



**Information Paper:
“Introduction to Timber Aircraft Construction”**

This information paper is intended for the person who is considering building a timber aeroplane from plans and would like to get an idea about what’s involved with aircraft woodworking.

*As presented at Wagga Wagga 2003 SAAA National Convention by
SAAA Technical Counsellors:*

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What plans are available for timber aircraft?

- **Corby CJ-1 Starlet** – Australian designed single seat low wing monoplane
- **Evans Volksplane** – simple to build single seat low wing strut braced monoplane
- **Jodels** – various models available ranging from 2 to 4 seaters
- **Rand KR2** – two seat side by side, timber AND fibreglass & foam construction
- High performance retractable **Falco**
- High performance retractable **GP4**
- numerous others

Are they “approved” for Amateur Construction?

Some, like the Corby Starlet, Volksplane & KR2 indeed are, under the old CAO 101.28 Amateur Built class. Under “Experimental” regs these days, no formal approval is required to construct an aircraft, you are free to select any design from Australia or overseas, or indeed design your own.

Where to source these plans?

- Corby Starlet – John Corby, Sydney NSW (details on last page)
- Jodel series – Frank Rogers, Sydney NSW (details on last page)
- Websites:
 - www.landings.com – homebuilts section
 - www.kitplanes.com - annual plans built directory issue
 - www.avweb.com – homebuilts section

What instructional books are available?

- EAA Aircraft Building Techniques -WOOD – EAA (USA)
- Sportplane Construction Techniques – Tony Bingelis
- The Sportplane Builder – Tony Bingelis
- FAA Advisory Circular 43.13–1b. *Chapter 1, section 1 (available on SAAA website)*

What timbers can I use?

• Sitka Spruce – generally considered the benchmark of timbers for aircraft construction. However..... The Australian Standard Specification for Aircraft Material (1944) “*Australian Timbers for use as substitutes for Sitka Spruce*” tells us about other usable timbers. It certainly *does not say* “lesser quality than spruce”, so you may have great confidence in them.

- **Hoop Pine**
- **Queensland Maple**
- **Bollywood**
- **Silver Quandong**
- **Silver Silkwood**
- **Bunya Pine**

Also known to have been widely used are

- **Oregon** (*or Douglas Fir*)
- **Klinki Pine** from PNG
- **Western Hemlock.**

Are these “approved” for aircraft construction?

Under “Experimental”, *there is no such thing* as “approved” timber, it is up to the builder to determine suitability of all materials used. (*ref: CASA AC21.4(2) para 7.2*)

Having said that, there are no doubt some persons in Australia that are experienced, qualified and approved (by the predecessors of CASA) to select, inspect and grade aircraft timbers.

Contacting local timber aircraft builders in your area might give you some leads.

What about plywoods?

- Grade 1 (GL-I) Birch or Mahogany Aircraft Plywood is readily available
- Hoop Pine plywood
- Some types of Marine Plywood to Australian Standard AS/NZS 2272 - **Marine (A Bond)** may also suitable

Where to get these timbers and plywoods?

- Specialist boat building timber suppliers such as Marine Timbers P/L in Melbourne. (*Check your newsagent for **Australian Boatbuilding** magazine - they have many suppliers advertising in various states.*)
- Available in “flitches” (planks) for you to cut up yourself, or;
- Some suppliers will cut and dress pieces of timber to your requirements, but be advised, ***they are boatbuilders***, certainly knowledgeable about their timber, but don’t expect them to sell you “Aircraft Grade” materials, and don’t complain if you get a piece not suitable for your job. They know boats, not aeroplanes!!!

Grading and testing to determine suitability:

- Inspect for defects and general suitability: grain slope, annual rings per inch, knots, pitch or bark pockets, moisture content, strength, glue-ability
- Sample break testing can easily be accomplished at home

Refer to instructional books and references for guidance, both the EAA Wood book and FAA AC43.13-1b have excellent clear guidelines which you can easily follow to inspect your own timber.

Also refer to some CASA publications:

- CAO 108.22 (ANO 108.22) Klinki Pine for Aircraft Use
- CAO 108.23 (ANO 108.23) Marine Plywood for Aircraft Use
- CAO 108.29 (ANO 108.29) Timber for use in Aircraft Propellers

What glues are available?

- Resorcinol Formaldehyde Resin (a two part synthetic resin)
- Epoxies - West System, Techniglu, Four Seasons, Araldite K134, T-88, & others

Where to get these?

- Boatbuilding suppliers, marine chandlers, fibreglass supply stores
- Look under “adhesives” in the yellow pages

Are these glues approved?

Under “Experimental”, *there is no such thing* as “approved” glue, it is up to the builder to determine suitability of all materials used. Surprisingly, even under the old CAO 101.28 amateur building class, there was no “approved” glue, but there were several types of glue “not permitted.” The main criteria for usable glues were:

- the manufacturer specifically recommended the product for joining timber
- mix and cure strictly in accordance with the manufacturers directions
- test pieces made with the glue should clearly fail in the wood and not in the glue bond

These things are all still very valid criteria today when building a timber aircraft.

