tube so that half its length is exposed. Plug onto this the screen centre batten tube

c) Curve the ensemble to match the curve of the roof and windscreen as precisely as possible. It may be necessary to trim the length of the screen centre batten to fit.

d) Apply the thin self adhesive foam strip to the batten ensemble where it will touch the lexan.

e) Fix into position. Use 4mm aluminium rivets to fix to the roof area as per 15.2  k). Do not use any rivets down the forward windscreen portion – use only one rivet in the screen centre batten just beyond the join. Secure the bottom end of the screen centre batten using a 4mm rivet or 4mm bolt to pass through the glassfibre upper rear cowling piece, the lexan and through the batten.
16 Doors
The doors should be made to fit, with the wings in place for the final trimming. Care with cutting and positioning the doors will reduce the number of draughts!
Check and double check the fit before cutting the parts, especially the Lexan. The exact measurements depend upon a number of factors, such as sills, floor etc. Use the drawings as a guide only.

16.1 One Piece Door

Figure 294; one piece door.

Figure 295; one piece door frame.
16.1.1 Door sills

a) Trim the fibreglass door sills to fit around the undercarriage drag link and to fit inside the cowling at the front.

![Figure 296; door sill.](image)

b) Secure them by the bolt at the bottom of the side of the tu34 cabin upright tubes.

*The bolt must pass right through the cowling, the sill and the tube.*

c) Use rivets or self-tapping screws to fix the sills to the horizontal tubes tu16 at the base of the door openings, at a maximum spacing of 150mm.

*These can be fitted vertically to the underside of the tubes, to keep them out of sight, but at least three should be fitted to the sides, with equal spacing, to help rigidity.*

16.1.2 Lexan fixed gussets

a) Cut the two triangular pieces of Lexan required to attach in the area to the lower rear of the door, between tu144 and tu6.

*The rear and lower edges can be cold folded to 45 degrees 10mm from the edge to form a neat finish. This can be done in a bending brake, or by clamping between two bits of stout timber.*

![Figure 297; triangular piece of Lexan..](image)
16 Doors

Attach them using Rivets. Only rivet along the lower and rear tubes, don’t rivet to the steel diagonal tube. Use a minimum of three rivets per edge.

16.1.3 Door frame

a) Drill out the hole at the top of the cabin uprights tu34 to 5mm.

b) Take the door frame and offer it up to the opening.

Aim for a final position with an even 10mm spacing from the cabin uprights tu34 and the top of the door sill. The rear edge should be approximately 20mm from the rear cabin uprights tu6 and due to its shape rather more from the steel diagonal brace tu144.

c) Carefully bend the frame as required to ensure the best fit.

The relative positions of the rear cabin uprights tu6 and the cabin uprights tu34 requires that the rear edge is also bent outwards slightly relative to the front.

d) With the frame supported in position mark the front edge of the door frame 10mm lower than the pivot bolt centre in the cabin upright tu34.

The pivot bolt will pass through the hole at the top of tu34.

![Figure 298; forward and rear pivots.](image)

e) Mark the rear edge 15mm up from the lower edge of the rear spar attachment bracket.

f) Remove the door frame and carefully hacksaw to these marks and dress with a file.

g) Fix in place the upper rear hinge piece to the rear cabin upright tu6.

This attaches at its top with a 5mm bolt through the hole already in tu6. Secure the lower fixing with a 4mm rivet. Slide the L-shaped part of the hinge assembly onto the spigot.

h) Temporarily fit the front hinge plate onto the hinge bolt though tu34.

i) Offer up the door frame to the correct position. Mark the forwards edge with the correct position for the hinge plate drillings.
j) Remove, drill and rivet in place the hinge plate.
   *Use 4mm steel rivets.*

k) Refit the door frame. Offer up the top cross-piece of the doorframe and mark to attach it to the doorframe.

   *Its forward edge should be positioned so the upper edge is flush with the top of the doorframe tube. The rear should be positioned so the that the top of the tube is level with the top of the rear hinge plate (5mm above fixing bolt centre).*

l) Offer up the rear gusset plate (found in the bag of door fittings) to the L-shaped part of the hinge assembly. Mark their positions.

m) Drill and rivet the top cross-piece, gussets and hinge piece.

   *Use 4mm steel rivets.*

n) Fit the door frame and check satisfactory fit and opening.

o) Offer up the centre cross-piece tube and mark the length to trim.

   *This piece has a slight curve, trim from the straight end. It should fit to align with the top of the cowling at the front and sit just above the bend in the frame at the rear.*

p) Drill and rivet the centre cross-piece and gussets, Figure and Figure.

   *Use 4mm steel rivets.*

q) Do a final check of fit and operation of the doorframe.

Figure 299; rear of centre cross-piece.
16.1.4 Fitting the Lexan

a) Cut out the Lexan sheet from the patterns.

*Use a large pair of tin snips. The patterns are supplied as a guide, and your individually constructed doors may vary slightly, so cut oversize initially to be safe.*

b) With the door in position offer up the Lexan and mark some reference points to align with the door frame.

*The Lexan can be fitted flush or overlapped with the windscreen and cowling at the front edge and overlap at the lower edges by approximately 25mm. The rear edge should be overlapped to at least the centre of the rear cabin upright **tu6**. The upper edge should sit inside the wing root and should be 50mm or so above the wing undersurface. It may have to be trimmed slightly lower than this at the rear to avoid fouling the structure during opening.*

c) Before riveting mark the holes on the doorframe.

*Use a nominal rivet spacing of 60mm. Remove the protective coating from the inside face of the Lexan, leave it in place on the outside but remove it using your fingernail around each point to clear the rivet heads.*

d) Drill and rivet in place using 4mm aluminium rivets.

*Work from the upper front corner, and rivet the front edge first. Follow this by riveting the lower edge. Due to the curve in the central cross-piece the rear edge will have to be worked around the curve, to avoid a wavy edge.*

*It may be necessary to drill out some rivets and reposition the tension in the Lexan slightly to get the best fit. Do not be tempted to put more curve in the central cross piece to give greater shoulder room or you will turn this into an impossible task! Finish by riveting the upper cross piece and then the central cross piece.*

*When drilling angle the drill slightly away from the last rivet. When squeezing the rivets bring the rivet upright. This then applies some light tension to the Lexan and prevents the Lexan bulging between rivets. Take care when drilling to ensure the tube is drilled centrally.*

e) Fit the door and check its fit and operation.

f) Trim the rear edge of the Lexan to match the line of the triangular pieces behind the lower doors.

g) Trim the Lexan to accurately fit around the forward wing spar and the aileron cables, and trim the top edge to miss the wing tension bolts.

h) Fit the thin self-adhesive foam strip around the lower and rear edges.
16.1.5 **Fittings**

a) Fit the lower catch assemblies as per Figure and Figure.

*It should be positioned so that the 6mm hole is drilled 300mm rearwards from the rear edge of the cabin uprights tu34 and the cowlings.*

*Use two 4mm steel rivets to attach the aluminium plate to the doorframe.*

![Figure 300; lower catch.](image)

b) The inner edge of the sill should be positioned so the latch it a tight fit to lock into place.

*The fibreglass can be filed a little to achieve a slight indent to prevent the lever from inadvertently rotating to the open position, or an aluminium piece can be riveted on to protect the fibreglass from wear.*

c) Position the front catch just above the gusset plate for the forwards edge of the centre cross piece.

*UKMOD: this is an additional catch for UK aircraft to secure the front of the doorframe to the cabin uprights tu34.*

*It should be fitted with the bolt tightened to ensure enough friction to prevent inadvertent rotation. A convenient hole in tu34 can be used as a detent, or one drilled for the purpose.*
d) With the wings fitted and in place fit the open door keeper, Figure.

