



CIVIL AVIATION GUIDANCE MATERIAL – 8106



DESIGN OF REPAIRS

CAAM PART 21 SUBPART M

CIVIL AVIATION AUTHORITY OF MALAYSIA

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Introduction

This Civil Aviation Guidance Material 8106 (CAGM – 8106) is issued by the Civil Aviation Authority of Malaysia (CAAM) to provide guidance for design of repairs pursuant to Civil Aviation Directive 8106 – Design of Repair (CAAM Part 21 Subpart M)..

Organisations may use these guidelines to demonstrate compliance with the provisions of the relevant CAD's issued.. Notwithstanding the Regulation 204 and Regulation 205 of the Malaysian Civil Aviation Regulations 2016 (MCAR 2016), when the CAGMs issued by the CAAM are used, the related requirements of the CAD's are considered are met, and further demonstration of compliance may not be required.



(Captain Chester Voo Chee Soon)
Chief Executive Officer
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Civil Aviation Guidance Material components and Editorial practices

This Civil Aviation Guidance Material is made up of the following components and are defined as follows:

Standards: Usually preceded by words such as “*shall*” or “*must*”, are any specification for physical characteristics, configuration, performance, personnel or procedure, where uniform application is necessary for the safety or regularity of air navigation and to which Operators must conform. In the event of impossibility of compliance, notification to the CAAM is compulsory.

Recommended Practices: Usually preceded by the words such as “*should*” or “*may*”, are any specification for physical characteristics, configuration, performance, personnel or procedure, where the uniform application is desirable in the interest of safety, regularity or efficiency of air navigation, and to which Operators will endeavour to conform.

Appendices: Material grouped separately for convenience, but forms part of the Standards and Recommended Practices stipulated by the CAAM.

Definitions: Terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have an independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

Tables and Figures: These add to or illustrate a Standard or Recommended Practice, and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

Notes: Included in the text, where appropriate, Notes give factual information or references bearing on the Standards or Recommended Practices in question but not constituting part of the Standards or Recommended Practices;

Attachments: Material supplementary to the Standards and Recommended Practices or included as a guide to their application.

It is to be noted that some Standards in this Civil Aviation Guidance Material incorporates, by reference, other specifications having the status of Recommended Practices. In such cases, the text of the Recommended Practice becomes part of the Standard.

The units of measurement used in this document are in accordance with the International System of Units (SI) as specified in CAD 5. Where CAD 5 permits the use of non-SI alternative units, these are shown in parentheses following the basic units. Where two sets of units are quoted it must not be assumed that the pairs of values are equal and interchangeable. It may, however, be inferred that an equivalent level of safety is achieved when either set of units is used exclusively.

Any reference to a portion of this document, which is identified by a number and/or title, includes all subdivisions of that portion.

Throughout this Civil Aviation Guidance Material, the use of the male gender should be understood to include male and female persons



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Table of Contents

1	GENERAL	1-1
1.1	BACKGROUND.....	1-1
1.2	ABBREVIATIONS.....	1-1
2	APPLICATION FOR A REPAIR DESIGN APPROVAL (CAD 8106 5)	2-1
2.1	CAD 8106 5.1 – FORM AND MANNER.....	2-1
2.2	CAD 8106 5.1 – AERONAUTICAL PRODUCT DESIGN APPROVAL HOLDER APPROVED DATA.....	2-1
2.3	CAD 8106 5.1 – STATEMENT OF COMPLIANCE.....	2-2
2.4	CAD 8106 5.2 – CERTIFICATION PROGRAMME FOR A REPAIR DESIGN APPROVAL	2-2
3	REQUIREMENTS FOR APPROVAL OF A REPAIR DESIGN (CAD 8106 6)	3-1
3.1	CAD 8106 6.2 – REPAIR DESIGN AND RECORD KEEPING	3-1
4	CLASSIFICATION AND APPROVAL OF REPAIR DESIGNS (CAD 8106 7)	4-1
4.1	CAD 8106 7.1 – CLASSIFICATION OF REPAIRS.....	4-1
4.2	CAD 8106 7.1 – CLARIFICATION OF THE TERMS MAJOR/MINOR.....	4-1
4.3	CAD 8106 7.1 – AIRWORTHINESS CONCERNS FOR MAJOR/MINOR CLASSIFICATION	4-1
4.4	CAD 8106 7.2 – REPAIR DESIGN APPROVAL.....	4-2
4.5	CAD 8106 7.2(A) – REPAIR DESIGN APPROVAL BY CAAM.....	4-3
4.6	CAD 8106 7.2(B) – REPAIR DESIGN APPROVAL BY THE DOA HOLDER	4-3
5	UNREPAIRED DAMAGE (CAD 8106 11)	5-1
5.1	CAD 8106 11 – UNREPAIRED DAMAGE.....	5-1
6	RECORD KEEPING (CAD 8106 12)	6-1



