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Title: Aircraft Design Changes - Guidance on the approval of modifications and repairs

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2 INTRODUCTION

Note 1 For the purposes of this airworthiness advisory memorandum (AAM), an aircraft design change is assumed to be a modification or a repair.

Note 2 In many areas the approval process is similar for modifications and repairs and the following information applies equally to both cases. Where there is a difference in approach, this is noted in the text by using the words ‘design change’ (applies to both cases) or ‘modification’ or ‘repair’.

Note 3 This document is only applicable for aircraft design changes being approved under the Irish National approval system. Aircraft design changes being approved under the EASA approval system, must comply with the requirements of Commission Regulation (EC) No 1702/2003.

Note 4 This AAM is restricted to aircraft design changes associated with an aircraft, engine or propeller.

Note 5 Irish national law in relation to aircraft design changes includes Statutory Instrument No. 324 of 1996, article 17 and Aeronautical Notices A.6 and A.9

The purpose of this airworthiness advisory memorandum (AAM) is to provide guidance on the actions required to perform design changes to aircraft type design made through the accomplishment of aircraft modifications and aircraft repairs.


This AAM provides guidance on the actions necessary to change the aircraft type design, including the application to the Irish Aviation Authority (IAA), design change classification, establishing the certification basis, means of compliance, demonstration of compliance, finding of compliance, design change approval and post-approval requirements.

Modifications are intended to change a function, operation, limitation, performance, or characteristic of an existing aircraft, engine or propeller for the purpose of achieving a desired feature, role or capability for the affected product.

An aircraft will experience accidental damage, wear and tear, environmental deterioration, fatigue, malfunction, and failure during its operational life. Repair is a corrective action intended to restore an aircraft back to its approved type design and, is regarded primarily as a maintenance function.

3 REFERENCES

- ICAO Document 9760, May 2007 Title
- Statutory Instrument No. 324 of 1996 – Airworthiness of aircraft
- Aeronautical Notice A.6 – Approval of modifications
- Aeronautical Notice A.9 – Maintenance on Annex II aircraft operating on a Certificate of Airworthiness
- This Advisory Memorandum supersedes and replaces Airworthiness Advisory Memorandum 09-10.

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4 AIRCRAFT DESIGN CHANGE APPLICATION

4.1 Applicant for an aircraft design change

An applicant requesting approval of a proposed modification to an aircraft, engine or propeller can be an organisation, an individual or a representative for that organisation or individual. Examples of an applicant could be the type certificate holder, an aeronautical product manufacturer, a specialized design engineering organization, an air operator with engineering capability, individual engineers as consultants, or an aircraft maintenance organisation or repair station.

Regardless, the applicant is the organisation or individual that has responsibility for the proposed modification and in whose name the approval will be granted. In cases of complex design changes involving multi-national agreements, joint ventures, partnerships or similar collaboration, the applicant remains overall responsible for integrating all design data from its various sources, and submitting it to the IAA as a complete and detailed proposal for the modification of an aircraft, engine or propeller.


Any person or organisation may apply for approval of a repair design to an aircraft. An applicant may be located within the geographical jurisdiction of the IAA (considered a local applicant) or located in another State (considered a foreign applicant). The emphasis is on the aircraft operator to ensure that a repair design is approved and specifically applicable to the affected aircraft, prior to its release back into service. The aircraft operator does not have to be the holder of the repair design approval.

A person or organisation (holder) to whom a Type Certificate was issued for an aircraft, engine or propeller can apply for an amendment of their Type Certificate. The holder is responsible for the type design of the complete aeronautical product, and is entitled under the privileges of their Type Certificate to introduce modifications to their type design, while still maintaining full responsibility for the complete product. It is also the privilege of a holder to request approval of their modification through a supplemental approval instead of an amendment of their Type Certificate. The decision to pursue an amendment or supplemental approval is usually made by the holder.

A person or organisation (non-holder) who does not hold the Type Certificate for the product can apply for approval of their modification as a supplement to a Type Certificate, commonly referred to as an approval under a Supplemental Type Certificate (STC). An STC is an approval of only those aspects or areas of the aircraft, engine, or propeller that were modified. This is the primary reason why a non-holder of a Type Certificate is not eligible to apply for an amendment of a Type Certificate.

The design of major design changes to aircraft, engines or propellers should not be attempted unless the applicant has a sound knowledge of the design principles embodied in the aeronautical product being considered for a design change. There may be cases where access to the analyses and test reports from the original type certification activity of the aeronautical product is needed in order to assess compatibility or suitability of the proposed design change. If this is the case, it is recommended that the applicant seek ways for the participation in, or review and comment on, the design change by qualified representatives from the holder of the Type Certificate. Where such cooperation is not available, the IAA will not approve the design change unless it is confident that the applicant has:

- a comprehensive knowledge, experience and capabilities in the applicable technologies, such that in-depth analyses can be performed where required; and
- sufficient information on the type design of the aircraft involved (if there is any doubt, consultation is required with the airworthiness authority of the State of Design).