*This should be positioned so that the door handle can be rotated into it. It is fitted to the wing surface with two screws (cut these to length) with spreader plates made from two rectangles of scrap Lexan 30mm X 150 (15mm radius at each end) either side of the wing fabric. This job will require two people or very long bendy arms!*

Figure 301; front catch.

Figure 302; open door keeper.
16.2 Two Piece Door

16.2.1 Lower door frames

![Two piece door](image)

Figure 303; two-piece door.

a) Fit the fibreglass door sills if desired.

The Skyranger UK two-piece doors can be fitted with or without the fibreglass doorsills supplied in the main kit. The standard patterns and some of the hardware assume that the doorsills are not fitted (the recommended option for weight reasons, they weigh 1kg). If you choose to fit the sills then some adjustment will have to be made to the vertical position of the lower tube piece on the bottom door, plus some trimming of the gusset plates and the Lexan pattern for the lower doors.

The sills require trimming to fit around the undercarriage drag link and to fit inside the cowling at the front. They should be secured by the bolt at the bottom of the side of the **tu34** cabin upright tubes, passing through the cowling, the sill and the tube. Rivets or self-tapping screws should be used to fix the sills to the horizontal tubes **tu16** at the base of the door openings, at a maximum spacing of 150mm. These can be fitted vertically to the underside of the tubes, to keep them out of sight, but at least three should be fitted to the sides, with equal spacing, to help rigidity.

b) Ensure that the aluminium door hinges have been fitted to the cabin uprights **tu34**.

Typically these should be fitted so that the bottom edge is above the lowest bolt on the cabin uprights, with the top edge approximately level with the bottom of the dash board lip. However this will vary depending on the positioning of the dashboard.

Remember that the doors open outwards and forwards, so the hinge “bulge” needs to be on the outside.
c) Position the lower door frame tubes so that the lower tube clears the ends of the cabin cross member \textit{tu15} by at least 5mm, with the forward end of the upper door frame tube sitting snugly just under the dash board lip, and at its rear end the upper edge of the tube should align with the colour change in the rear fuselage fabric.

\textit{If your instrument panel is non-standard use the Lexan pattern to guide you for vertical position at this point.}

\textit{Make sure that the rear part of the door frame is close enough to the rear cabin upright to allow the door catch to reach without requiring the rivets to be positioned too close to the door tubes.}

d) When happy with the positioning tape the doorframe tubes to the structure in the closed position.

\textit{Take care that the upper tube is the correct way around (bend rearmost) and not sagging due to rotation.}

e) After verifying the correct positioning drill through the tubes and hinge and either attach with Cleco’s (temporary rivets) or aluminium rivets (which will be removed later when fitting the Lexan).

f) Drill and rivet the gusset plates into position – six of the 4mm aluminium rivets should be sufficient.

\textit{Make sure that the doorframes are not allowed to twist during this process.}

g) Un-tape and check correct fit and opening and closing.

\textit{Some adjustment by carefully bending the tubes may be required.}

h) Fit the small fixed part of the slide bolt to the aluminium angle piece.

\textit{Drill and countersink the rivet holes so that the rivets do not protrude noticeably from the surface of the bracket and cause misalignment with the slide bolt.}

\textit{Do not fix it to the door pillar at this stage.}

i) Use the fixed part as a guide to determine the correct positioning of the main part of the slide bolt on the gusset plate.

\textit{Use the aluminium rectangles under the slide bolt to lift it and ensure correct alignment with the fixed catch.}

j) When satisfied with the positioning fix the main part of the slide bolt into place.

\textit{The fixed catch part should be fitted to the door pillar later, after the Lexan has been fitted, as fitment of the Lexan can cause changes in the exact alignment.}
16.2.2 Upper door frames

d) Fit the upper rear hinge piece to the door pillar \textit{tu6}, Figure.
\textit{This attaches at its top with a 5mm bolt through the hole already in \textit{tu6}. Secure the lower fixing with a 4mm rivet.}

e) Slide the L-shaped part of the hinge assembly onto the spigot.

f) Offer up the upper doorframe into position.
\textit{Space it evenly 20mm above the lower doorframe.}

g) The rear upright part of the doorframe must be bent outwards to match the different angles of the cabin uprights and the door pillar \textit{tu6}.

h) Drill out the hole at the top of the cabin uprights \textit{tu34} to 5mm, Figure.
\textit{The doorframe will pivot on a bolt through this hole.}

i) When happy with the fit of the upper doorframe, mark the position of the hole to be drilled in the doorframe for the pivot bolt.
j) Offer up the top crosspiece of the doorframe and mark the position to attach it to the doorframe.

*Its forward edge should be positioned so the upper edge of the tube is 10mm lower than the forward pivot bolt hole centre. The rear should be positioned so that the top of the tube is level with the top of the rear pivot plate (5mm above the fixing bolt centre).*

k) Offer up the rear gusset plate (found in the bag of door fittings included in the main kit) and the L-shaped part of the hinge assembly. Mark their positions.

l) Remove the door pieces.

m) Drill the hole for the forward hinge bolt.

n) Drill and rivet the top cross piece, gussets and hinge piece all together.

o) Refit the door by sliding it onto the rear hinge spigot before inserting the forwards hinge bolt, with a small piece of plastic tube used as a spacer on the bolt between door frame and cabin uprights.

p) Check satisfactory fit and opening of the door.

16.2.3 **Fitting the Lexan**

a) Mark out the Lexan sheets using the patterns supplied.

*The Lexan is big enough but there is not much spare space. Lay out the patterns and find the best arrangement to ensure they can all be cut from the sheet. Remember to allow for enough spare to make the two triangular pieces required to attach in the area behind the lower door, between tu144 and tu6.*

b) Cut out the Lexan using a pair of large tin snips.

*The patterns are supplied as a guide and your individually constructed doors will vary slightly, so cut out oversize to be safe.*

c) Fit the Lexan to the lower doors first.

*Use the forward and upper edges as your accurate edges and trim so that these fit nicely. Allow a generous overlap on the lower and rear edges, which can be trimmed later.*
d) Before riveting mark the position of the holes to be drilled on the doorframe.

   Use a nominal rivet spacing of 60mm adjusted where required to provide an even spacing on each side. Remove the protective covering from the inside face of the Lexan, leave it in place on the outside, but remove it using your fingernail around each point to clear the rivet heads.

e) Drill and rivet the Lexan into place.

   Work from the upper front corner, outwards and downwards together. When drilling angle the drill slightly away from the last rivet. When squeezing the rivets bring the rivet upright. This then applies some light tension to the Lexan and prevents the Lexan bulging between rivets.

   Take care when drilling to ensure the tube is drilled centrally.

f) Repeat this process for the upper doors.

   The Lexan should overlap the lower doors by 20mm or so. The upper edge of the Lexan will tuck inside the wing root and can be trimmed for neatness later to be 50mm or so above the wing undersurface. The forward edge can either be fitted flush or overlapped up to the windscreens. Allow an overlap at this stage anyway and trim back as desired later.

g) Repeat this process for the two triangular pieces required to attach in the area behind the lower door, between \textit{tu144} and \textit{tu6}.

   Only rivet along the lower and rear tubes, don't rivet to the steel diagonal tube. Use a minimum of three rivets per edge.

h) When the doors have been fitted trim the rear edge of the upper door Lexan to match the line of the triangular pieces behind the lower doors. The lower edge may be cold folded if desired to form a neat return.