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1 General

1.1 Background

- 1.1.1 An aircraft may experience accidental damage, wear and tear, environmental deterioration, fatigue, malfunction, and failure during its operational life. A repair is a corrective action intended to restore an aeronautical product to an airworthy condition as defined by the appropriate airworthiness requirements and is regarded primarily as a maintenance function. An unapproved repair design could render a Certificate of Airworthiness invalid.
- 1.1.2 Accomplishing a repair on an aircraft may involve such actions as performing maintenance or servicing procedures, replacing a defective part with a like serviceable unit or with an approved substitute part, or designing and incorporating a repair scheme.
- 1.1.3 Generally, the documents encompassing the ICA such as, but not limited to, maintenance manuals, servicing instructions, overhaul manuals and repair manuals contain adequate maintenance procedures that are recognised by ICAO Contracting States as either approved or acceptable for purposes of accomplishing repairs to aircraft. For example, a structural repair manual (SRM) contains several State of Design approved repair schemes for typical damages or structural failures that can be readily applied by an operator, without the need to obtain prior approval of the Authority.
- 1.1.4 However, where the repair action specifically requires designing a repair scheme, the repair design must be approved by the Authority. All changes to limited life components limits must be incorporated in the maintenance programme following the design repair approval.

1.2 Abbreviations

AD	=	Airworthiness Directives
AMOC	=	Alternative Method Of Compliance
APU	=	Auxiliary Power Unit
DAH	=	Design Approval Holder
DOA	=	Design Organisation Approval
ICA	=	Instruction for Continued Airworthiness
NAA	=	National Aviation Authority
SOC	=	Statement of Compliance
STC	=	Supplemental Type Certificate



TC = Type Certificate



2 Application for a Repair Design Approval (CAD 8106 5)

2.1 CAD 8106 5.1 – Form and Manner

2.1.1 The applicant should file an application using a form for the approval of design of major repair (CAAM/AW/8104-02) or for the approval of design of minor repair (CAAM/AW/8104-03), which may be downloaded from the CAAM website, together with prescribed fees in Civil Aviation (Fee and Charges) Regulation 2016.

2.1.2 The forms should be completed in accordance with the instructions embedded at the bottom of the application forms, and sent to CAAM by in-person or regular mail. During certain special circumstances (e.g. travel restriction order, urgent cases, etc.) the form can be submitted to CAAM Head of Initial Airworthiness Section via e-mail. However, the physical copy of the form should be submitted as soon as possible..

2.1.3 In conjunction with the form required in CAD 8106 paragraph 5.1, the applicant should provide to CAAM relevant information pertaining to the proposed design of repairs. Information on the proposed repairs should include, at a minimum, the following:

- a) the name and address of the applicant to which the approval will be issued;
- b) the make and model of the affected aeronautical product (registration and/or serial number) and its type certificate number (or approval reference);
- c) the title, detailed description, and purpose of the proposed repair, including any changes affecting the noise and emissions level of the aircraft or engine;
- d) the proposed airworthiness standards, including environmental standards if applicable, to which the proposed repair is intended to show compliance, including the identification of any impact on approved airworthiness limitations contained in the ICA for the affected aeronautical product; and
- e) documentation and/or substantiating data of the repair design.

