MAJOR MODIFICATIONS AND REPAIRS APPROVAL

1.0 PURPOSE

This Order is issued to provide guidance to inspectors when assessing an application of a major modification or major repair for approval.

2.0 REFERENCE

Regulations 57 and 65 of the Civil Aviation (Air Operator Certification and Administration) Regulations

3.0 GUIDANCE

3.1 General Information

3.1.1 A major modification or repairs to an aircraft are normally accomplished in accordance with design data approved by the State of Design and accepted by the Authority.

3.1.2 Major modifications and repairs design are prepared only by persons duly authorised with knowledge of the design principles embodied in the aircraft type being modified or repaired.

3.1.3 The effects of any potential incompatibilities between the proposed design change and any known existing or reasonably foreseeable modifications or repairs information to correct airworthiness deficiencies discovered in service which relate to the design change should be documented and submitted to facilitate the approval analysis.

3.1.4 There should be a provision to notify the Authority immediately when during the course of incorporation or operation an unsafe condition related to the design change is found.

3.2 Approval Procedures — Repairs

3.2.1 A repair is intended to restore an aeronautical product to an airworthy condition after it has been damaged or subjected to wear. The repair must be appropriately designed and installed to ensure restoration of the type design characteristics.

3.2.2 Where a repair design is intended to correct damage to an aeronautical product, the design is generally unique to the specific unit damaged. Approval may be granted for a number of units where the damage to each is such that a common repair design is applicable. A repair design may be approved for all units of a given type of aeronautical product where the repair is suitable for repeated incorporation during overhaul and maintenance activities. Such repairs usually correct the effects of normal usage.
3.2.3 Compliance must be shown with the approval basis of the aeronautical product. To ensure compliance with the approval basis of the aeronautical product, all applicable factors included in the original approval of the product must be addressed. This may require reference to the original type design holder. The following are some areas to be considered:

(a) Static and fatigue strength of structure;
(b) Whether structure is safe-life, fail-safe or damage tolerant;
(c) Corrosion protection;
(d) Mass and balance (for the aircraft overall or for balanced flight control surfaces);
(e) Flammability standards;
(f) Access and inspectability requirements;
(g) Electromagnetic interference (EMI) protection;
(h) Electrical conductivity (lightning strike);
(i) Colour and reflectance (i.e. ultraviolet absorption, thermal radiation);
(j) Process specifications (nitriding, etc.);
(k) Environmental standards (noise, smoke and gaseous emissions); and
(l) Failure modes and effects analysis.

3.3 Procedures

3.3.1 A major repair to an aeronautical product shall be accomplished in accordance with design data approved by, or acceptable to the authority. In this regard the structural repair manual (SRM) of the manufacturer of the aeronautical product is usually accepted, provided that it has been approved by the airworthiness authority of the State of Design directly or by delegation. Repairs incorporated in accordance with such a manual may be deemed to be in accordance with approved data.

3.3.2 In the case where a repair is not already approved or accepted, the following activities are required to be performed by, or on behalf of, the applicant by a person or organization acceptable to the Authority:

(a) Conduct all analyses, calculations and tests necessary to demonstrate compliance with the applicable airworthiness and environmental standards;
(b) Prepare all necessary documentation;
(c) Determine that the design can be installed in the product in conformity with the drawings and instructions; and
(d) Ensure that adequate instructions are provided for the continuing airworthiness of the repair, e.g. inspection programme amendments.

3.4 Documentation

3.4.1 The required documentation may include:

(a) Compliance programme;
(b) Master drawing or drawing list, production drawings, and installation
instructions;
(c) Engineering reports (static strength, fatigue, damage tolerance, fault analysis, etc.);
(d) Flight test programme and results;
(e) Mass and moment change data;
(f) Maintenance and repair manual supplements;
(g) Instructions for continuing airworthiness; and
(h) Flight manual supplement.

### 3.5 Structural Repairs

3.5.1 The design of repairs for structural components must take into consideration the nature of the structure involved. Three different structural philosophies have been used in the design of aircraft structures which are in service at present. These are discussed below.

