

# **TITAN AIRCRAFT T-51 MUSTANG**

## **CONSTRUCTION BRIEF**

First time builders and those unfamiliar with sheet metal construction and polyfiber covering are recommended to read 'Jeppesen's Aircraft Sheet Metal', source information from the Internet and others familiar with these materials and methods.

The following is a brief outline suggesting how the Titan T-51 building process may be planned based on sourced information and our experience:

1. First, check the inventory sheet/packing slip to be sure everything is included. There is the possibility that some parts may be back ordered. Now is the appropriate time to put the Uralane/Araldite two-part glue into cold storage (as recommended in the manual) until it is needed (put back into cold storage after each use). It is also recommended to store the glue in the supplied bottles to reduce air exposure.
2. Any ferrous parts that are not protected may need CRC or similar to prevent rust until painting – this includes the main landing gear.
3. Decide where to start – there are two options: fuselage or center section. Regardless of what is started first, the two fuselage steel frames and main landing gear legs (which will need to be removed from the center section) will need to be prepared (degrease and scotch brite), primed and painted.

### **STARTING WITH THE CENTER SECTION**

1. The center section assembly should be completed up to the installation of the top skins and covering the fuel tanks. These items should be left until the center section is attached to the fuselage and the fuel tanks are plumbed. It is recommended to build the outer wing panels off of the center section, which can be done before the center section is attached to the fuselage. The ailerons and flaps can also be temporarily installed and fitted at this time. Using this method, the center section acts like a fixture for the wings and the wings become the fixture for the flaps and ailerons. Bear in mind that the outboard wing ribs need to be kept aligned with the root end rib to eliminate the possibility of unwanted washout (keep checking during construction). All of this can be done in the vertical position (nose down) with the center section sitting in the foam shipping saddles that it arrived in. The main gear can be removed for this process making it easier to move the center section around if necessary. Once the wings are built with the ailerons and flaps temporarily fitted, the bottom wing skins can be riveted in place. The wings can then be removed and stored until the fuselage and center section are put together. Before the wings are fitted to the center section it may be necessary to remove any excess glue from around the polystyrene leading edge cell in the wing. This will allow the 'right angle flange' attached to the outboard center section rib to fit underneath the leading edge wing skin for riveting.
2. The main landing gear doors can be constructed during the center section assembly while the main gear legs are in place, but before the outer wing panels are installed. Also, this is a

convenient time to install the landing gear up and down micro-switches. This can be seen in the Center Section folder on the photos disc.