16.2.4 Fittings

e) Drill through the centre of the upper door frame lower tube 400mm from the forward edge of the door using a 6mm drill bit to accept the door handle.
f) Use the handle / catch parts from the main kit, inserting the handle through the hole in the doorframe.

g) On the inside fit a thin plastic washer followed by the plain nut, hooped shape handle and Nyloc nut.

h) Tighten the nuts against one another to lock the parts into position.

   Adjust the position of the nuts so that some friction is felt when rotating the handle. The hooped handle can be left as is or the hooped part cut off to leave a flat lever as desired.

Figure 307; upper door catch.

i) Fit the forward catch by drilling a 5mm hole in the forward vertical of the upper door frame 340mm down from the hinge bolt centre.

   If a hole is present on the inside of the cabin upright tu34 close to this position then adjust the position slightly to use the hole as a detent. Alternatively an extra hole can be drilled.

   Assemble the parts with two 2mm plastic washers between catch and doorframe.

j) Adjust the tension to achieve some friction.

Figure 308; upper door forward catch.

k) The lower door should have the self-adhesive foam strip applied to its upper outer edge, and its inner side and lower edges to suit.
16 Doors

1) The upper door should have the foam tape applied to its rear edge only.

m) Fix the lower door catch fixed part to the door pillar to suit, using two 4mm rivets.

n) Fix the wings.

o) Trim the upper door Lexan to accurately fit around the forward wing spar and aileron cables, and trim the top edge to miss the wing tension bolts.

p) Fit the open door keeper, Figure.

"This should be positioned so that the door handle can be rotated into it. It is fitted to the wing surface with two screws (cut these to length) with spreader plates made from two rectangles of scrap Lexan 30mm X 150 (15mm radius at each end) either side of the wing fabric. This job will require two people or very long bendy arms!"

16.2.5 Type two door catches

These are optional sprung ‘slam shut’ door latches with remote opening levers.

a) Offer up the catch and aluminium angle. Determine the best position to fix the angle to the door pillar, so it lies flat against the gusset plate on the door, and doesn’t cross any rivet heads. Drill and rivet it in position. Use two 4mm steel rivets and snug down firmly, so that it fits tightly with no movement.

b) Determine the best position for the latch, ensuring maximum engagement when closed. Mark the position and drill and rivet in position. Note there is a standoff plate that must go between the latch and gusset plate.

c) Determine the best position for the opening lever so that at rest it is vertical. Mark and drill a 4mm hole in the door frame. Fit the lever to the door frame with its 4mm panhead securing bolt, head to the outside. A small washer should be fitted either side of the lever. The lever must have a little play to avoid friction, so don’t do up the nut too tight.
17 Seats and Seatbelts

17.1 Seats

a) Assemble the frame as per the drawing, noting that the seat back piece is not fitted quite yet.

_{Note the choice of holes in the front of the side tubes, to set the seat position. If the seat is positioned forwards, a wooden spacer or similar should be made and secured with cable ties to support the seat back.}_

_{Insert the front three tubes into the front of the seat, then lever apart the rear ends of the side tubes and secure to the rear tube.}_

b) It is worth cutting the threaded ends of the eyebolts to the minimum 1.5 threads showing above the Nyloc, in order to make the seats more comfortable when getting in and out of the aircraft.

c) Fit the seat frames to the aircraft.

Figure 311; seat frames.
The seats themselves have a frame inserted into the back. This should be bolted to the rear of the seat base frame with the seats in position.

Note that the seat frame threads into holes in the seat back fabric that run most of the length of the seat. It is a common mistake only to pass the frame through the short webbing reinforcement strips.

Ensure that the securing bolts have the threads pointing forwards. It is acceptable to drill out the holes in the seat base to 5mm, which allows some movement of the bolts without straining them.

A wooden seat base is included which may be useful for shorter pilots. Taller pilots should omit this to give increased head-room.

e) Install the seats into the aircraft using clevis pins and split pins.

f) A small diagonal bracing piece should be fitted to each seat base, Fig 313. This is a mandatory requirement specified in Service Bulletin SKR-SB-001.

The brace should be at approximately 45° to the two tubes to which it attaches. Mark the position of the brace on the seat base rear tube, and drill and rivet in place with a 4mm steel rivet. Then, with the seat in position on its supports, mark and drill the other hole to accurately hold the correct position, and secure with another 4mm steel rivet.
17.2 Seatbelts

a) The seatbelts should already have their shoulder straps looped over the upper rear cabin cross-piece, Fig 314.

This was done before the covering was riveted along the front of the cross-piece – take care not to drill and rivet through the belt!

b) The lap strap part of the seatbelts should be looped around the main undercarriage cross-beam.

Take a double wrap around the beam to prevent the strap slipping under side-loads.

Figure 314; shoulder strap looped over frame.

Figure 315; lap strap looped around undercarriage beam.
c) The seatbelt should be brought around the front of the seat, without passing around the drag link upper brace (the diagonal steel tube with the cover) Fig 316.
18 Spats

![Image of nose wheel spats]

**Figure 317; spats.**

18.1 *Nose Wheel*

a) Check that the axle is correctly positioned behind the forks.

b) The spat should be offered up to the nose-wheel, to mark the position of the hole for the nose-leg, if not already marked and/or cut-out.

> Cut the hole using the same technique as those cut in the instrument panel, link-drilling and finishing with a flap-wheel. Cutting a little oversize and finishing the hole with rubber edging super-glued into place gives a good effect.

> The spat may be positioned as per Figure 317. Raising the rear of the spats a little further can give a more racy look if desired, figure 318.

![Image of nose wheel spat]

**Figure 318; nose wheel spat.**
c) The spat should be slipped over the nose-leg, and positioned as required. Mark a point on the spat corresponding to the fork of the nose-leg, close to the bottom of the spat.

   *The nose-leg will have to be dropped out of the aircraft to fit the nose-wheel spat. Undo the bolt securing the nose-leg at the top of the leg, and the bolt securing the steering bar to the nose-leg. Have someone hold the tail of the aircraft down whilst you slide the nose-leg out.*

   *The spat was not fitted earlier to protect it from all the parts which you dropped whilst fitting the engine!*

   d) Drill the spat and the nose-leg for a 4mm diameter steel rivet or self-tapping screw on each side, and rivet the spat in place.

   *A washer may be required on each side between the fork and the spat to achieve the correct spacing without distorting the spat. A washer on the outside helps spread the load.*

### 18.2 Main Wheels

a) The spats may be positioned as per Fig 319.

   *Note the bulge goes to the inside to encompass the brakes, with the flat spat side outwards.*

![Figure 319; main wheel spat.](image)

b) The spats will have to be cut away to clear the undercarriage leg, Fig 320.

   *Again note that the spats fit over the brake callipers.*

c) Remove the wheel retaining tubes and attach the aluminium angle pieces to the ends.

   *Position them to be flush with the end of the tube. Drill through the lower surface of the tube only, and attach with the M5x20 bolt supplied.*

d) Refit the retaining tubes.
e) Fit the spats and secure them with M5 bolts with Nylon washers under the heads to protect the fibreglass.

*Three bolts secure each spat, two on the inside and one on the outside.*
19. Fitting the mark II Curved top Instrument Panel Option

19.1 Fitting the instrument panel

a) Working with the panel material.

The material is polyester glassfibre. This can be cut either with a hacksaw blade or a ‘Dremel’ type tool. Edges can be dressed and finished using sandpaper and a sanding block. Take care when sanding and cutting not to put too much pressure on an upward stroke or the gelcoat surface finish may be chipped. Sanding along the edge of the material is recommended rather than across it for this reason.

b) Cut and fit the panel in position

Trim the top and bottom flanges on the instrument panel to allow it to sit flat against the cabin uprights.