#### 3.5.2 Safe-life

This is a term applied to a structure that has been evaluated as being able to withstand the repeated loads of variable magnitude expected during its service life without detectable cracks. Safe-life structure often has a non-redundant arrangement of load-carrying members. Because failures of elements of this type of structure can be critical to the safety of the aircraft, fatigue life limits are carefully determined and it is mandatory to remove safe-life components from service when the life limits are reached. Because configuration changes can drastically affect fatigue life, the repair of a safe-life component necessitates that the remaining life be re-established and approved by, or on behalf of, the airworthiness authority. In most cases this task should not be attempted without the assistance of the organization having responsibility for the type design.

#### 3.5.3 Fail-safe

This is a term applied to a structure that has been evaluated to ensure that catastrophic failure is not probable after fatigue failure or obvious partial failure of a single, principal structural element. A fail-safe structure is characterized by multiple or redundant load paths. Considerations which should be addressed in the design and substantiation of repairs to fail-safe structure include:

- **(a)** The static strength must be shown to be adequate after failure of single neighbouring structural elements, i.e. fail-safe design cases must be considered;
- **(b)** Fail-safe design features must not be compromised (e.g. integrity of crack stoppers must be maintained);
- **(c)** Inspectability must be maintained or, alternatively, appropriate nondestructive inspection procedures introduced;
- **(d)** Good detail design should be employed to reduce, to the extent possible, the introduction of stress raisers leading to premature fatigue cracking of the repair or the surrounding area; and
- **(e)** The structural inspection intervals for the area repaired should be re-assessed to determine whether they should be shortened to account for
possible fatigue life reduction resulting from the repair.

3.5.4 **Damage tolerant**

This is a term applied to a structure that has been evaluated to ensure that should serious fatigue, corrosion, or accidental damage occur within the operational life of the aircraft, the remaining structure can withstand reasonable loads without failure or excessive structural deformation until the damage is detected. Characteristics often, but not always, found in a damage tolerant structure include multiple or redundant load paths, materials with slow crack growth rates, ability to withstand relatively long cracks before unstable crack growth occurs, and design for good inspect ability. An effective structural inspection programme is an essential element of damage tolerant design and must be developed to permit adequate opportunity to detect damage in principal structural elements before such damage becomes critical.

3.5.5 Substantiation of a repair to a damage tolerant structure requires that a damage tolerance evaluation be performed in addition to a static strength substantiation. The damage tolerance evaluation requires a determination of the probable location and modes of damage due to fatigue, corrosion and accidental damage. Fatigue initiation thresholds and crack propagation rates must be established. Inspection methods, thresholds and frequencies must be defined such that the residual strength of the repaired structure at any time during the operational life of the aircraft is sufficient to withstand the damage tolerance load cases listed in the applicable design requirements. The aircraft damage tolerance documentation must be revised to reflect new inspection methods, thresholds and frequencies established for the repaired structure and the revisions approved by, or on behalf of, the airworthiness authority. A damage tolerance assessment should not normally be attempted without the assistance of the organization having responsibility for the type design.

3.6. **Service Limitations for Repairs**

3.6.1 Pending the completion of a permanent repair, it is occasionally necessary to restore a damaged aeronautical product. Such a repair may be permissible under controlled operating conditions and subject to the approval of the authority. Two categories in which service limitations apply are described below.

3.6.2 **Interim repairs** are deemed to comply with applicable design standards at the time of their implementation and for a limited time thereafter. However, they may be subject to long-term effects which in time would compromise their compliance with regulatory requirements. An example of an interim repair is a structural repair which has been shown to have adequate static strength, but which has not been substantiated for damage tolerance requirements. In such a case a two-stage evaluation may be acceptable, as follows:

(a) A static structural strength evaluation is made prior to release of the aircraft into service with a stated time for completion of the damage tolerance evaluation; and

(b) A damage tolerance evaluation of the repair is made within the prescribed time period after this interim release.