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4.2 Application data for an aircraft design change

An application for the approval of a proposed design change should be submitted in a form and manner prescribed by the IAA (see Aeronautical Notices A.6 and A.9). Information supplied to the IAA on the proposed design change should include, as a minimum, the following:

- the name and address of the applicant to which the approval will be issued
- the make and model of the affected aeronautical product (registration and/or serial number) and its Type Certificate number or other approval reference
- the title, detailed description, and purpose of the proposed design change, including any changes affecting the noise and emissions level of the aircraft or engine
- the type of approval requested
- the proposed airworthiness standards, including environmental standards if applicable, to which the proposed design change is intended to comply
- documentation and/or substantiating data of the design change
- for a local applicant, an indication on the need for a concurrent or subsequent approval by another State, and
- for a foreign applicant, evidence of prior approval by the State that has jurisdiction over the individual or organisation responsible for the design change

An application for a modification or repair is normally considered outstanding or open until an approval is finally issued. There is no validity period for an application within which the IAA must grant the approval. The operating schedule of the aircraft operator normally indicates the time limitation by which an approval is needed, in order to release an aircraft back to service.

5 CLASSIFICATION OF AIRCRAFT DESIGN CHANGES

Modifications will vary in design philosophy, application technology, complexity, and magnitude. Modifications should be categorised as either a major modification or a minor modification.


Repairs, including the installation of a replacement part, must be in accordance with the airworthiness requirements of the IAA. Repairs are categorized as either a major repair or a minor repair.

5.1 Major modification classification

By definition, a major modification has an appreciable, or other than negligible, effect on the airworthiness of an aeronautical product. The applicant should evaluate the technical merit of each modification proposal and establish a clear understanding of the intended and/or consequential effect on the affected product. The intensity of such effect will vary with the complexity and extent of the proposed design change, but is generally recognized as being, substantial, significant or not significant.

5.1.1 Substantial modification

A proposed change in design, configuration, power, thrust, speed Limitations, or mass is so extensive that a substantially complete investigation of compliance with the applicable airworthiness standards is required. A design change at this level is generally viewed as having a technical scope and nature that the affected product, when modified, can be regarded as essentially a new product, i.e. there are differences in major design and/or production elements. Further, due to the extensiveness of the proposed modification, most of the existing

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substantiation of the product will no longer be applicable. Therefore, there is a need for a substantially complete, or complete, re- investigation of compliance of the new substantiating data with the applicable airworthiness requirements. A substantial change to an aeronautical product may evolve from single extensive design change proposal, or from previous relevant design changes that incrementally evolved an aircraft, engine or propeller over a period of time.

Some examples of modifications that are generally regarded as substantial are:


- in the case of aircraft, the modification involves change in the number or location of engines, change in the number of rotors, increase from subsonic to supersonic flight regime, change from high wing to low wing configuration, or change from an all metal aircraft to an all composite primary structure (fuselage, wing, empennage);
- in the case of an aircraft engine, the modification involves change in the principle of operation or use of different principles for propulsion; or
- in the case of propellers, the modification involves change in the number of blades or the principle of pitch change operation.

5.1.2 Significant modification

A proposed change in the general configuration, principles of construction, assumptions used for the certification, or a combination of these, for a type certificated product, but not to the extent to be considered a substantial change. A significant change in the general configuration are design changes that are likely to require a new product model designation to distinguish it from other product models. A significant change to the principles of construction are changes to the materials and/or construction methods that affect the overall product's operating characteristics or inherent strength. A significant change to the assumptions used for certification are changes to the product level assumptions associated with the compliance demonstration, performance, or operating envelope so different that they invalidate the original assumptions. The assessment of the effect of a significant change is made on the overall aircraft, engine, or propeller, rather than at the level of a part, component or system. A significant change usually results in a modified product that is distinct from other models of the same product, while still retaining common major design or production elements.

In general, a significant change is either the result of an accumulation of previous modifications or occurs through an isolated but extensive major modification that rises to a product level. A modification to a single area, system, or component of an aircraft, engine, or propeller will not likely result in a product level change.

When assessing the proposed modification, the cumulative effect of previous relevant modifications in the areas related to the current proposal should be considered. For example, previous relevant aircraft design changes may address incremental increases in mass or thrust that, while individually not significant (for example, 2 per cent, 4 per cent, 5 per cent discrete increases) can, through a series of modifications, achieve a significant product level change. The collective and cumulative effects of previous modifications, along with the proposed modification, may result in the modified product being considerably different from the latest product or model. If this is the case, the proposed modification should be categorized as a significant change. Typically, significant product level changes result in a model change necessitating an amendment to the Type Certificate or an STC that rises to a level similar to that of an amended Type Certificate.

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Some examples of modifications that are generally regarded as significant are:

- in the case of aircraft, the modification involves increase in the seating capacity, installation of floats or skids, conversion from passenger to freighter version, fuselage stretch, increase in design mass of more than 10 per cent, primary structure change from metallic to composite material, certification for flights into known icing conditions, or comprehensive flight deck upgrades;
- in the case of an aircraft engine, the modification involves use of new design fan blade and fan hub in a turbine engine, change in the containment case material, conversion from mechanical to electrical control systems, addition of a turbocharger, or conversion from spark-ignition to compression-ignition for piston engines; or
- in the case of propellers, the modification involves introduction of a different principle of blade retention.

5.1.3 Not significant modification

This is a modification whose effect on the product does not rise to the level of either a substantial or significant modification. A Not Significant modification remains a major modification, and should not be confused as equivalent to, or treated like, a minor modification. The effect of a Not Significant change is usually confined to a single area, system, or component of an aircraft, engine or propeller.