Fig 323 instrument panel edges

The panel should fit approximately 355mm measured from the cockpit floor to the lower edge of the panel. If the panel is too low the throttle lever will foul the lower edge of the panel before reaching the full throttle stop. You can check this by measuring from the top of the instrument panel to the inside face of the throttle lever without the end knob. The maximum distance is 40mm.

Fig 324 Vertical dimension

Carefully trim the lower centre portion of the panel to allow it to fit in the correct position according to the measurements and checks above. Allow at least 3mm clearance when trimming around the control stick torque tube.

The outer edges of the panel should be trimmed to fit just inside the door hinges, overlapping the cabin upright.

When trimmed, clamp the panel in position and verify that all fits and is square. Mark the position of the lower edge of the panel on the cabin uprights. And then remove the panel.
c) Fix in place the mountings and secure the panel

The panel secures to the cabin uprights each side via a pair of mounting angles. These should be positioned as shown 20mm and 140mm respectively from the lower edge of the panel. Drill the uprights with a 4mm drill and secure the angels in place with 4mm steel rivets. Refit the panel, mark the panel through the angles, remove and drill the panel using a 5mm drill bit. Refit the panel bolting it in place to the angles with the 5mm pan head bolts.

![Fig 324 securing angles and dimensions](image)

The lower centre portion of the panel secures to the central TU19 tubes using two L brackets and hose clamps as shown. Temporarily secure the L brackets in position with the clamps and slide them up to position flat against the back edge of the panel. Check the panel is in the correct position and the lower centre portion is not flexed forwards or backwards relative to the rest of the panel. Measure upwards 30mm from the top of the tube TU19’s and drill a 4mm hole each side. Mark through to the L brackets. Remove them and drill through on the marks with the 4mm drill bit. Refit and bolt in position with 4mm screws.

![Fig 325 Securing the lower edge](image)

d) Fit the instruments in the panel
You should now have a blank panel secured in the right position. Now is the time to plan the instrument layout, being mindful of the position of the throttle levers and their torque tube. A good tip is to cover the face of the panel with masking tape, which then can be drawn on to mark the intended position of the instruments. Once the rough layout has been decided on the panel can be removed and the exact positions and dimensions marked on ready for cutting out.

Cutting out the holes for the instruments can be done in a variety of ways. Rough cutting can be done by Dremel tool, or by link drilling (drilling a series of holes next to each other and finally breaking / cutting the centre out). Fine sanding should be used to finally open up accurately to the marking out. This can be with a Dremel sanding attachment, or an abrasive flapwheel used in a normal drill, or with sandpaper wrapped around a tube. The main thing is to take your time, be careful not to chip gelcoat, and use the actual instrument to check fit as you approach the final stage. Simple and cheap drilling templates for the mounting screw positions can be bought that are sized for the two standard instrument sizes (Light Aero Spares stock them), or you can carefully mark out and drill them. Be aware that Glassfibre dust can cause skin and respiratory irritation. Wearing overalls with sleeves taped, and a particle mask are recommended (also avoid doing this in the Kitchen!)

e) When the instruments are fitted in the panel the panel can be refitted.

The top is braced with two aluminium angles as shown. These can be cut from the aluminium angles supplied in the main kit that are used to brace across the standard instrument panel. Cut them so the rebated end will fit under the panel lip bent down to match the angle of the lip. Size them to fit as shown running from under the top lip of the instrument panel to just behind the windscreen where it joins the glassfibre scuttle piece, approximately 10mm below the windscreen edge. They should be fixed under the instrument panel lip 170mm apart measured from the inside faces of the angles. Use the two 4mm countersunk bolts, countersinking the holes in the glassfibre after drilling using a large drill bit turned slowly by hand. Secure the angles to the engine brace tubes with the P clips supplied as shown.

Fig 326 Upper bracing angles
19.2 Fitting the dash top

The dash top is supplied in two halves. Due to the individual nature of each homebuild aircraft these are supplied oversize, and must be trimmed to fit, prior to covering with the finishing material.

a) Trim the dash halves to fit.

Offer them in place and mark where trimming is necessary. Large areas of excess may be removed with a rough cut using a hacksaw blade or sharp ‘Stanley Knife’. 80 grit sanding paper used on a sanding block can be used for precise final shaping.

When trimming do a little at a time and keep checking the fit. It is useful to mark the centre of the panel, which can be used as a reference to ensure you are not trimming too much away at the sides!

The lip protruding over the instrument panel should be around 30mm. Don’t sand away too much material at the front and reduce this overhang, or the reinforced areas for the fixing screws won’t be in the right place!

During the trimming process it is easy to scratch the windscreen as the dash tops are repeatedly fitted and removed. It is a good idea to protect the vulnerable areas with masking tape.

b) The parts can now be covered.

When happy with the fit, the halves are ready for covering. Lay on the material and cut out allowing for a 50mm overlap around the front and sides and 70 mm on the rear edge (the edge that protrudes over the instrument panel).
Lightly sand the top of the dash halves to remove any bumps or spikes that may be present in the glassfibre – but don’t sand much – it is only glass tissue and very thin.

Apply vinyl spray adhesive, or similar impact adhesive to stick the fabric in place. Try to work in a little tension to get the fabric to lay nice and flat with no wrinkles.

Wrap it around the edges, cutting darts where necessary to allow the fabric to contour around inside curves, and neatly fold edges. The same adhesive as above can be used, but something with a little better ‘grab’ is easier – a hot glue gun works well for this. The fabric should be anchored in place on the underside using a domestic stapler. Take care not to staple too close to the edge on the area that will overhang the instrument panel, or they will show when fitted.

Fit the dash halves in place. Shape the insert pieces to fit. Cover them in fabric using the same techniques as above.

c) Fitting the dash parts in place.

Fit a strip of self adhesive Velcro to the underside of the insert pieces. The inserts are held in place using the aluminium strips which span the angle braces. These should have strips of Velcro applied so they can attach to the inserts and the angles.
With everything in place and positioned for best fit, drill for the fixing bolts. The holes should be positioned 35mm and 360mm from the panel centerline respectively, to pass through the panel upper lip 15mm behind the face, drilled through 5mm. Slide the captive nut clips in place on the dash lip, and then use the 5mm bolts to secure. Finish with the ‘skiffy cap’ covers.

Fig 330 fixings for Dash halves

d) Fit the throttle stops.

Size the throttle levers as required trimming so that the end knobs are just below the dash lip. Position the throttle stops so that the end knobs contact them in the centre of their radius. Mark the position, drill and fix them in place using 4mm screws.

e) For those retrofitting this option, check that full throttle can still be achieved at the carburettors.

Fig 331 Throttle stops
20. Fitting the Centre console option.

![Fig 332 Centre console overview](image)

a) First remove the seats to gain free access, if already fitted.

b) Offer up the side panels.

*It may be necessary to trim the edges so that they sit flat against the TU19 tubes. The rear edges should butt up snug against the TU15 tube. With the panels resting in place mark the forward edge position with a piece of tape. The forward mounting bracket should be fitted to align with this mark. Use the two self tapping screws to secure it in the floor positioned as shown.*

![Fig 334 forward fixings](image)
c) Fit the rear mounting bracket. It secures on the mounting bolts for the floor rear support bracket.

![Fig 335 rear fixings](image)

d) Put a strip of self adhesive hook Velcro on the sides of the TU19 tubes. Put a strip of the opposite loop Velcro on the inside face of the top of the side panels.

e) Fit the side panels in position. Mark the positions to drill the securing bolt holes. Remove and drill 5mm. refit and bolt in place using the 5mm pan head screws.

f) Offer up the top panel in position.