2.2 CAD 8106 5.1 – Aeronautical Product Design Approval Holder approved data

2.2.1 In conjunction with the form required in CAD 8106 paragraph 5.1, for aeronautical product design approval holder (DAH) approved data , in addition to paragraph 2.1.1 and paragraph 2.1.2 of this CAGM, the applicant should provide to CAAM relevant information pertaining to the proposed design of repairs. Information on the proposed repairs should include, at a minimum, the following;

- a) the name and address of the applicant to which the approval will be issued;
- b) the make and model of the affected aeronautical product (registration and/or serial number) and its type certificate number (or approval reference);

- c) the title, detailed description, and purpose of the proposed repair, including any changes affecting the noise and emissions level of the aircraft or engine;
- d) identification of any impact on approved airworthiness limitations contained in the ICA for the affected aeronautical product;
- e) documentation and/or substantiating data of the repair design specifying the following information:-
 - 1) damage description;
 - 2) repair description;
 - 3) applicable certification requirement or product qualification basis, if applicable;
 - 4) availability of instructions of continued airworthiness;
 - 5) availability of any repair limitations;
 - 6) repair classification (i.e. major or minor);
 - 7) repair category (permanent / temporary); and
 - 8) repair design approval.
- f) Any other data that CAAM may request from the applicant , DAH or the State of Design

2.3 CAD 8106 5.1 – Statement of Compliance

2.3.1 For each major or minor repairs which requires CAAM approval, upon accomplishment of the project, the applicant should fill and submit Statement of Compliance – STC / Modifications / Repairs Form No. CAAM/AW/8104-04 (SOC form) which can be obtained from CAAM website.

2.3.2 The SOC form must list the following as applicable:

- a) the certification programme / certification compliance plan;
- b) the documentation and/or substantiating data of the design change;
- c) the instructions for the embodiment / installation of the change (e.g. service bulletin, modification bulletin, production work order, etc.)
- d) documents necessary for operation of a repaired aircraft;
- e) compliance test reports; and
- f) any other documents required by CAAM.

2.3.3 The SOC form should be signed by the applicant (or the authorised person on behalf of the organisation) to which the approval will be issued

2.4 CAD 8106 5.2 – Certification programme for a repair design approval

2.4.1 Clarification for paragraph 5.2(a) of CAD 8106: the description of the repair should consist of:

- a) the pre- and post-repair configuration;
- b) a drawing or outline of the repair;
- c) a list of the detailed features;
- d) a description of the type and extent of the inspection; and
- e) an outline of the damage.

2.4.2 Clarification for paragraph 5.2(c) of CAD 8106: the identification of reinvestigations does not refer to the demonstration of compliance itself, but to the list of the affected airworthiness codes, together with the means of compliance.

2.4.3 Means of Compliance

2.4.3.1 The means of compliance is usually dictated by the design standard(s) in the approval basis for which compliance will be demonstrated, and generally falls into one or any combination of the following:

- a) Test – is performed when the requirement explicitly calls for a demonstration by test (physical, actual or simulation). Examples of test are fatigue test, simulation, functional or operational test, fire or flammability test, and environmental test (e.g. salt spray);
- b) Analysis – is performed when the requirement explicitly calls for a demonstration by analysis (qualitative, quantitative, or comparative). Examples of analysis are failure modes and effects analysis, static strength or damage tolerance analysis, and structural loads analysis;
- c) Inspection or evaluation – 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; and
- d) By derivation or similarity – is performed when a new repair design can be developed or derived from a previously approved repair and the two repair designs can be considered similar.

2.4.4 Demonstration of compliance

2.4.4.1 The demonstration of compliance requires that the applicant submit substantiating data (design data, reports, analysis, drawings, processes, material specifications and ICA). The data should be complete and in a logical format for review by the CAAM.

2.4.4.2 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 should be witnessed by the CAAM or its delegate, when authorised.