Some examples of modifications that are generally regarded as Not Significant are:

- in the case of aircraft, the modification involves general avionics upgrade, relocation of galley, installation of non-essential auxiliary power unit, substitution of one structural bonding method for another, installation of wheel skis, installation of quieter exhaust system, increase in fuel tank capacity, installation of new type passenger seats, or mass increase of less than 5 per cent;
- in the case of an aircraft engine, the modification involves change in oil tank design, fan blade re-design, software changes, bearing change, change in limits on exhaust gas temperature, change from one hydro-mechanical control to another hydro-mechanical control, change in crankshaft, or redesigned cylinder head, valves or pistons; or
- in the case of propellers, the modification involves change in the material of the bearing or change to a component in the control system.

5.2 Minor modification classification

By definition, a minor modification is a design change that is not classified as a major design change. It has a negligible, or no appreciable, effect on the mass, balance, structural strength, reliability, operational characteristics, or other characteristics affecting the airworthiness of the product. The accomplishment of minor modifications normally involves use of standard or generally accepted practices.

5.3 Major repair classification

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A major repair is usually considered a repair that might appreciably affect mass, balance, structural strength, performance, power-plant operation, flight characteristics, or other qualities affecting airworthiness. A repair in this category normally requires some form of engineering analysis or assessment. The applicant should evaluate the technical merit of a repair design proposal, and establish a clear understanding of the intended or consequential effect on the affected product. For example, it may not be appropriate to approve a repair that is purposely designed to be much stronger than the structure being repaired because the effect may be an undesirable change in the original structural load distribution. For the purpose of illustration, the following are examples that can be used to categorise a major repair:

- Repairs involving a principal component of the aircraft structure, such as a frame, stringer, rib, spar of stressed skin
- Repairs to structural elements that were approved using damage tolerance or fail- safe evaluation
- Repairs to pressurized areas
- Repairs involving the installation of an item of mass necessitating structural re- evaluation
- Repairs to structural attach points intended for the stowage or retention of significant mass
- Repairs to load bearing structure of aircraft seats, harnesses, or to occupant restraint equipment
- Repairs involving substitution of materials, or use of a different repair process or technique
- Repairs to components, parts, appliances where form, fit, and function may be affected


5.4 **Minor repair classification**

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5.5 **Other classification issues – noise and emissions**

As part of an assessment of a design change as either major or minor, the effects on the noise and emissions levels should also be categorised and an emissions change category established.

The type certification of an aircraft and engine includes compliance with, and certification to, the environmental standards of ICAO Annex 16, Environmental Protection. The demonstrated levels of noise, exhaust smoke emissions, gaseous emissions and fuel venting for which an aircraft and/or engine were approved for purposes of issuance of a Type Certificate are those recorded in the Type Certificate Data Sheet (TCDS). The intent of ICAO Annex 16 is to ensure that these recorded levels are maintained, or improved, throughout the operational life of the aircraft or engine. If the proposed design change changes or improves the current emissions level of an aircraft or engine (such as retrofit of hush kits or re-engine programme), a re-certification is necessary to establish compliance with the applicable requirements. Three emission change categories are possible;

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- Noise Level Change - Any change in the type design of an aircraft which may increase or decrease the noise levels of that aircraft
- Engine Emissions Change - Any change in the type design of the engine which may increase or decrease the exhaust smoke and gaseous levels of that engine
- Fuel Venting Change - Any change in the type design of the aircraft or engine which may affect the certification related to prevention of intentional fuel venting into the atmosphere

6 COMPATIBILITY OF AIRCRAFT DESIGN CHANGES

When any design change is installed on an aircraft, care should 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 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.

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, 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 damaged areas, designed in a manner to reduce any stress concentrations to a level that will not produce fatigue cracking.


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, they may 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 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.

7 ESTABLISHING THE CERTIFICATION BASIS

The main objective of the aircraft design change approval process is to determine the overall compliance of a proposed change with the applicable airworthiness and environmental standards, such that the affected aeronautical product, when changed, will continue to have a valid and approved type design.

7.1 Establishing the certification basis - modifications

The type certificate data sheet (TCDS) of an aircraft, engine or propeller identifies the detailed certification basis by which the type design of that product was approved. The major components of a certification basis are the airworthiness and environmental standards, including if any, special conditions of airworthiness, findings of equivalent level of safety, and exemptions. Applicants should consider developing modifications to a level of safety higher than that intended by its original certification basis. This policy requires that modifications demonstrate compliance with design standards that are in effect on the date of application, or with later amendments to the design standards recorded on the TCDS,

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whenever the IAA deems that such policy will result in a material contribution to the safety of the modified product and is practical (cost-effective and feasible). The effect of such policy is a progressive upgrading of the inherent levels of safety of products to the greatest extent practicable, as it undergoes several modifications throughout its service or operational life.

In the application for a modification approval, the applicant proposes the airworthiness and applicable environmental standards to which they intend to demonstrate compliance.

Depending on the modification, additional airworthiness or operational requirements may be imposed by the IAA, or an applicant may be required to show that the product meets additional standards in order to receive approval in another State, due to differences in requirements. All these requirements are established collectively to become the certification basis for the modification.

It should be noted that while the certification basis is established very early in the approval process, the final certification basis of a modified product may, in some cases, end up being different from that established initially. The difference(s) may come when the IAA issues special conditions of airworthiness (SC – see section 6.1.4), findings of equivalent level of safety (ESF – see section 6.1.5), or an exemption (see section 6.1.6). At the conclusion of the approval activities, the applicant should identify all SC, ESF, exemptions and other voluntary compliance that transpired during the approval period in order that these activities may be recorded as part of the final certification basis.