*Sand the forward face as required to butt up at the right angle neatly against the instrument panel. It may be necessary to file a small angle on the forward face of the control stick torque tube support bracket to allow the top panel to sit down in position. Do not file more than 10mm off the corner.*

![Fig 336 angle](image)
g) When happy with the fit of the top panel, and after ensuring the stick has full and free movement without fouling anything, fit the two small securing brackets at the rear.

To do this first replace the bolts that secure the central brace angles with the slightly longer ones supplied. Then with the top panel in place offer up the brackets and mark the position for the securing rivets. Remove the top panel and drill and rivet the brackets in place using the 4mm aluminium rivets supplied.

![Fig 337 Bolt swap](image)

![Fig 338 Console top rear fitting](image)

h) Apply Hook Velcro to the inside edges of the top panel sides. And loop Velcro to the rebated edge of the side panels.

i) Fit the top panel in place. The rear brackets attach to the excess threaded portion of the bolts. Fit a 6mm nut and washer on each.
j) Check the clearance to be able to operate the flaps.

*If necessary remove the detent lever, clamp the riveted end in a vice and using a short length of tube slipped over the detent lever arm bend it upwards approximately 15 degrees. Inspect for a smooth fracture free bend and refit.*

![Fig 339 Detent lever clearance](image)

Finally check everything is secure and the stick has full and free movement, and there are no cables rubbing on the glassfibre parts. Refit the seats.
21. Fitting the Adjustable Seat Option

21.1 Description

The adjustable seat option allows rapid seat repositioning between two settings. The seat back is attached to the seat base on a pair of rotating arms. The seat is held in the forward position by a pair of webbing straps, and in the aft position by Velcro ties. In the forwards position the seat back sits forwards of the main fuselage structure supported by a bracket pivoted off the seat back and clipping to the fuselage cross member TU40.

![Fig 339 Seat positions overview](image)

21.2 Modifying the seat base

a) Move the front cross member to the second hole – 50mm behind the first

b) Drill a 6mm diameter hole in the vertical plane 425mm behind the forward hole centre. Re site the rear cross member in this position.

c) Drill a 4mm diameter hole in the horizontal plane 360mm behind the forward hole centre. This will be used as the pivot hole for the swing arms.
21.3 Modifying the seat back

a) The seat back support hoop slides into pockets that run vertically down the seat cushion. In order to fix the pivoted extension hoop, it must be modified to allow the frame to come out of the pocket at the pivot point.

*Use a sharp blade and carefully cut horizontal slots in the pockets at the positions shown. If possible heat the blade so that the cut edges are not left ragged.*

![Fig 340 Seat cushion pocket modification](image)

b) Drill the pivot holes in the seat back hoop.

*Drill these 4mm diameter in a transverse orientation 310mm above the lower fixing holes*

![Fig 341 Drilling the hoop pivot holes](image)
21.4 Assembly

a) Assemble the seat frame, with the fabric base in position.

b) Fix the rotating arms assembly to the base using 4mm bolts. Place washers either side of the rotating arms, and tighten only enough to take out any slack, but still permit easy rotation.

c) Assemble the seat back components, sliding the seat back support in the pockets in the seat cushion as shown in the photos. Fix in place the extension hoop, using 4mm bolts, heads to the insides.

![Attaching the hoop](image)

**Fig 342 Attaching the hoop**

d) Attach the seat back assembly to the rotating arm assembly using 4mm bolts heads rearwards.

e) Drill the rear cross member with two 4mm holes and secure the Velcro ties in position with a 4mm steel rivet each. Holes should be positioned 40mm outside the existing holes.

![Securing the Velcro ties](image)

**Fig 343 Securing the Velcro ties**
f) Make sure the seat base is square and then fit the bracing strap in the rear corner nearest the outside of the aircraft, drilling and securing with 4mm rivets.

![Fig 344 Bracing angle](image)

g) Fit the webbing straps, running them under the seat, around the forwards cross member and the pivoting arm assembly cross member

![Fig 345 Webbing straps](image)

h) Finally refit the seat in the aircraft
22. Preparing for Flight

Rig the aeroplane ready to fly.

22.1 Airframe

22.1.1 Dihedral and washout

The following specifications are intended as a rough indication of the correctness of the alignment of the wings. Unless there is a noticeable deviation from these, such as the presence of anhedral or wash-in, any concerns will be addressed at the test flying stage where the use of different-length lift-strut end-fittings can be used to adjust the wing alignment.

a) The dihedral should be around 1.2° per wing: a straight line between centre of the leading edge tubes at the wing tips should be around 10cm above the same position at the centre of the cabin.

b) The washout should be around 1° at the wing tips compared to the wing roots: this corresponds to a twist upwards of around 2cm of the height of the trailing edge over the chord of the wing, from root to tip.

*If this is grossly wrong it is likely that the internal bracing cables are not taught. If either cable is loose the turnbuckle should be tightened. If one of the cables remains slack whilst the other is tight it may be that the covering is not properly seated on the leading edge, requiring removal of the wing covering and refitting as per the instructions.*

22.1.2 Jury struts

![Image of jury struts](sky ranger.net)

Figure 346; jury struts.

a) With the wing properly mounted and aligned, the jury struts can be made to fit.

*Do not fit the jury struts before the aircraft is completed, as this will change the required lengths significantly and cause the lift struts to be pulled out of alignment.*

b) Check that the upper mounting brackets are long side downwards, Fig 324.
c) The jury strut components are of differing lengths. Determine the correct tubes for each position.

d) The horizontal bracing strut should be cut to length, drilled and fitted to the lift struts, Figure.

Figure 347; jury strut upper bracket, fuselage to left of picture.

e) Ensure that the horizontal brace is not being bent into a curve by misalignment of the lift struts.

*If necessary the stainless-steel lift strut end fittings may be tweaked slightly.*

f) Then cut, drill and fit the front and rear jury struts.

*Ensure that they fit properly, without pushing or pulling the lift struts out of line. The ends of the tubes will need to be filed to clear their mounting bolts as required.*

*The tubes should be on the inboard side of the brackets.*

Figure 348; jury strut to lift strut attachment, fuselage to left of picture.
22.1.3 Aerofoil Jury struts

Aerofoil Jury struts are available as an option and are the required fit for the Skyranger Swift approved build standard.

a) Check that the eyebolt attachment in the wings are aligned fore and aft. Rotate if necessary

b) Loosely fit the lower U brackets to the wing lift struts. The horizontal bracing strut should be cut to length, drilled and fitted to the lift struts, with its ends flush with the ends of the brackets.

   The front bracket is the one that leans forwards. The rear bracket is more upright. The rear bracket is not symmetrical however and has the edge most upright to the front.

c) Fit the horizontal brace and U brackets as shown, with a thin plastic washer between the U bracket and the lift strut.

d) Fit the Jury struts and bolt them into position. The lower fitting uses a 4mm bolt. The upper fitting has a rubber grommet fitted to the eyebolt to prevent lateral movement, and the Jury strut fits over this. It is then fixed with a 4mm bolt and aluminium spacer over the bolt. Washers should be used both under the head of the bolt and under the nut.

Fig 349; Aerofoil jury strut overview
Fig 350; Rear and front lower fittings. Note orientation (looking from rear)

Fig 351; Rear and front upper fittings.

Fig 352; Upper fixing hardware. Note position of rubber grommet
22.1.4 General checks

a) Check that all nuts and bolts are properly tightened and threadlocked.
b) Check that all bolts subject to rotation in use are correctly split-pinned.
c) Check that all electrical connections are properly made, with no risk of short-circuiting.
d) Check that all fuel, oil, and water pipe clips and other connections are properly tightened and sealed.