3.6.3 **Temporary repairs** do not fully restore damaged components to compliance with applicable regulatory requirements, but instead restore the aircraft to a condition acceptable for ferry flight, with appropriate restrictions, to a maintenance base for permanent repair.
4.0 COMPATIBILITY OF MODIFICATIONS AND REPAIRS

4.1.1 When any modification or repair is installed on an aircraft, care must be taken to ensure that it is compatible with all other design changes installed on that aircraft. Modifications or repairs designed separately may conflict or interfere with each other, despite having been individually analysed, tested and shown to comply with all applicable standards of airworthiness. Interaction between different modifications or repairs may be of a physical, aerodynamic, structural or fatigue strength, electromagnetic or any other nature. Such interaction may jeopardize the airworthiness of the aircraft.

4.1.2 An example of potential incompatibility would be a repair installed in close proximity to an existing repair. While the two repairs individually may be completely satisfactory if separately installed on an aircraft with no other design changes in the vicinity, the combination in close proximity may introduce additional stress concentrations which cause fatigue cracks to occur after a period of time in service. The designer of a repair scheme should survey the aircraft to be repaired to establish whether there are any other design changes in the vicinity which may interfere. In the case of an existing repair in close proximity to the new damage, it may be necessary to remove the old repair and install a new repair encompassing both damage areas, designed in a manner to reduce any stress concentrations to a level that will not produce fatigue cracking.

4.1.3 In a more general situation, modifications may be separately designed for the same basic aircraft type by different organizations with no knowledge of the other’s work. The modifications may be shown separately to comply with all applicable airworthiness standards; however, on attempting to install them on the same aircraft, it may be found that they physically interfere with each other. Alternatively, no problems may be encountered with the installations, but it may be found in service that the combination causes aerodynamic buffeting, stability or control problems, fatigue cracking, structural failure, electromagnetic interference, or any number of other problems. If the concurrent installations of different modifications are not rigorously assessed for compatibility, there exists the possibility that in combination they may cause serious airworthiness hazards.

4.1.4 Modifications and repairs may be designed by the same organization that operates the aircraft into which they are incorporated. In the more general case, however, the organization that designs and obtains design approval for the modification or repair, the operator of the aircraft, and the organization that installs the design change on the aircraft may all be different. Their separate responsibilities are discussed below.

5.0 RESPONSIBILITIES OF HOLDERS OF APPROVALS

5.1 In the case of a design change intended as a unique installation on a single aircraft, the aircraft records and the aircraft itself should be surveyed to identify all other design changes to the aircraft which may in any way interfere with the proposed installation. All such existing installations should be considered in the analysis and testing conducted to demonstrate compliance with the standards of airworthiness.

5.2 In the more general case where a design change is intended to be sold to many aircraft operators and incorporated on multiple aircraft, it may not be feasible for the designer of the modification or repair to obtain knowledge of the modification status of every aircraft affected. The designer should account for the effects of any potential
incompatibilities between the proposed design change and any known existing or reasonably foreseeable modifications or repairs when conducting analyses and tests to demonstrate compliance with the standards of airworthiness and obtain design approval. Alternatively, limitations may be placed on the design change, explicitly advising potential users that it has not been cleared for compatibility with other modifications or repairs and that the installer should obtain separate design approval for installation in combination with those others.

5.3 The holder of a design change approval has a responsibility to assist the approving airworthiness authority to correct airworthiness deficiencies discovered in service which relate to the design change. If, during the course of investigating a perceived unsafe condition related to the design change, the approval holder determines that the unsafe condition results from an incompatibility between the design and another modification or repair, the approval holder should notify the authority immediately and recommend corrective measures. If the authority determines that the design change must be altered to prevent the unsafe condition from occurring in other aircraft on which it is installed, it will normally require the approval holder to develop the corrections and issue instructions for the installer. These instructions should provide corrective measures for existing installations and revisions to the installation instructions for future installations. The authority should issue an airworthiness directive to mandate the measures to correct the deficiency on existing installations.

6.0 RESPONSIBILITIES OF INSTALLERS

Because the holder of a design approval for a particular modification or repair cannot be expected to be aware and to have conducted analyses and tests for all the possible design changes installed on all aircraft of a given type, the installer has a responsibility to verify compatibility with other modifications and repairs before installing any design change. The installer should survey the aircraft records and the aircraft itself to determine what other design changes exist on the aircraft. Any questions of incompatibility with other modifications or repairs arising from the survey should be referred for resolution to the operator.