7.1.1 Airworthiness Design Standards – Amendment levels

Airworthiness standards are amended from time to time to improve the overall level of safety inherent in these standards. At the time of application, it is generally regarded that the latest amendment level of a standard offers the highest level of safety for the product, and the intent is to certify the type design to this level

Where compliance with the latest design standards is deemed to materially contribute to the overall level of safety of an aircraft, engine, or propeller, the next step is to further assess the cost-effectiveness of applying such policy. Demonstration of compliance entails costs, and the applicant should assess if the incremental costs associated with demonstrating compliance with the latest design standards is commensurate with the incremental safety benefit to be gained. If the incremental safety benefit can be shown to economically justify the incremental costs, then the policy should be applied.

Otherwise, the applicant should continue complying with the design standards recorded in the existing certification basis of the product, or if the applicant chooses, with later amendments to those design standards. It is not the intent of this policy to improve safety regardless of costs.

Each proposed modification will be judged on its own merit when making the final determination of the certification basis. The certification basis will not be dependent on whether the Type Certificate holder or an applicant for a STC is undertaking the proposed modification. The process applies equally to applications made for Type Certificate amendments, STCs, or STC amendments. A brief introduction to the steps in the process for determining the appropriate amendment level of airworthiness standards follows;

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- Identification of the proposed modification - The applicant should identify the proposed modification to the aeronautical product and its effects on other systems, components, equipment, or appliances of the affected product.
- Determine if the proposed modification is substantial change - See section 5.1.1.
- A complete re-investigation of compliance with the applicable airworthiness standards, latest amendment level is required.
- Determine if the proposed modification is significant - See section 5.1.2. The applicant should demonstrate compliance with the applicable airworthiness standards, latest amendment level for all affected areas of the product.
- Not significant change or minor change – See sections 5.1.3 and 5.2. The applicant should demonstrate compliance with the applicable airworthiness standards, at the original amendment levels. The applicant may, however, volunteer to demonstrate compliance with later amendments of the design standards.

7.1.2 Airworthiness design standards – Latest amendment levels

There may be cases where using the latest design standards may be too expensive to pursue, in contrast to the extra safety benefit to be gained. In this case, the costs of compliance may discourage the installation of modifications of potential safety benefits. The applicant should complete a detailed review of each affected area of the modification to consider prior amendment levels to the latest design standards where the increased safety can be economically justified.


In order to determine what areas are affected by a modification, the applicant should consider the physical aspects (structures, systems, equipment, components, and appliances) and the performance / functional characteristics (performance features, handling qualities, emergency provisions, fire protection, structural integrity, aero elastic characteristics, or crashworthiness).

It may not be desirable for all areas affected by the proposed design change to comply with the latest design standards. This can occur when demonstrating compliance with such requirements would not contribute materially to the level of safety or would be impractical. The applicant should determine the appropriate amendment level (other than the latest) of the design standards that should be applied to each affected area.

7.1.2.1 Amendment level - Contributing materially to the level of safety

Typically, there are modifications that can achieve a positive safety benefit that are resource effective. Conversely, there are modifications that may achieve a small safety benefit at the expense of a large amount of resources to implement. This process is intended to be used along with good engineering judgment and a strong commitment to practicality. An appropriate amendment level (of a design standard) is where the applicant and the IAA are both convinced that the safety benefits justify the resources involved.

Compliance with the latest design standards could be considered to not contribute materially to the level of safety if the proposed design and relevant service experience

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can demonstrate that a level of safety comparable to that provided by the latest design standards can be achieved with the existing design standards, or if compliance may compromise the existing level of safety. The applicant should provide sufficient justification to allow the IAA to make this determination. Some of the factors to consider are design, service experience and design standard effectiveness.

- Design - The applicant should consider the consistency of the design. If a new design affects a small area of an aircraft, for example, the level of safety may not be materially increased at the product level by applying the latest design standards to only this small area.
- Service Experience - It maybe possible to use relevant service experience, such as fleet hours performance or reliability statistics, to demonstrate that compliance with the latest design standards may not contribute materially to the level of safety, and as such the use of other than the latest design standards may be appropriate. The service experience levels necessary to demonstrate the appropriate level of safety as they relate to the proposed modification would have to be reviewed and agreed with the IAA.
- Effectiveness of the design standard - Design standards are intended to address specific hazards. The effectiveness of a design standard to address the hazard(s), from minimising its effects to eliminating the source, will vary with its amendment history. The effectiveness of the design standards at various amendment levels should be estimated and the safety benefits compared to that achieved by complying with the existing certification basis.

7.1.2.2 Amendment level – What is practical?


Compliance with the latest design standards may be considered not practical if the applicant can substantiate that it would result in additional costs that are not commensurate with the safety benefits to be gained. The costs are those that would be incurred beyond the basic costs of demonstrating compliance with the existing certification basis, and could include additional design changes to the proposed modification required for compliance and the effort required to demonstrate such compliance. The applicant should supply substantiating data and analyses to support the position that compliance is not practical. It will be necessary for the IAA to review and agree with this position, before proceeding.

7.1.3 Environmental Standards

The applicable environmental standards for a modification of an aircraft or engine are described in ICAO Annex 16 — Environmental Protection.