22.2 Baggage Bag

a) Loop the rear securing straps around the base of the rear fuselage bracing frame at its lower corners, with the buckle towards the fuel tanks.

   *The strap should loop around the back of all the tubes.*

![Figure 353: rear securing strap.](image)

b) Pass the upper securing straps around the upper rear fuselage tubes above, but not around, the turnbuckles.

   *The straps will have to be slid back down the tubes for them to reach.*

c) Burn a hole through each strap where the Velcro is, and secure with small pan-head bolts, with the pan-head towards the tube.
22 Preparing for flight

22.3 Controls

a) Mount all the control surfaces and secure with split pins, unless further transportation is to occur.

b) Check the full and free movement, in the correct sense, of all combinations of the controls.

c) Check the neutral positions of the flaps and their operation.

*The flaps should be set with the centre of their trailing edges 5cm below the level of the rear fuselage covering.*

*Put some prop tape around the flap pushrods where they rub against the fuselage covering surrounding their exit holes.*

Figure 354; upper securing strap with Velcro and bolt.

d) Burn holes in the lower Velcro straps and secure with small pan-head bolts.

e) Connect the lower straps to the rear securing straps using the click-in buckle.

*Note that the lower fixing do not go around the rear cabin uprights TU6. The baggage bag should be free to move upwards and backwards or access to the fuel tank fillers will be restricted.*
d) Check the neutral positions and operation of the ailerons.

*Ensure that the stick is kept central whilst adjusting the ailerons.*

The ailerons should be set with their trailing edges level with those of the flaps.

*Check that the aileron upward movements are around 25° using a protractor. The downwards movement is less, due to the differential built into the system.*

*If necessary, restrict the movement by increasing the diameter of the stops at the torque-tube horn, using tape around the tube to pad-out the stops.*

e) Check the tension in the aileron cables.

*Pulling the overhead cable rearwards to contact the wing covering tensioner tubes should require a pull of 3kg, plus or minus about 0.3kg. This will result in the overhead cable resting on the tubes in the wing roots, but being clear of the tubes at the jury strut attachment locations. Tension will be felt as the cable is pulled rearwards to around the location of the colour change on the wing upper-surface.*

f) If there is any remaining friction in the aileron control circuit, the fit of the aileron hinges must be checked.

*The ailerons should drop freely under their own weight with the cables detached. If any friction is felt then remove the aileron eyebolt hinges and file the holes in the aileron leading edges until the ailerons move freely. This will greatly improve the feel of the aileron controls.*

*A very small touch of oil on the hinges works wonders, but not too much otherwise it will stain the coverings where it blows off.*

g) Ensure that the tubes which the aileron cables touch are protected by oversized pieces of prop tape or similar.

h) Check the neutral position and operation of the elevator.

*The elevator should be horizontal with the stick at 90° to the central cabin tubes, not vertical.*

*Elevator movement should be 25° each way. If necessary file the stop positions on the stick pivot piece to increase movement.*

i) Ensure the rudder-stop cables have been properly crimped and fitted.

j) Check the neutral position and operation of the rudder and nose-wheel.

*With the rudder straight, the nose-wheel should be straight. Rudder movement should be 25° each way. Nose-wheel movement should be symmetrical each way.*

k) Wire-lock all turnbuckles.

l) Check the correct operation of the brakes.
22.4.1 Fuel tank calibration
   a) Put a small quantity of fuel into the tanks.
   b) Drain the fuel through the fuel pickup connection.
      *Any remaining fuel is roughly the unusable fuel, although it will be affected slightly by the flying attitude.*
   c) Add measured quantities of fuel into the tanks, marking the side of the tanks at 5 litre intervals, starting from zero at the unusable fuel level.
      *Allow time for the tank levels to balance before marking each level. This can take a few minutes.*

22.4.2 Propeller pitch
Assemble and fit the propeller following the instructions supplied with the propeller.
Set the propeller pitch to that specified in the HADS for your propeller.

Note that some installations are defined on a max static RPM (5000RPM for 912 and 912S installations using the Kiev prop 273 and 283 respectively). This means that once the engine has had its initial run up the propeller pitch may have to be finely adjusted to accurately achieve this. If the RPM is a long way out when the prop is set on its recommended starting pitch, then the RPM guage may not be indicating accurately and may need calibrating with an optical tachometer (your inspector or local engine service facility should have one).

22.4.3 Engine run-up
Read the engine manual for procedures relating to the first operation of the engine, and subsequent running-in. Follow all requirements for engine and gearbox oil, coolant mix etc.

It may be advisable to tie the aircraft to a solid structure before any engine power tests, rather than relying on the brakes, particularly on wet grass.

Carburettor balancing on the Rotax engines may be set approximately by comparing the movements of the throttle levers on the carburettors, however for best results the balance should be set by a Rotax engineer familiar with vacuum-gauge balancing.

The Engine Installation Checklist will have to be completed with the assistance of your Inspector.

22.4.4 Throttle Friction
This is adjusted using the two nuts at the port end of the throttle lever torque tube. Set enough friction by tightening the inboard nut to prevent the throttles from vibrating open or closed, then lock this setting with the second nut. Do not set any friction at all on the starboard end of the torque tube.
22.4.5 912 Idle Adjustment

The throttles on the 912 engines are sprung to the open position and rely on the cables being pulled taught to achieve the idle setting.

To get a reliable idle setting first loosen the idle adjustment screw(s) on the carburettor(s). Set the idle with the throttle levers against the stops in the cabin, by adjustment of the cables at the carburettor. When this is complete, screw the idle adjusters on the carburettor(s) until they nearly, or only just, touch the throttles.

If your engine idles with the lever held rearwards, but the RPM springs up significantly when it is released, then the setup is not correct. The most likely causes are:

1. Carburettor levers touching the stops on carbs before the throttle lever touches its stop.
2. Insufficient throttle lever friction.
3. Too much throttle lever friction (causes a ‘stepped’ opening and closing)
4. Firewall flexing where cables outers attach. In this case either reposition the cable guides closer to the edge where it meets the cowling, or make up a bracing strut to stiffen it (this can come forwards at an angle and attach to the cabin upright tube)
22.4 6 Fuel flow measurement

This should be performed with the help of your inspector who should have suitable equipment or access to such. Connect a T-piece into the fuel line near the carburettor(s). Connect this to a fuel pressure gauge and a fuel tap, using a length of pipe long enough to reach back into the cockpit.

The fuel flow rate may then be measured: run the engine at full power (aircraft will need stoutly securing for this – and mind the propwash doesn’t do any damage to aircraft or objects behind!) with the end of the fuel pipe pointed into a measuring jug in the cockpit, open the tap until the fuel pressure drops to no less than the minimum specified in the engine instructions; measure the time required to bleed off 1 litre of fuel into the measuring jug. Note 1 bar = 100kPa = 15psi roughly.

The excess fuel flow rate is calculated by dividing 3600 seconds by the number of seconds taken for 1 litre. This is required to be greater than 25% of the full power fuel consumption, typically 20-30 litres per hour depending on engine type. Therefore an excess fuel flow rate around 5 litres per hour or greater is required. Much greater flow rates than this minimum are normally found.

An alternative method is to arrange a separate fuel tank to supply the engine by gravity feed, whilst measuring the amount of fuel the pump supplies into a measuring jug beneath the aircraft (use an extension tube on the fuel line, don’t try to hit the bucket from the engine!). This then gives the entire fuel flow rate, which must be greater than 125% of the full power fuel flow rate.

22.5 Weight and Balance

A weight and balance spreadsheet is included on the CD to assist you.