- 2.4.4.3 The applicant should give the CAAM access to the aeronautical product being repaired in order to make any inspections, test, and engineering assessment that may be necessary to determine compliance with the approval basis of the repair. However, the applicant should perform its own inspection and test necessary to demonstrate compliance, prior to presenting the repaired aeronautical product to the CAAM for testing or evaluation.

- 2.4.5 Finding of compliance
 - 2.4.5.1 The CAAM makes a finding of compliance with the approval basis. The finding of compliance can be made by the CAAM, or by its authorised delegate, depending on the predefined levels of involvement in the repair approval process.

 - 2.4.5.2 Following a successful demonstration of compliance by the applicant, the CAAM or authorised delegate should make a finding of compliance and conclude the approval process. .

3 Requirements for Approval of a Repair Design (CAD 8106 6)

3.1 CAD 8106 6.2 – Repair design and record keeping

- 3.1.1 Relevant substantiation data associated with a new major repair design and record keeping should include:
- a) the identification of the damage and the reporting source;
 - b) the major repair design approval sheet identifying the applicable specifications and references of justifications;
 - c) the repair drawing and/or instructions and scheme identifier;
 - d) the correspondence with the holder of the type certificate (TC) or supplemental type certificate (STC), if its advice on the design has been sought;
 - e) the structural justification (static strength, fatigue, damage tolerance, flutter, etc.) or references to this data;
 - f) the effect on the aircraft, engines and/or systems (performance, flight handling, etc., as appropriate);
 - g) the effect on the maintenance programme;
 - h) the effect on airworthiness limitations, the flight manual and the operating manual;
 - i) any weight and moment changes; and
 - j) special test requirements.
- 3.1.2 Relevant minor repair documentation includes paragraphs 3.1.1(a) and (c) of this CAGM. Other points of paragraph 3.1.1 of this CAGM may be included where necessary. If the repair is outside the approved data, a justification for the classification is required.
- 3.1.3 Special consideration should be given to repairs that impose subsequent limitations on the part, product or appliance (e.g. engine turbine segments that may only be repaired a finite number of times, the number of repaired turbine blades per set, oversizing of fastener holes, etc.).
- 3.1.4 Special consideration should also be given to life-limited parts and critical parts, notably with the involvement of the TC or STC holder, when deemed necessary under paragraph 6.1(d) of CAD 8106.
- 3.1.5 Repairs to engine or APU critical parts would normally only be accepted with the involvement of the TC holder
- 3.1.6 An applicant for design of repair should consider all previously installed modifications or repairs including any Airworthiness Directives (AD) to the affected

aeronautical product that are relevant to the proposed repair for compatibility. It is important that the effects of the proposed repair on other systems, components, equipment or appliances of the affected aeronautical product be properly identified. The intent is to encompass all aspects where there is a need for re-evaluation, that is, where the substantiation presented for the aeronautical product being repaired should be reviewed, updated or rewritten.

Note.— Alternative Method of Compliance (AMOC) by State of Design maybe required to continue compliance to an AD should the repair affected an AD.

- 3.1.7 Once approved, the data package is considered as an Approved Data and incorporation of the repair on other aircraft is subject to the established applicability. Applicant is required to ensure that the proposed repair can be incorporated to the subject aircraft or its components and that the interrelationship between the modification or repair and any other modification or repair incorporated will not adversely affect the airworthiness of the modified product.
- 3.1.8 For incorporation of the repairs, the instructions and limitations (including the applicability) of these repairs shall be strictly followed without any deviation. Any deviation from these Approved Data shall be considered as a new repair and will be subject to compliance with the procedures outlined in this document.



4 Classification and Approval of Repair Designs (CAD 8106 7)

4.1 CAD 8106 7.1 – Classification of repairs

4.1.1 CAAM requires approval of major and minor repairs. However, minor repair may also be approved by an approved design organisation within the scope of its privileges, as recorded in the terms of approval.