7.1.4 Special conditions of airworthiness

A special condition of airworthiness (SC) is issued when a proposed modification incorporates novel or unusual design features and the applicable airworthiness standards do not contain adequate or appropriate safety standards for certifying such feature. For example, the airworthiness standards may only contain provisions for use of metal for structural parts, and therefore a proposal to use composite materials will be novel or unusual to the standards. A SC should contain only such additional airworthiness standards for the novel or unusual features as are necessary to establish a level of safety equivalent to that intended by the certification basis established for the modification.

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7.1.5 Finding of equivalent level of safety

A finding of equivalent level of safety (ESF) is not an additional airworthiness requirement by itself, but rather a finding of compliance with the intent of an airworthiness standard(s). Usually, the applicant will identify a need for an ESF against certain airworthiness standards, attributed to a peculiarity in the proposed modification. The level of safety to be established under an ESF should be equivalent to that intended by the certification basis established for the modification.

7.1.6 Exemptions

A request for exemption is a proposal that a non-compliance with a specific certification requirement can be allowed. A request for exemption must be based on convincing evidence that granting the exemption relief will not adversely affect safety and that the requirements for environmental protection are still met. For any proposed modification involving a request for exemption, the possibility of a ESF should be considered in the first case. The assessment should consider the overall degradation that an exemption could potentially cause on the overall aircraft, engine, or propeller level of safety, rather than just on the affected areas of the proposed modification.

7.1.7 Elect to comply


Airworthiness standards are mandatory requirements. However, there may be aspects of the standards that are not enforceable because they are offered as an optional provision (for example, ditching provisions). The decision to avail of an optional airworthiness provision rests with the applicant. In addition, an applicant may elect to comply with recent amendments to the airworthiness standards that only became available after submission of the application for modification approval. “Elect to comply” in this context means a voluntary act by the applicant to include these optional standards as part of the proposed certification basis. Once the “elect to comply” items have been accepted and established by the IAA as part of the certification basis, demonstration of compliance is mandatory and not an applicant’s option.

7.1.8 Certification basis for modifications - Conclusion

In establishing the certification basis to use, the applicant should document and supply to the IAA all substantiating data used. The certification basis used could include, but not be limited to:

- Compliance with the latest design standards is necessary.
- Compliance with an amendment level between the existing certification basis and the latest design standards would adequately address the hazard at an acceptable cost. Complying with the latest amendment level would not be practical. The applicant would then propose the intermediate amendment level of the requirement.
- The increased level of safety is not commensurate with the increased costs associated with meeting the latest amendment instead of the existing certification basis. Therefore, the applicant would propose the existing certification basis.
- The results of the assessment were inconclusive. Further discussions with the IAA are warranted.

The certification basis of the proposed modification can now be finalized, and may consist of a combination of the latest design standards, the design standard of the existing certification basis, or an

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intermediate level between the existing and the latest design standards. Areas of the aircraft, engine or propeller that are considered unchanged or not affected by the proposed modification can continue to comply with the existing certification basis (i.e. there is no need to re-visit the certification basis).

7.2 Establishing the certification basis - Repairs

The basis of approval for a repair design should be the same airworthiness standards used in the certification of the type design. The following is the basic policy for repairs;

- For an aircraft, the approval basis is the aircraft design standards recorded in the Type Certificate Data Sheet issued by the State of Design.
- For an engine or propeller, the approval basis is the engine or propeller design standards recorded in the Type Certificate Data Sheet issued by the State of Design of the engine or propeller. It is not the State of Design of the aircraft on which the engine or propeller is installed that applies.
- For a component, part, appliance or article that is not type certificated or has a separate design approval other than a Type Certificate, the approval basis is the airworthiness standard of the type certificated product (aircraft, engine, or propeller) on which the component, part, appliance or article is installed.

The approval basis for a repair design shall not include any proposal for an exemption or a finding of equivalent level of safety because a repair is a restoration to an approved type design. The intent of the repair is to maintain the same level of safety that the product was certified to.

The approval basis could also be affected by additional requirements that are not related to the original approval or type certification of the product. For example, a supplemental structural integrity programme or a repair assessment programme for ageing aircraft may influence repair designs to be held to higher design standards or evaluation techniques. In establishing the approval basis, the applicant should also account for other factors, such as maintenance or operating rules, which may affect the actual installation of the repair.

8 ESTABLISHING THE MEANS OF COMPLIANCE


It is the sole responsibility of the applicant to demonstrate compliance of the proposed design change with the certification basis established by the IAA in accordance with the methods accepted by the IAA. In order to manage this aspect during the modification approval process, and before an applicant commits to any compliance action, it is necessary to agree on a certification compliance plan that clearly identifies the types of action to be applied against each item of the certification basis.

8.1 Means of compliance

The means of compliance is usually dictated by the specific item of the certification basis, and generally falls into one or any combination of the following;

8.1.1 Test

A test is performed when the requirement explicitly calls for a demonstration by test (physical, actual or simulation). Examples of test are flight test, ground test, fatigue test, simulation, fire or flammability test, environmental test (e.g. salt spray), functional test, bird strike test, and engine ingestion test.

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8.1.2 Analysis

This is performed when the requirement explicitly calls for a demonstration by analysis (qualitative, quantitative, or comparative), or when the applicant can demonstrate, based on previously accepted test results, the validity of using analysis in lieu of testing. Examples include failure modes and effects analysis, weight & balance analysis, electrical load analysis, flight performance data reduction and expansion, structural loads analysis, and software evaluation.