The aircraft will have to be weighed with the assistance of your Inspector, using the information given in the HADS. Note that the weighing attitude is critical on a tall aircraft like the Skyranger, and that bathroom scales are notoriously inaccurate. Typical weights are around 255kg for a four-stroke example with typical level of equipment, give-or-take 5kg or so.

Due to the seat weight limits and fuel capacity being greater than the minimums required, plus the option of the baggage bag, the weight and balance spreadsheet is likely to show CG limits being exceeded at loads considerably above the 450kg MTOW. To resolve this the BMAA technical office has suggested that the max seat loads entered on the spreadsheet are reduced from their 120kg per seat value until the CG is within limits. This does not affect the actual max seat load, but note that the 450kg MTOW must be complied with to automatically guarantee that the CG remains within limits.
22.6 Placards

A number of items require placards as listed in the HADS. A generic placard sheet is supplied including a cable-crossing placard. Apply this to the front vertical tube in sight of the pilots, to show the required crossing of the aileron cables. Do not omit this placard, miss-rigged controls are a common but avoidable problem on any aircraft, and have potentially fatal consequences.

For any other placards, a PC can be used to create and print them out onto paper. Then cover them in an oversize piece of Fablon or similar to hold them in place, this is simple and works well. Alternatively printable adhesive film is available from some computer and office suppliers.

A number of the placards require information gathered during test flying, and so must await its completion.

22.7 Test Flying

22.7.1 Paperwork

a) See the section on the BMAA homebuilt system at the beginning of this manual.

b) Register the aircraft with the CAA and fit registration letters.

c) In case of queries with these BMAA administered procedures, ask your inspector and/or the BMAA.

d) Read the Pilot’s notes.

e) Ensure that all paperwork is complete. In particular the AW029 needs to be signed by the BMAA Chief Technical Officer and then finally by your inspector. Check that the airfield you intend to fly from has been approved on the form, and that you and the test pilot at least are named on the form.

22.7.2 Flight Test Day

With all the paperwork completed the day of the test flight will come!

Test flying any newly constructed aeroplane is a serious business, and should be accomplished with the likelihood of possible emergencies as the major consideration. For this reason the airfield used for test flying should be of generous proportions.

As a guide the field should have a useable runway length of at least 400M without obstructions like wires or buildings on approach or climb-out within another 200M. Surrounding terrain should be such that options exist for all stages of initial climb to altitude to land successfully in the event of an emergency.

It may be tempting to ask the test pilot to fly the aeroplane from the small strip where it has been constructed, and will be based, which may not be ideal for test flying. Please do not put them in the awkward position of having to refuse. The inconvenience of moving the aeroplane to a suitable test flying location is far less than the inconvenience of a rebuild!

A windsock and fire extinguisher on site are essential items. A device for measuring windspeed is desirable.
Some of the test flying will be involved with sorting out a few final adjustments, so make sure you take to the field the following items:

The +5mm lift strut end (the extra one lying at the bottom of your pile of leftover parts!).
Lockwire, lockwire pliers and side-cutter pliers.
General tools (Screwdrivers, spanners etc.)
Propeller pitch setting tool
Fuel, in cans to allow choice of fuel load to vary CG position
Some spare hardware – split pins, nyloc nuts etc.
All 450kg of associated paperwork!

Refer back to section 1.2 for more information on the paperwork and test flying procedure.

And finally, don’t forget your camera to record the moment!

Happy Flying!
23 Additional Information

23.1 Example BMAA Homebuilt Registration Form

Introduction
This form is designed to declare the details of a homebuilt aircraft project to the BMAA. It does not take the place of any other reports that may be requested by the BMAA Chief Technical Officer but is essential to clearly show what the planned project is and the source of main parts to be used. Where information is not available or irrelevant leave blank - the BMAA will correspond with you if this data is essential. BMAA will not accept registration of a project until it has been proven a viable microlight aeroplane, if in doubt, check!

1. Description

| (a) Type: SKYRANGER (UK) | (b) Registration: G-SKVR | (c) Plans or kit No: V1C/1400 |

If any configuration changes are planned which are not on a currently approved aircraft, please detail this on a separate sheet. There is no extra charge for changes to configuration but please inform the BMAA at the outset wherever possible.

2. Intended Power plant

| (a) Engine type / model: ROTAX 912 UL | Upright □ Inverted □ |
| (b) No. Cylinders: 4 | Horizontal □ Radial □ |
| (c) 2 stroke / 4 stroke: | Other □ (specify): |
| (d) Capacity / hp | 121.1 ? 2 / 81 HP |
| (e) Exhaust: ROTAX | (f) Intake system: |
| (g) Gearing System and ratio: INTENATIONAL GEARBOX 2.27:1 |
| (h) Propeller Type: KIEN 263/1700 | (i) No. blades: 3 |
| (j) Diameter: 180 cm | (k) Pitch: (if known) 24° @ 35 cm |

If an unorthodox engine (e.g., jet, rotary or diesel) is to be used, please describe on a separate sheet(s). BMAA may request detailed further information for any engine or propeller type not previously cleared.

2. Fuel System

| (a) Fuel Tank(s) STANDARD SKYRANGER KIT | (b) Fuel Pumping method(s) ENGINE DRIVEN |
| Source / location / type(s): | PUMP - STANDARD 912 |

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4. Wings

(a) Covering material: STANDARD SKYRAIDER KIT, DALDON
(b) Supplier: RED/WHITE

5. Wheels

Mainwheel type: STAND AND
Size:
Supplier:

Nose/tailwheel/skid type: SKYRAIDER
Size:
Supplier:

Brakes type, source and description:

6. Owner/Builder’s Details

Name: JOE BLOGGS
BMAA No: DDD1
Home tel: 02222 33333
Work tel:

Correspondence address:
SKYRAIDER HOUSE, WINDTRAP CLOSE, RANDON,
Build location: HOME/GARAGE

☐ I would like to receive a form BMAA/AW/036 Hardback Aircraft and Engine Logbook (£14)

7. Nominated Senior of Homebuilt Inspector’s Details

Inspector must sign below to confirm that they are prepared to inspect this project and have inspected and consider satisfactory the build location/ workshop facilities. This must be an inspector approved by the BMAA Chief Inspector, who expects to be able to take on supervision the entire project.

Name: GMBASY JDE
BMAA No: DD2
Inspection No: DDD1
Home tel: 0101 2222
Work tel:

Correspondence Address:
THE CARAVAN; BACK OF HANGAR;

8. Checklist

(a) Form fully completed and signed ✓
(b) Certificate of conformity (required for registration of series kits) ✓
(c) Copy of engine certificate of conformity (can be supplied later) ✓
(d) Copy of propeller certificate of conformity (can be supplied later) ✓
(e) Cheque for £30 (or £44 if you require an aircraft logbook) payable to BMAA ✓

Inspector’s signature: Date: 22/2/03
Owner’s signature: Date: 22/2/03

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23.2 Wire-locking

NOTE
THE SAFETY WIRE IS SHOWN INSTALLED FOR RIGHT-HAND THREADS. THE SAFETY WIRE IS ROUTED IN THE OPPOSITE DIRECTION FOR LEFT-HAND THREADS.
Section 2. SAFETY METHODS FOR TURNBUCKLES

212. GENERAL. Safety all turnbuckles with safety wire using either the double or single wrap method, or with any appropriately approved special safetying device complying with the requirements of FAA Technical Standard Order TSO-C21. The swaged and unsawaged turnbuckle assemblies are covered by AN Standard Drawings. For safety wire sizes and materials, refer to figure 4.22. Do not reuse safety wire. Adjust the turnbuckle to the correct cable tension so that no more than three threads are exposed on either side of the turnbuckle barrel. Do not lubricate turnbuckles.