## **STARTING WITH THE FUSELAGE**

1. A common method for set-up is to rest the fuselage steel frame on several saw horses along the lower frame cross members and longerons. This method is good for doing the internal parts fit out and will allow the builder to have the aircraft at a comfortable working height. There are several other options to choose from, including constructing a spine jig, which runs the length of the fuselage and supports the steel frame at the upper cross members, keeping the aircraft suspended – this is very useful for doing belly work. Other builders have gone to the effort of making entire jigs to hold the fuselage in a solid state. All of these methods are useful in their own way, and it is up to the builder which is best for them – clearly the simplest and quickest way is to use saw horses. However, there is one point which we have found to be critical to the skinning and tail section assembly process: **do not drill the outer main side skins 'D' and 'E' onto the fuselage unless the fuselage frame is attached to the centre section. Similarly, do not fit the vertical and horizontal stabs (including the hori-stab carrythru's) unless the fuselage is attached to the centre section.** Temporarily attach the fuselage to the center section for these processes, and ensure the steel fuselage frame structure is level and straight with regards to the center section, all the way to the tail section. Once the skins are drilled to the desired hole size (most likely 1/8") and the tail surfaces have been fitted, the fuselage can be removed from the center section to carry on with the rest of the fuselage and empennage skinning and fit out. All hat sections and stringers will need to be fitted and/or installed prior to fitting skins.
2. After the steel fuselage frames have been degreased and painted with a ferrous metal primer, or cad plated, or powder coated, then proceed to fitting and bonding the hat sections to the fuselage frame – the photos will show you where hat section is not required. At station #2 where the steel fuselage frame longerons are circular, allow for the curved fuselage cross section shape by bonding the hat sections on the same angle as determined by the upper and lower bulkheads. Joggle the overlaps where the hat sections meet with a joggling tool – this is detailed in the construction manual. Prior to fitting the hat sections, fit and Cleco all upper and lower bulkheads. Also, if the hori-stab carry thrus have not yet been installed, then temporarily clamp them in position – this will ensure that hat sections are not installed in the wrong places. **There is no need to drill any holes in the hat sections prior to the skinning process – due to the slight variations in the steel fuselage frame it is better to lay down the rivet lines onto the main side skins first (#40 hole size), and then match drill these holes onto the hat sections.** However, care must be taken to ensure the rivet layout does not interfere with the steel fuselage frame. Once all the fuselage hat sections are bonded onto the steel frame, paint the entire structure with a good primer. It is recommended to paint all aluminium to prevent corrosion. Steel parts must be painted. It is also recommended to use an anti-corrosive product such as AV8 Dinitrol (comes in aerosol) on all unseen internal areas (on top of paint) to add to corrosion prevention.
3. Once the fuselage is attached to the center section for the last time, the skins can be riveted as access to areas becomes unnecessary. However it is much easier to complete the construction process without riveting skins on until the final stages when all internals are completed, otherwise it makes for a very difficult and time consuming task if skins are preventing good access to your area of work. All cockpit floor panels will need to be installed before the fuselage is married to the centre section for the final

time. Temporarily remove the two steel windscreen frame support tubes to allow better access during the cockpit construction stage – they will need to be installed and removed several times throughout the instrument hood and windscreen construction stage however. Ensure the cockpit floor panels are in place prior to fitting the u-channels for the cockpit inner side panels. Also, it is easier to drill the cockpit inner side panels at the same time as drilling the outer main side skins by using the same holes and drilling all the way thru from the outside into the cockpit u channels and inner cockpit side panels all at once. Bulkheads #2 (firewall) and #3 will need to be installed at this stage. Installation and fit-out of the rudder pedals, control sticks, bell cranks, cable lines, tail wheel, hydraulic lines, braked lines, cockpit layout, instrument panel, radiator pipes, tail section (control surfaces), baggage compartments, radiator ducting, windshield, rear cockpit partitions, hat rack, and mounts for battery; hydraulic pump; E.L.T, etc, will be easier to do prior the marrying the fuselage and centre section for the final time. Certain partitions and plumbing will have to be carried out after the fuse and center section meet however.

4. Once the fuselage is mated to the center section for the final time, the outer wings can be installed for the final time also. The top skin should remain off until all ailerons and flaps have been installed and set up however. The aileron will need to be temporarily removed to install the aileron and flap deflector pieces, however it will be necessary to have it in place during the fitting of this piece to ensure proper fitment. The flap can remain attached to its hinges throughout the fitment of the deflectors and swing upside down so as to stay clear during those times in the fitment and installation process when they would otherwise be in the way.
5. Comments on skinning: Most builders have elected to employ lap joints instead of butt joints – this saves on time and materials, as well as generally looking better and resulting in a smoother finish. Start by fitting main side skins ‘D’ and ‘E’ – layout the rivet pattern on the skin first and then match drill thru hat sects. Use the factory cut edge as the top edge of the skin, and place this flush with the upper longeron hat sects. Drill out to #40 hole size, then proceed to 1/8” if dimpling, or #30 hole size if using dome head rivets. However, it may be useful to leave the hole size at #40 until other internal parts that pick up on outer skin rivet holes have been fitted, and then drill thru all the parts together for the final hole size - this ensures the hole does not become enlarged from constant re-drilling and cleoing thru the same hole. Fit the turtle deck and belly skins if they haven’t already. Ensure the edges (esp. top edge) of the side skins that overlap the upper skins are joggled (slightly rolled over using a skin edge joggling tool) to ensure a neat finish without gaps along the edges – this is important for corrosion prevention also. To maintain a clean looking fuselage skin line, the upper skins are overlapped with the side skins along the entire length of the fuselage. This is one way of arranging the skins. Where you have a lap joint, drill the overlapping skin first, and then place the underlying skin in place and match drill thru it. Some builders have also joggled the edges of the underlying skin with a sheet metal bench mounted joggling tool to achieve a ‘flat’ surface finish – once again, it is up to the builder to what level of finish they want. The simplest method is to use lap joints and dome head rivets. The forward upper bulkhead flanges (the surface the skins attach to) may need to be slightly shaped outward to allow for the angled skin line in that area. Most builders rivet up the tail section skins (once the tail section is complete) and turtle deck first, as these skins are not restrictive of access to the rest of the fuselage. Then once the belly radiator ducting is complete, the belly and belly side skins are installed. Leaving the main side skins off until the internal fit out and systems checks are complete is highly recommended.
6. The installation of temporary stringers (lengths of right angle aluminum) between bulkheads is also helpful to add rigidity to the structure, and keeps bulkheads straight and perpendicular during the