8.1.3 Inspection or Evaluation

This is performed against an item that does not require test or analysis, but relies on observation, judgment, verification, evaluation, or a statement of attestation from the applicant or its vendors/contractors.

8.1.4 Derivation or Similarity


This can be used for repair design. A new repair design can be developed or derived from a previously approved repair and the two repair designs can be considered similar.

8.2 Certification compliance plan

The certification compliance plan is the primary document in the design change approval process that serves both as a checklist and official record of compliance. The applicant should prepare a certification compliance plan and establish its contents with the agreement of the IAA. The certification compliance plan should, as a minimum, contain the following information:

- itemized breakdown of the certification basis
- identification of affected Airworthiness Directives
- identification of items of voluntary compliance (elect to comply)
- proposed means of compliance for each item (test, analyses, inspection, or combination of these, or finding of equivalent level of safety)
- lists of tests to be conducted
- identification of substantiation reports to be submitted (as proof of compliance)
- identification of persons responsible for making findings of compliance
- the level of involvement of the IAA, the applicant, or a delegate of the IAA in the findings of compliance or witnessing of tests
- modification project schedule, including the applicant’s milestones and when final approval is expected

Tests, analyses, and inspections are expensive in terms of cost and time. Applicants should, therefore, seek concurrence from the IAA that their proposed means of compliance with the certification basis are acceptable. The acceptance of the means, however, is not an acceptance of the data in advance, it is merely a recognition of the means as satisfactory for the demonstration of compliance. The certification compliance plan, although initially agreed to by the IAA, is a living document whose contents may

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change (the structure and Format will remain the same) throughout the course of modification approval process. Some of the possible sources of change to this document are as follows:

- design changes due to refinements or development
- revised or alternate means of compliance
- changes in level of involvement of the IAA and applicant
- changes to the certification basis caused by the issuance of special conditions of airworthiness, or exemptions
- other issues affecting the design or approval that modify any of the aspects of the certification plan

The activities involving demonstration of compliance should not begin until after a certification compliance plan has been agreed between the applicant and the IAA. The original (or master) copy of the certification compliance plan is retained by the IAA until completion of the modification approval activity. Upon completion of the programme, the plan can be the official certification compliance record for the modified product.

8.3 Level of delegated involvement

If the applicant proposes to utilise delegated persons or organisations in the design change approval programme, the exact role of these delegates should be clearly identified in the certification compliance plan and agreed with the IAA. The levels of involvement of the delegates will be defined by and take into account such factors as limitations of the delegates, complexity of the design change, availability of technical resources, and time constraints of the design change approval project.


9 DEMONSTRATION AND FINDING OF COMPLIANCE

Proof of compliance with the design aspects of the airworthiness requirements is established through the approval of the type design and the performance of necessary inspections, ground tests and flight tests. In the certification compliance plan, the means of demonstrating compliance (test, analysis, or inspection/evaluation) and the levels of involvement (applicant and the IAA) are already specified for each item of the certification basis. The applicant is responsible for demonstrating compliance through the agreed means. Demonstration of compliance should be recorded against each item in the plan, as evidence of a successful completion. The implementation of the plan and meeting the milestones in the modification approval schedule contained in the certification plan is the responsibility of the applicant.

The demonstration of compliance requires that the applicant submit substantiating data (design data, reports, analysis, drawings, processes, material specifications, operations limitations, flight manuals, instructions for continued airworthiness). The data should be complete and in a logical format for review by the IAA. Where the demonstration of compliance involves a test, a test plan should be developed and approved prior to any actual test being performed. Official certification tests maybe witnessed by IAA personnel or by an IAA delegate, when authorised.

The applicant should give the IAA access to the product being modified in order to make any inspections, test, and engineering assessment or conduct any flight or ground test that is necessary to determine compliance with the certification item. However, the applicant should perform his own inspection and test necessary to demonstrate compliance prior to presenting the modified product to the IAA for testing or evaluation.

Where a demonstration of compliance is to be made using a finding of equivalent level of safety, the

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applicant should provide sufficient justification to the IAA that describe the design feature, action taken (i.e. compensating factor), and how such action provides an equivalent level of safety to that intended by the applicable airworthiness standard.

In the certification compliance plan, the means of demonstrating compliance (test, analysis, or inspection/evaluation) and the levels of involvement (applicant and the IAA) are already specified for each item of the certification basis. The applicant is responsible for demonstrating compliance through the agreed means of compliance.

The IAA will participate in the process through one or any combination of the following actions:

- Acceptance of substantiating data - Reports, analysis, drawings, or similar documents are usually produced against each certification item which are reviewed and accepted. Specific attention is paid to the methodology and assumptions, rather than the detailed calculations or analysis.
- Witnessing of Test - Tests are performed, and witnessed by the IAA where required or agreed to, in accordance with an approved test plan. The test will be conducted only after conformity with the test plan has been established for the test articles, test environment and test facilities. For flight testing, the IAA or its delegate may perform the flight testing.
- Engineering Inspection - Any aspect of the type design, for which compliance with the certification item cannot be determined through review of drawings or reports, may receive an engineering compliance inspection. An engineering compliance inspection is to assure that an installation, and its relationship to other installations on a product, complies with the design requirements.
- Conformity inspection - Where required, will be performed by the IAA to verify conformity of the modified product with drawings, specifications, and special processes. An engineering inspection should not be confused with a conformity inspection. A conformity inspection is done to determine conformity to the engineering data, while an engineering compliance is done to determine compliance with the certification requirement.
- Flight Test - For aircraft, an actual demonstration of flight capabilities and characteristics in accordance with an approved flight test plan. This method of finding compliance is not used for repairs.