7.0 RESPONSIBILITIES OF OPERATORS

Operators have the overall responsibility to ensure the compatibility of all design changes incorporated in their aircraft. The operator contracting with an installer for incorporation of any aircraft modification or repair should provide the installer with information on all existing design changes to the aircraft so that compatibility may be verified. Any questions of design change incompatibility which may arise during installation or in service should be thoroughly investigated by consultation with the approval authority or approval holder, or by an independent engineering organization. In every case of incompatibility between modifications or repairs, the problem must be corrected and it must be established to the satisfaction of the authority of the State of Registry that the modified aircraft continues to comply with the applicable standards of airworthiness.
In addition to correction of the problem on the aircraft on which it is discovered, it is necessary that any incompatibilities between modifications or repairs be addressed on all other affected aircraft. The operator should promptly report any design change incompatibilities detected during installation or in service to the approval holder, to the installer and to its own airworthiness authority.

8.0 RESPONSIBILITIES OF STATES

The airworthiness authority issuing a design change approval should require that compatibility with other existing modifications, repairs and airworthiness directives be adequately verified. Additionally, some authorities have a standard caution statement concerning compatibility with other design changes, which is included on each modification and repair approval document issued.

9.0 APPLICATION FOR APPROVAL OF MAJOR MODIFICATIONS AND REPAIRS

The application for major modification and/or repair is made by submitting in duplicate a dully completed original Authority’s prescribed application **Form: AC-AWS 014** for approval of major modifications and/or repairs.

9.1 Acceptance of the Application

9.1.1. Ensure application has been made using the prescribed application form submitted in duplicate.

9.1.2 The following modification or repair documents should be attached –

a) Detailed description of the proposed modification or repair;

b) A master documentation list detailing the individual drawings and specifications which define the modification or repair;

c) Drawings and instructions necessary for incorporation of the modification or repair;

d) Testing procedures or methods to meet certification and operating rules, such as flammability, carbon monoxide, and noise requirements

e) Test procedures that are appropriate to the modification or repair and to verify that the modification or repair meets applicable certification requirements.

f) Detailed design standards, to ensure that the operator has considered all applicable design requirements and acceptance engineering reports including expected test results to be used in determining the compliance of the modified or repaired product.

g) A record of the change in mass and moment arm when the modification or repair is installed in the aeronautical product;

h) A record of the change in electrical load when the modification or repair is installed in an aircraft;

i) Supplements to:

(i) The approved flight manual

(ii) Maintenance instructions;

(iii) Instructions for continuing airworthiness
(iv) Repair instructions.

j) Any other factors that may affect safety or airworthiness;

### 9.2 Application and Documents Evaluation

The major modification or repair documents submitted must be in accordance with the aircraft design data approved by the state of design.

*Note:* Repairs designed in accordance with the manufacturers Structural Repair Manual (SRM) approved by the airworthiness authority of the State of Design may be accepted because such manuals are considered to be in accordance with approved type certificate data.

#### 9.2.2 Evaluate Application to ensure that:

a) The description of the proposed modification or repair correctly and accurately describes the modification or repair.

b) Documents are complete and if not advice applicant what additional information is needed.

c) The applicant has conducted and submitted an acceptable conformity evaluation statement that ensures the proposed modification or repair will not impact the airworthiness of the aircraft.

d) There is proof that the modification or repair is compatible with previously approved modification or repairs.

#### 9.2.3 Study the application document and verify that:

a) The proposed modification or repair has no unsafe features;

b) The applicant has met the requirements for the provision of engineering data and documentation from the State of Design; and

c) The applicant is authorized or has stated a competent AMO to perform the modification or repair.

### 9.3 Approval

9.3.1 Approval of major modifications and repairs is signified by signing the approval section of the application forms. One copy is returned to the applicant the other is retained by the Authority for records.

9.3.2 If the modification or repair documentation as required has not been submitted, the approval process is stopped and the person responsible for safety oversight is informed and the applicant is notified in writing the reasons for suspension or denial.

9.3.3 The applicant can be given opportunity to make corrections as necessary and re-submit the application.

---

Civil Aviation Authority