skinning process. Also, because of the hole enlargement that happens as a result of the dimpling process, it is advised to keep the hole size as small as possible for the dimple die so as to avoid oversized holes which may result in rivet failure – as stated previously, do not drill out rivet holes to their final size until all the layers that use the same hole are fitted.

7. The vertical stab will need to be installed (mentioned earlier) prior to fitting the tail section skins.
8. The horizontal stabs should be built attached to the fuselage whilst the fuse is attached to the centre section, after the horizontal stab carry thrus have been installed. Fit the leading edges into the stab carry thrus, and then proceed to fit the ribs, aft spar, and then skins. Ensure the structure is built level and square with reference to the fuselage, which should be level and square with reference to the centre sect. Once the stabs have been constructed the elevators can be fitted in place also. The elevators and rudder will need either covering with fabric or aluminum, depending on the chosen engine type (Rotax engine = fabric, Suzuki engine = metal). The elevator trim tab wiring will need installing prior to this. Leave the outer rib on both stabs clecoed during the final installation of the stabs to allow easier installation of the elevators. The tail side skins will need to be riveted prior to the final installation of the stabs and elevators.
9. The forward baggage compartment is useful for those using the Rotax engine (due to tail heaviness a rear baggage locker is not advised). Vice versa for the Suzuki engine models – a rear baggage locker is advised instead of the forward locker. However, access to station #2 is required to provide access to the engine management computer and brake fluid reservoir for those using the Suzuki engine.
10. It is recommended to partition off the rear cockpit from the rest of fuselage (which is necessary for those having a rear baggage locker anyway), and from the flap driver and radiator intake area. This can be seen on the photos disc. Having an access panel on the bottom or side belly skins can facilitate access to the radiator.
11. Radiators, regardless of engine type, need to be placed in the belly scoop area to facilitate sufficient airflow. **Several builders of Rotax powered T-51s have had overheating issues when the radiator is placed in the engine cowling area, and is not advised.**
12. The concern of possible carb icing on the Rotax engines can be eliminated by the installation of the ‘Skydrive carb heat kit’, or a fuel injection mod.
13. The two steel brackets welded to the aft fuse steel frame in the T/W area (with hole cut-outs) are for inserting a tube – this is extremely useful for supporting the fuselage in a suspended fashion for landing gear testing, lifting, etc (see photos). Respective holes will need to be cut out of the side skins to accommodate this function. With regards to ground crew handling - it is easiest to handle the aircraft with two people, one on each wingtip. Failing that, the prop, gear legs, and aforementioned tube are all usable for this purpose. There is also a steel plate welded to the fuselage frame on the upper longeron in the rear seat area – this is an optional handle to assist climbing onto the centre section wing walkway area, and requires cutting away of the outer cockpit skin and installing a hinged aluminum flap. However, it has been found that mounting the centre section is easiest by ‘climbing’ up from the front wheel.