9.1 Non-compliance

The IAA will notify the applicant in writing of any non-compliance found during the process of data review, inspections, ground and flight tests or if it becomes necessary, the discontinuance of official type certification tests. The applicant should advise the IAA when the non-compliance finding has been resolved or when the cause of discontinuance of the tests has been corrected. The identification and resolution of non-compliance items should be properly documented and kept part of the record for the modification approval project.

10 APPROVING THE AIRCRAFT DESIGN CHANGE

When the applicant has demonstrated compliance, to the satisfaction of the IAA, on all items of the certification basis, including the resolution of outstanding items, approval may be granted. The approval of the design change means that:

- the areas of the type design affected by the modification meet all the relevant requirements specified in the certification basis, including special conditions of airworthiness (if any) issued by

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the IAA

- all engineering and conformity inspections have been completed and the modified product has been found to meet all pertinent requirements
- in the case of aircraft, the modified aircraft has been test flown, as required, and found to comply with all the performance requirements of the pertinent airworthiness standards

10.1 Issue of approval – Major modification

Approval of a major modification is granted using one of the three forms of approval below, provided the proposed modification is not so extensive as to require a new Type Certificate. The form of approval for the proposed modification is usually indicated by the applicant at the time of application

- Amendment of a Type Certificate - Approval of design changes made by the holder of a Type Certificate. An amendment of a Type Certificate retains the holder's overall responsibility for the type design of an aircraft, engine or propeller, both as approved under the initial Type Certificate and as modified.
- Supplemental Type Certificate - A Supplemental Type Certificate is an approval of a major modification covering those areas or aspects of an aeronautical product that were modified. Together, the Supplemental Type Certificate and the relevant Type Certificate constitute the approved type design for a modified aircraft, engine, or propeller. It should be noted that an aeronautical product that does not have a Type certificate can not be issued a modification approval under a Supplemental Type Certificate (examples are appliances, parts, components, instruments). Further, a Supplemental Type Certificate should not be issued for approval of minor modifications, or approval of replacement parts or repair, unless its installation represents a modification.
- Approval Letter - For modifications that do not warrant the detailed approval process of an Amended or Supplemental Type Certificates, approval is granted normally by an approval letter. Modifications that are candidates for this approval category typically involve on-demand design changes by aircraft operators, maintenance and/or design organizations, and manufacturers to support varying maintenance and operational needs under time constraints.

10.2 Issuance of approval – Minor modification


Approval of a minor modification is granted using an approval letter.

10.3 Issuance of approval – Repair

The IAA will document their approval through one of the following means:

- Issuance of an approval letter signed by the IAA
- Issuance of an approval using a standard form established by the IAA
- By signature or marking (stamp or seal) the repair approval document as submitted by the applicant
- In the case of recognizing foreign approvals, a statement of endorsement that such foreign approval is considered approved by the IAA, may be issued, if requested.

The repair design will not be approved if there is a known or suspected design feature that could make the repaired product unsafe after installation. For example, the use of an inappropriate type of blind

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fasteners (multi-piece) to install a structural repair patch in an area subject to repeated vibration could eventually loosen the fasteners and weaken the repair. Applying this type of repair in the intake area of a turbine engine could result in loose or dislodged fasteners being ingested during engine operation.

The IAA will stipulate limitations (if any) associated with their approval of the repair design including, but not limited to, time limits (in the case of temporary repairs, or life-limited repairs), follow-up or repeat inspection requirement, installation considerations, specific applicability (or repeatability of application) to aeronautical product(s), permitted deviations or substitutions from the repair design. The stipulation may also identify approved changes or revisions to the approved airworthiness limitations contained in the Instructions for Continued Airworthiness for the affected product.

Repair designs provided by the original equipment manufacturer (OEM), which includes aircraft, engine and propeller manufacturers, should clearly indicate the approval status of their repairs.

10.4 Responsibility for the design change approval

The person or organisation (holder) to whom the design change approval is granted has responsibility for the approved design change. If multiple participants (e.g. joint design ventures, partnerships, sub-contracting or similar arrangements) are involved in the design change, the IAA will require one person or organisation to be responsible for the overall design change, and to whom the approval will be issued.

An approval granted for a design change (amended Type Certificate, Supplemental Type Certificate, Approval Letter) shall remain valid until otherwise specified or notified by the IAA.

10.5 Providing evidence of design change approval

Applicants should provide clients or customers with a copy of the IAA approval, or provide a declaration that a design change is IAA approved. The person or organisation performing the installation of a design change on an aircraft, engine, or propeller has a responsibility to ensure that the design changes are in accordance with approved data. In addition prior to installation of a design change it must be determined that the interrelationship between the design change and any other previously installed design change (modification and/ or repair) will introduce no adverse effect upon the airworthiness of the product. The IAA will identify this responsibility in the approval letter. Providing a copy, or making a declaration, of the IAA approval, facilitates the fulfilment of an aircraft Operator's responsibility under the Maintenance provisions to retain details of design changes and evidence of its approval.


