



## **Course Content**

for

**Training in**

**Aircraft**

**Composite**

**Repair**

# **Training in Aircraft Composite Repair**

## **General notes**

The following recommendations are based on our considerable experience in training aircraft maintenance personnel for aircraft composite repair.

The approach to composite repair and the recommendations given by manufacturers are constantly changing as more experience has been gained by the industry. The course content has been devised to respond to these changes and now reflects the current requirements for composite repair within the industry.

The training given by Aeroskills is recognised by the CAA and has been adopted by many international companies within the aerospace field as a standard training programme in composite repair.

All the techniques used in the training are based on those given by aircraft and power plant manufacturers and theory given is current and pitched at a level appropriate to the practical work.

Both theoretical notes and details of repair techniques are provided as a complete set for each delegate in a bound folder. They are backed up by overhead transparencies in the lectures, lecture room exercises, videos and research activities where appropriate.

Delegates are encouraged to question, criticise and to suggest improvements to all the techniques learnt during the training since the subject is still growing and there is disagreement among manufacturers about the best way to approach some problems.

## **Assessment and certification**

The practical progress of the delegates will be monitored throughout. Additionally, a multiple choice question paper on the health and safety, and the general theoretical aspects of the subject, will be taken by each delegate at the end of the course.

A delegate who satisfies the trainer that he meets the following practical criteria in terms of accuracy and quality, and who achieves a mark of more than 65% in the multiple choice question paper will receive a certificate of success. However the assessment criteria and award can be changed by agreement to meet individual companies' requirements.

### **Accuracy and quality criteria:**

Each delegate will be assessed according to the following criteria during the practical parts of the course:

Did the candidate take the correct safety precautions?

Was damaged laminate prepared in accordance with instructions?

Did the candidate follow the correct surface preparation procedures?

Were repair layers laid in correct sequence and alignment?

Did honeycomb repair plug fit to recommended tolerances?

Was the resin to fibre ratio calculated correctly?

Was the bagging sequence followed correctly?

Was the hot bonder programmed and used correctly according to the recommended cure conditions?

Were the alarms set correctly?

Was the cure completed satisfactorily?

Did the candidate satisfy all the necessary quality assurance requirements?

Did the candidate follow the correct hygiene and decontamination procedures?

## **10 day course in Aircraft Composite Repair.**

This course contains about 80% practical work and is intended for those members of staff who will be carrying out repairs on composite aircraft structures. It will give them sufficient knowledge to be able to complete the repair to approved aerospace standards. The content is based on our experience of the type of situations that will be met by such operatives. No previous experience is required or assumed.

There is enough theoretical content to allow the delegate to produce quality repairs using the correct materials and procedures and to work safely.

The techniques used are those currently recommended in manufacturers structural repair manuals and emphasis will be placed on strict adherence to these procedures. The importance of quality assurance is stressed throughout and the particular attention is paid to the adoption of quality control procedures throughout the repair process.

The main aims of the course are:

- To familiarise the delegate with the materials and techniques used to manufacture and repair composite components.
- To provide the delegate with the knowledge to satisfy the appropriate health and safety requirements.
- To equip the delegate with the knowledge and practical skills required to carry out sound and effective repairs on composite aircraft components, according to the methods recommended and accepted by the aircraft manufacturers.
- To provide the knowledge required to interpret standard structural repair manuals and to relate them to a given repair situation.
- To familiarise the delegate with a wide range of structural repair methods so that he/she can find all the relevant information relating to a particular repair.
- To satisfy all the relevant quality assurance requirements.

An outline of the training programme is given on the next page.

# Training Programme

## First Monday

am: *Introduction to composites*  
*Reinforcing materials*  
*Resin theory*

pm: Hand-lay up exercise

## First Tuesday

am: *Pre-pregs*  
*Vacuum bagging*  
*Hot bonding*

pm: Monolithic carbon panel manufacture  
Surface preparation exercise

## First Wednesday

am: *Honeycomb & other cores*

pm: Manufacture of sandwich panel

## First Thursday

am: Repair of flat sandwich panel/  
monolithic panel

pm: Repair of flat sandwich panel/  
monolithic panel

## First Friday

am: Cutting cores & laminates  
Completion of repairs

pm: Engine cowling section manufacture  
*Material selection*

## Second Monday

am: *Interpretation of SRMs*

pm: Puncture repair  
*Damage assessment*  
*Quality control*

## Second Tuesday

Double sided repair of curved panel using prepregs

## Second Wednesday

Completion of Tuesdays work & destructive testing

## Second Thursday

am: Edge band repair using improvised tooling

pm: *Comparison of repair methods*  
Continuation of edge repair

## Second Friday

Completion of edge repair  
*Assessment and course review*

## Training details:

### **Day 1 morning:**

Delegates will be introduced to composites, their structure, properties and reasons for using composites in aircraft components.

The theory will cover the properties and behaviour of the epoxy resins used for manufacture and repair of aircraft composites and concentrate on aspects of their behaviour which have to be taken into consideration when designing or performing a repair.

The importance of resin hardener ratios will be stressed and some resin/hardener calculations will be practised.