14. At the bottom rear of station #14 is a threaded hole for a tie down hoop. A hole will need to be cut in the bottom tail skin to accommodate this. This can also serve as a 'skid' in the advent of T/W failure, and/or tail first landing.
15. The instrument panel can accommodate a removable 'six pack' of flight instruments. There are many alternatives in this area, some builders opting for the fully glass panels, whilst others choosing a basic minimum to meet their requirements. There are two bolts welded to the fuselage frame at station #4 in front of the instrument panel – these bolts can be used as a common electrical ground.
16. The use of lightening holes throughout bulkheads is useful for keeping weight down, and for providing extra strength if the hole edges are joggled/pressed. Consult Titan for allowable placement areas.
17. Ensure to fit forward fuselage skins prior to engine installation, so as to ensure fuselage frame is not altered by the engine weight. If engine is mounted prior to riveting (which it probably will be), check frame is not altered prior to riveting. Support the weight of the engine to be sure, especially the heavier types.
18. The oil cooler works well when placed in the nose bowl chin scoop directly beneath the prop spinner. Engine cowling holes that replicate the original P-51D provide good engine airflow thru also.
19. It is advisable to accommodate some form of clean outside air intake for the pilot and passenger. A duct in the forward fuselage area (beneath exhaust line and other engine fluid "blow out" area) and belly area has proven to be useful. Some builders have taken air from the nose bowl chin scoop also, however this requires large holes for ducting to be cut into the firewall. It is recommended to put CO detectors on the left and right hand side where the canopy shuts. Insulating the radiator water pipes that traverse thru the cockpit is also advised.
20. For those registering their T-51 as a N.Z Microlight (under 1200 Lbs category), the following is advised:
  - Rotax 912
  - The use of low profile nuts (as opposed to the factory supplied regular size nuts, but only where tensile strength is not required)
  - Lightening holes in bulkheads, rudder pedals, and other allowable areas
  - Minimal instrumentation
  - No G.P.S
  - No 'add-ons', e.g. – mock guns, strobe/nav lights
  - Minimal paint application
  - Polished aluminum finish
  - Ali rivets in non critical areas
  - No rear baggage compartment
  - Also, to keep C of G forward it is recommended to place as much weight as possible forward of the cockpit, e.g. – battery, hydraulic pump, etc.

As a final note, it is useful to think several steps ahead when building. The construction manual drawings generally focus on one point or detail at a time and it is easy to overlook related details in the area being worked on. Review all drawings and notes for a particular area or system before beginning assembly. Use common rivet holes for various parts where possible (e.g. inner cockpit

skins and stiffeners). Most of the time the parts will be independent of each other but will fit a lot simpler, neater and will save extra materials if they can become interdependent. When considering this approach, temporarily place all of the parts that belong in the current area of work in their respective positions before installation.

Titan Aircraft must be consulted before any significant modifications, changes, or additions are made to the kit (by the builder/owner).

The explanations above are only a brief outline of T-51 construction tips that have culminated from the combined experience of both Titan Aircraft and Campbell Aviation. The standard rivet in the kit is the (Dome) head pop-rivet, although there are some rivets that will require dimpling or countersinking. If flush rivets are used, it may change the order of operations. Titan Aircraft makes dimple tooling specifically for the type of rivets used for flush riveting, and is available upon request.

A photo CD is provided with the manual and contains photos of the T-51 in various stages of construction. Photos are taken from many different builders from around the world and can be used as a guide for builders and to answer questions that the manual may not clearly explain. If something is unclear please do not hesitate to contact Titan Aircraft or your local dealer. There is also a "Titan Mustang Yahoo Group" link on TitanAircraft.com. This forum is for builders to communicate with each other during their build.

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Titan Aircraft & Campbell Aviation  
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