10.6 Documents necessary for a modified product

If the approved design change affects any of the documents necessary for approved type design or operation of the aircraft, the applicant should prepare the appropriate revisions to this information and submit to the IAA for approval or acceptance. Following approval by the IAA, the revised information should be provided as part of the design change approval documentation.

11 Post-approval activities

11.1 Retention of design change data

The data constituting the design change are contained in records, reports, drawings, and other documents that describe collectively the exact configuration of the design change when it was approved. The design change data must be maintained by the holder of the design change approval. The design change records are permanent and may not be destroyed. Data maintained by the design change approval holder must be made available to the IAA for such routine activities as production inspection, surveillance, design change reviews, development of corrective actions, or for any other reasons deemed necessary by the IAA. The record keeping

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should consist of at least the following:

- the drawings and specifications, and a listing of those drawings and specifications necessary to define the configuration and design features of the design change as it was shown to comply with the requirements applicable to the product;
- reports on analysis and tests undertaken to substantiate compliance with the applicable requirements;
- information, materials and processes used in the construction of the aircraft, engine or propeller;
- an approved flight manual supplement or its equivalent (type-related document), including revisions to the master minimum equipment list and configuration deviation list, if applicable;
- approved revisions or recommendations to, maintenance programme or equivalent document, and aircraft maintenance manual with details of revisions to manufacturer’s recommended and IAA accepted scheduled maintenance plan and procedures guidelines;
- any other data necessary to allow, by comparison, the determination of airworthiness and noise characteristics (where applicable) of modified products of the same type.
- If the holder of the repair design approval is different from the aircraft operator, the aircraft operator must retain the repair data as a permanent record for the affected aircraft, engine, or propeller for as long as the affected product remains in service.

11.2 **Responsibility of modification approval holder**

The holder of the modification approval remains responsible for the continued integrity of the design change to approved type design and it or its representative must continue to be the IAA’s contact point for resolving issues that may require corrective action. To fulfill this responsibility, the holder should have the continued capability, or access to a capability, of providing appropriate technical solutions for service difficulties when service experience warrants it, or when the IAA requires mandatory corrective action. If the holder is no longer capable, the IAA must be informed.

Applicants should note that if the approval holder is outside the jurisdiction of the IAA and corrective action is needed, assistance will be requested from the CAA of the approval holder.


11.3 **Responsibility of repair approval holder**

The activities following approval of a repair design involve; the actual accomplishment of the repair on the aeronautical product, documenting the repair accomplished, and the maintenance release of the affected aeronautical product as being airworthy.

Applicants should note that if the approval holder is outside the jurisdiction of the IAA and corrective action is needed, assistance will be requested from the CAA of the approval holder.

11.4 **Responsibilities of design change 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 some responsibility to verify compatibility with other

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modifications and repairs before installing any design change. As stated in the following paragraph, the ultimate responsibility remains on the operator.

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.

11.5 Responsibilities of aircraft 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 design change 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 IAA that the modified aircraft continues to comply with the applicable standards of airworthiness.

The operator should report any design change incompatibilities detected during installation or in service to the design change approval holder, to the installer and to its own airworthiness authority.


Procedures should be established to ensure that the substantiating data supporting compliance with the airworthiness requirements are retained. The aircraft operator must retain records identifying any design changes incorporated on the aircraft, together with records of design approval and return-to-service approval. Retention of the records is required so that the modification and repair status of the aircraft may be readily established at any time. This may be necessary if an airworthiness deficiency is detected with a modification or repair requiring corrective measures or inspections and to ensure compatibility when making additional design changes to the aircraft.

The records required will vary with the complexity of the design change. In addition to the records of design approval and return-to-service approval, the following records should be included in any data retained for major modifications and repairs:

- o master drawing list and the individual drawings
- o photographs, specifications, records which locate the design change on the aircraft
- o mass and moment change records
- o a record of any change in electrical load
- o a Supplemental Type Certificate (STC) or equivalent document
- o service bulletin or structural repair manual reference, if applicable.

The details of design changes to an aircraft and its major components should be retained until they have been permanently withdrawn from service. In the event of a temporary change of operator, the records shall be made available to the new operator; and, in the event of any permanent change of operator, the records shall be transferred to the new operator.

Supplements to the approved flight manual, maintenance instructions, instructions for continuing airworthiness and repair instructions pertaining to a modification or repair are operating data that the operator should incorporate into the existing operating data for the aircraft. Since these supplements become a permanent part of the operator's operating instructions or instructions for continuing

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airworthiness, they need not be retained. The operator should record the incorporation of the required supplements in the appropriate revision logs.

The record retention requirements for minor modifications and repairs are much simplified. It is nevertheless necessary for the aircraft operator to retain sufficient records to:

- o identify the modification or repair and record that it has been classified as minor
- o record its location on the aeroplane
- o record mass and moment change, if significant
- o record the return-to-service approval.

11.6 Continuing airworthiness

Service experiences involving faults, malfunctions, defects and other occurrences that may affect the continuing airworthiness of the aircraft are required to be recorded, reported, and assessed. This information is used to determine if an unsafe or potentially unsafe condition exists in an aircraft. The design change approval holder plays an important role in deciding if and when airworthiness action is needed to either correct an unsafe, or avoid a potentially unsafe, condition.