213. DOUBLE WRAP METHOD. Of the methods using safety wire for safetying turnbuckles, the method described here is preferred, although either of the other methods described is satisfactory. The method of double wrap safetying is shown in figure 4.23(A). Use two separate lengths of the proper wire (see figure 4.22). Run one end of the wire through the hole in the barrel of the turnbuckle and bend the end of the wire towards opposite ends of the turnbuckle. Then pass the second length of the wire into the hole in the barrel and bend the ends along the barrel on the side opposite the first. Spiral the two wires in opposite directions around the barrel to cross each other twice between the center hole and the ends. Then pass the wires at the end of the turnbuckle in opposite directions through the holes in the turnbuckle eye or between the jaws of the turnbuckle fork, as applicable, laying one wire along the barrel and wrapping the other at least four times around the shank of the turnbuckle and binding the laid wires in place before cutting the wrapped wire off. Wrap the remaining length of safety wire at least four turns around the shank and cut it off. Repeat the procedure at the opposite end of the turnbuckle.

When a swaged terminal is being safetied, pass the ends of both wires, if possible, through the hole provided in the terminal for this purpose and wrap both ends around the shank as described above. When the hole in the terminal is not large enough to accommodate the ends of both wires, the hole may be enlarged in accordance with note 2 of figure 4.22 and the safetied completed as described above. If the hole is not large enough to allow passage of both wires, pass the wire through the hole and loop it over the free end of the other wire, and then wrap both ends around the shank as described.

a. Another satisfactory double wrap method is similar to the above, except that the spiraling of the wires is omitted as shown in figure 4.23(B).

b. The wrapping procedures described and shown on MS 33591 may be used in lieu of the safetying method shown herein.

---

<table>
<thead>
<tr>
<th>Cable size</th>
<th>Type of wrap</th>
<th>Diameter of safety wire</th>
<th>Material (annealed condition)</th>
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<tbody>
<tr>
<td>3/16</td>
<td>Single</td>
<td>0.040</td>
<td>Copper, brass.</td>
</tr>
<tr>
<td>1/8</td>
<td>Single</td>
<td>0.040</td>
<td>Copper, brass.</td>
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<tr>
<td>5/32</td>
<td>Single</td>
<td>0.037</td>
<td>Stainless steel, Monel and “K” Monel.</td>
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<tr>
<td>1/4</td>
<td>Double</td>
<td>0.040</td>
<td>Copper, brass.</td>
</tr>
<tr>
<td>5/32</td>
<td>Single</td>
<td>0.037</td>
<td>Stainless steel, Monel and “K” Monel.</td>
</tr>
<tr>
<td>3/16</td>
<td>Double</td>
<td>0.040</td>
<td>Stainless steel, Monel or “K” Monel.</td>
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<tr>
<td>5/16 and greater</td>
<td>Single</td>
<td>0.051</td>
<td>Copper, brass.</td>
</tr>
</tbody>
</table>

1. Annealed or tinned steel, or soft iron wire are also acceptable.
2. The safety wire hole in 3/32-inch diameter and larger turnbuckle terminals for swaging may be drilled sufficiently to accommodate the double 0.001-inch diameter copper or brass wire when used.

Figure 4.22—Turnbuckle safetying guide.
FIGURE 4.23.—Safetying turnbuckles.

(A) DOUBLE WRAP (SPIRAL)

(B) DOUBLE WRAP

(C) SINGLE WRAP (SPIRAL)

(D) SINGLE WRAP
214. **SINGLE WRAP METHOD.** The single wrap methods described in the following paragraphs and as illustrated in figures 4.23 (C) and (D) are acceptable but are not the equal of the double wrap methods.

   a. Pass a single length of wire through the cable eye or fork, or through the hole in the swaged terminal at either end of the turnbuckle assembly. Spiral each of the wire ends in opposite directions around the first half of the turnbuckle barrel so as to cross each other twice. Thread both wire ends through the hole in the middle of the barrel so that the third crossing of the wire ends is in the hole. Again, spiral the two wire ends in opposite directions around the remaining half of the turnbuckle, crossing them twice. Then, pass one wire end through the cable eye or fork or through the hole in the swaged terminals, in the manner described above, wrap both wire ends around the shank for at least four turns each, cutting off excess wire. This method is shown in figure 4.23(C).

   b. Pass one length of wire through the center hole of the turnbuckle and bend the wire ends toward opposite ends of the turnbuckle. Then pass each wire end through the cable eye or fork, or through the hole in the swaged terminal and wrap each wire end around the shank for at least four turns, cutting off excess wire. This method is shown in figure 4.23(D). After safetying, no more than three threads of the turnbuckle threaded terminal should be exposed.

215. **SPECIAL LOCKING DEVICES.** Several turnbuckle locking devices are available for securing turnbuckle barrels. Persons intending to use a special device must assure the turnbuckle assembly has been designed to accommodate such device. A typical unit is shown in figure 4.24. When special locking devices are not readily available, the use of safety wire is acceptable.

216.226. RESERVED.

---

**Figure 4.24.—Clip type locking device.**

TURNBUCKLE BODY MS21251

LOCKING CLIP MS21256

CLIP TYPE LOCKING DEVICE
### 23.3 Kit Boxes and Wing Fold Dimensions

<table>
<thead>
<tr>
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<th>WEIGHT</th>
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<td>BOX 2</td>
<td>SEATS</td>
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<td>330mm</td>
<td>330mm</td>
</tr>
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<td>BOX 3</td>
<td>SAILS</td>
<td>2400mm</td>
<td>770mm</td>
<td>230mm</td>
</tr>
<tr>
<td>BOX 4</td>
<td>ENGINE</td>
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<td>690mm</td>
<td>490mm</td>
</tr>
<tr>
<td>BOX 5</td>
<td>COWLS</td>
<td>770mm</td>
<td>600mm</td>
<td>900mm</td>
</tr>
<tr>
<td>BOX 6</td>
<td>WHEELS</td>
<td>420mm</td>
<td>420mm</td>
<td>420mm</td>
</tr>
<tr>
<td>BOX 7</td>
<td>LEXAN</td>
<td>1300mm</td>
<td>300mm</td>
<td>300mm</td>
</tr>
<tr>
<td>BOX 8</td>
<td>SPATS</td>
<td>740mm</td>
<td>570mm</td>
<td>440mm</td>
</tr>
<tr>
<td>BOX 9</td>
<td>UK MODS</td>
<td>280mm</td>
<td>280mm</td>
<td>280mm</td>
</tr>
<tr>
<td>BOX 10</td>
<td>FLOOR</td>
<td>1100mm</td>
<td>1100mm</td>
<td>4mm</td>
</tr>
</tbody>
</table>

Measurements and weights may vary, overall total weight should remain constant.

Figure 327: approximate size of aircraft with wings folded.
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### 19 Amendments

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<tr>
<th>Date</th>
<th>Page No.</th>
<th>Change / Addition</th>
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<tbody>
<tr>
<td>17/08/2004</td>
<td>All</td>
<td>Issue 3.0 based on issue 2.2 incorporating numerous hints and tips.</td>
</tr>
<tr>
<td>20/12/2006</td>
<td>All</td>
<td>Issue 4.0 based on issue 3.0, but incorporating additional drawings, CKT exhaust fitting, Drainable sump verification procedure, Screen centre batten option, Fuselage cross batten option, Revised door latches option, Skyranger Swift variant information, including Aerofoil jury struts. Additional hints and tips.</td>
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