Health and safety issues will be addressed.

### **Day 1 afternoon:**

After an introduction to the various forms and properties of glass reinforcements the delegates will prepare a simple glass reinforced composite by hand lay-up to familiarise them with the materials and to teach accurate and correct procedures in the handling of composites.

### **Day 2 morning:**

The delegates will be introduced to the fibres commonly used in aerospace composites. Details of their characteristic properties, methods of handling and particular peculiarities will be given.

Simple theory of hot cured epoxy resins will be given and the delegates will be introduced to the techniques of vacuum bagging and heat curing used for advanced composite repair on aircraft structures.

### **Day 2 afternoon:**

An exercise will be carried out to show the effect of fibre orientation on the properties of a composite and to stress the importance of fibre orientation in repair.

Correct and incorrect procedures for surface preparation will be demonstrated. The delegates will carry out an exercise involving various methods of surface preparation prior to repair. Since one of the most important stages in repair is correct surface preparation, this exercise is designed to foster good practices. Samples prepared in this session will be tested later when time permits.

Techniques learnt during this session will be emphasised throughout the course.

The group will prepare and heat cure a monolithic carbon reinforced panel for subsequent repair.

### **Day 3 morning:**

The theory of light cored composite structures will be addressed. The advantages, reasons for use and special characteristics of honeycomb cores will be discussed.

### **Day 3 afternoon:**

The techniques learnt in the previous sessions will be put into practice in the manufacture of a Nomex cored composite panel.

**Day 4 morning and afternoon:**

The previously manufactured panels will be damaged and repaired in accordance with the appropriate structural repair methods.

**Day 5 morning:**

Methods of cutting cores and laminates will be addressed giving details of the best types of tools to use, recommended cutting speeds and other precautions.

Outstanding work from day 4 will be completed.

**Day 5 afternoon:**

The group will prepare curved panels which replicate an aircraft structure such as an engine cowling. This will be achieved by a vacuum bagging technique using an actual aircraft component and gives useful insight into the problems posed when dealing with large and awkward shaped aircraft components

**Day 6 morning:**

The morning will be spent carrying out exercises involving the interpretation of various manufacturers' SRMs.

**Day 6 afternoon:**

The group will be recommended methods of damage assessment and given guidance in choosing the most appropriate method of repair.

The group will study the various methods of dealing with repair to curved panels including full puncture damage. The problem of access restricted to one side will also be tackled.

Recommendations for quality control and assurance will be discussed.

**Day 7 morning and afternoon:**

The choice between wet lay-up and prepreg repair will be addressed and the special characteristics of prepreps will be studied.

Full puncture damage repair to the curved panel will be carried out using prepreg materials.

**Day 8 morning and afternoon:**

Recommended methods of moisture removal and finishing will also be detailed.

The previous days' work will be completed and previous repairs will be tested destructively.

Allowable damage and the decision to repair will be dealt with.

Interpretation of the data relating to choice of materials and repair method will be discussed in depth.

**Day 9 morning:**

Repair to a honeycomb panel and edge band will be carried out making use of temporary tooling. This exercise will give some insight into some techniques which can be used for out-of-the-ordinary repairs.

**Day 9 afternoon:**

The structural repair manuals of several manufacturers will be compared with a view to discovering the different approaches to repair favoured by each manufacturer. This will be related to the practical experience gained during the preceding nine days in terms of ease of use, quality of repair and common sense considerations.

Some common pitfalls will be discussed and areas of ambiguity and contradiction in the SRMs will be highlighted.

Recommendations for record keeping will be given.

**Day 10 morning and afternoon:**

Outstanding work will be completed. The group will discuss the techniques practised over the ten days and compare the merits and problems that each technique presented.

The delegates knowledge of the subject will be assessed through a multiple choice assessment paper.

Delegates will be given a chance to evaluate the course.

## Timing

The timing and duration of the various subjects included in this scheme are based on the work rate of an average group. The timing and may have to be modified slightly depending on the work rate of the group. The topics planned for days nine and ten can be adjusted to take this into account.

An on-going exercise will be carried out by each delegate throughout the second week. This will be based on a real repair situation and involve damage assessment, determination of the component construction, choice of repair method and materials. All relevant information sources will be available including manufacturers' SRMs and data sheets.

## Aircraft types

The repair techniques specified in the aircraft manufacturers' structural repair manuals will form the basis of the course.

These techniques can be related directly to a number of aircraft types such as the Boeing 747, 757 and 767, Airbus A319/320/321, MD80/90 and smaller aircraft such as ATR, Fokker 50 since the basic techniques are similar for these aircraft. The attention of the delegates will be drawn to those areas where there are differences between the recommended methods of repair, material choice, cure cycle and ply overlap requirements for instance.

The detailed SRM interpretation exercise scheduled for day 6 onwards will be based on the Boeing 737-300.

Comparison between all aircraft manufacturers' recommended techniques will be made throughout the course.

## **Variation of the course content**

The course content outlined above constitutes our recommendations for a ten day course for aircraft maintenance personnel. The emphasis may be changed according to the requirements of the delegates.