Mixing of glue:

- by weight
 - using Chinese Balance Scales (accurate to 0.2 gram or better)
 - using electronic scales (only accurate to plus/minus 49% of 1 gram)
- by volume
 - use manufacturers guidelines; 50/50, 2:1, 5:1 etc.
 - use small plastic mixing cups with graduated quantity marks
- icy pole sticks
 - packs are about \$6 per 1000 in craft stores or Bunnings.

What tools are required?

- table saw (if selecting and cutting own timber)
- thicknesser (if selecting and cutting own timber)
- bandsaw - small home/hobby size is usually ideal
- disc sander - commercial, or one made from an old electric motor
- vertical drill press
- various hand tools: rulers, pencils, set square, triangles, jack plane, hobby plane, files, Stanley knife, sanding blocks and papers, cheap clamps (various sizes) masking tapes,
- Workshop Thermometer / Hygrometer

Transferring dimensions from plans to timber:

Whether or not full size patterns are given;

- Read any instructions thoroughly
- Study plans carefully
- Measure twice
- Cut once!

Try to work as accurately as you can, but in reality, tolerances of around 1/32nd to 1/16th of an inch are perfectly acceptable, as most components will get a final sand and fit before gluing.

Jigs:

A wood or metal frame for holding parts in exact alignment during construction.

Complex shapes can thus be constructed.

Examples: for fuselage formers and frames, wing ribs, wing spars. Instructional books show many examples.

Laminating Timber/Plywood:

A “lamination” is a single piece of timber, (or component) made from two or more pieces edge-glued, to form the required width or depth. The grain of all the adjacent layers runs approximately parallel. Laminating is often performed due to timber of the required size being unavailable, or for other reasons of required strength such as in a laminated wingspar. Also, it is used to form complex curved components such as wingtip bows, where the use of several thin strips of timber can be easily individually bent, whereas one thicker piece would not bend as readily.

Bending Timber:

Timber can be softened for bending, by subjecting it to heat and increasing its moisture content. This is achieved by either steaming the parts in a homemade steaming box, or even by immersing the wood in boiling water for 15 to 30 minutes. Another method is by wrapping with towels and pouring on boiling water, then allowing to soak for a period of time.

Splicing Timber:

The method of making a strong end joint between two solid timber members. Gluing surface area is increased dramatically compared to a simple end to end butt joint, perhaps up to as much as six or nine times.

Scarfig Plywood:

Commonly used to join plywood sheets. Again, gluing surface area is vastly increased compared to a simple end to end join of plywood sheets. Scarf joint ratios are commonly around “12 T”, or 12 times the Thickness of the plywood being used. So, a 3mm thick sheet using a 12 T scarf joint would have a glue surface area spanning 36mm. As you can see, a far superior way of joining plywood sheets.

Gluing Requirements:

- Appropriate cleanliness of workshop required, together with adherence to any temperature and humidity considerations of the glue being used.
- Ansell thin disposable rubber gloves (from supermarket) to prevent skin irritation from the glue AND because gluing can just get plain messy!
- Workshop ventilation to disperse fumes – very important when working with epoxies
- Preparation of surfaces to be glued – clean, dry, sanded or freshly planed

Clamping, nailing & stapling:

Methods of physically securing pieces of timber structure while the glue is curing.

Clamps of various sizes will be required. Usually, inexpensive ones from “\$2.00 shops” are perfect. Normally, staples and nails are removed after the glued has cured as they serve no useful purpose, they do not contribute to strength of the structure, in fact, the use of nails will only add weight to the aircraft.

Fixing up mistakes!

Generally speaking, wood is a very forgiving medium for the amateur aircraft builder to work with. If a mistake is made, it can usually be recovered from relatively painlessly by either:

- Dismantling the parts, (by carefully breaking apart or cutting), clean up all surfaces, replace any pieces rendered unusable and rebuild or re-glue.
- Addition of an extra piece of timber to laminate up to size
- Removing excess timber (within reason of course!) by planing, filing or sanding

Preserving the timbers:

All internal structures must have a preservative coating to protect the wood from deterioration and rotting, usually epoxy varnish – around two coats.

Suppliers mentioned in this presentation:

- **Instructional books:**
Skylines Aviation Supply, Moorabbin Airport. (03) 9587 3400
- **Corby CJ-1 Starlet plans:**
John Corby, 4B/29 Clovelly Road, Hornsby NSW 2077. ph (02) 94829650
- **Jodel series plans:**
Frank Rogers, 35 St Pauls Cres, Liverpool NSW 2170. ph (02) 9602 7764
- **Timber and plywood:**
Marine Timbers P/L, 71-73 Roberts Ave, Mulgrave 3170 VIC. ph (03) 9546 0311
- **SAAA website:** www.saaa.com
- **SAAA Headquarters,** 265 Queens Parade, Clifton Hill VIC 3068 ph (03) 9482 4716