4.1.2 An applicant seeking foreign National Aviation Authority (NAA) approval of its repair design, which has received prior CAAM or a Malaysian DOA approval, should coordinate its request with CAAM during consultation with the foreign NAA to clarify potential differences in the modification classification / category, and consequently their approval requirements

4.2 CAD 8106 7.1 – Clarification of the terms Major/Minor

4.2.1 In line with the definitions given in paragraph 3 of CAD 8104, a new repair is classified as 'major' if the result on the approved type design has an appreciable effect on structural performance, weight, balance, systems, operational characteristics or other characteristics affecting the airworthiness of the product, part or appliance. In particular, a repair is classified as major if it needs extensive static, fatigue and damage tolerance strength justification and/or testing in its own right, or if it needs methods, techniques or practices that are unusual (i.e., unusual material selection, heat treatment, material processes, jiggling diagrams, etc.)

4.2.2 Repairs that require a re-assessment and re-evaluation of the original certification substantiation data to ensure that the aircraft still complies with all the relevant requirements, are to be considered as major repairs.

4.2.3 Repairs whose effects are considered minor and require minimal or no assessment of the original certification substantiation data to ensure that the aircraft still complies with all the relevant requirements, are to be considered 'minor'.

4.2.4 It is understood that not all the certification substantiation data will be available to those persons/organisations classifying repairs. A qualitative judgement of the effects of the repair will therefore be acceptable for the initial classification. The subsequent review of the design of the repair may lead to it being re-classified, owing to early judgements being no longer valid.

4.3 CAD 8106 7.1 – Airworthiness concerns for Major/Minor classification

4.3.1 The following should be considered for the significance of their effect when classifying repairs. Should the effect be considered to be significant then the repair should be classified 'Major'. The repair may be classified as 'Minor' where the effect is known to be without appreciable consequence.

- a) Structural performance of the product includes static strength, fatigue, damage tolerance, flutter and stiffness characteristics. Repairs to any element of the structure should be assessed for their effect upon the structural performance.
- b) Weight and balance. The weight of the repair may have a greater effect upon smaller aircraft as opposed to larger aircraft. The effects to be considered are related to overall aircraft centre of gravity and aircraft load distribution. Control surfaces are particularly sensitive to the changes due to the effect upon the stiffness, mass distribution and surface profile which may have an effect upon flutter characteristics and controllability.
- c) Systems Repairs to any elements of a system should be assessed for the effect intended on the operation of the complete system and for the effect on system redundancy. The consequence of a structural repair on an adjacent or remote system should also be considered as above, (for example: airframe repair in area of a static port).
- d) Operational characteristics. Changes may include:
 - 1) stall characteristics
 - 2) handling
 - 3) performance and drag
 - 4) vibration
- e) Other characteristics
 - 1) changes to load path and load sharing
 - 2) change to noise and emissions
 - 3) fire protection / resistance

Note.– Considerations for classifying repairs 'Major/Minor' should not be limited to those listed above.

4.3.2 Examples of 'Major' repairs

- a) A repair that requires a permanent additional inspection to the approved maintenance programme, necessary to ensure the continued airworthiness of the product. Temporary repairs for which specific inspections are required prior to installation of a permanent repair do not necessarily need to be classified as 'Major'. Also, inspections and changes to inspection frequencies not required as part of the approval to ensure continued airworthiness do not cause classification as 'Major' of the associated repair.
- b) A repair to life limited or critical parts.
- c) A repair that introduces a change to the Aircraft Flight Manual.
- d) A minor repair on a primary structure or component may constitute as a major repair.

4.4 CAD 8106 7.2 – Repair Design Approval



4.4.1 Repair approvals are limited to the approval of the design data only and does not constitute installation approval.

4.5 CAD 8106 7.2(a) – Repair Design Approval by CAAM

4.5.1 Products first type-certified by CAAM

4.5.1.1 CAAM approval is required in cases of major repair designs proposed by design organisation approval (DOA) holders that do not hold the necessary privilege as per paragraph 15.3(e) of CAD 8401 to approve certain major repair designs, as well as in cases of minor repair designs proposed by persons or organisations that do not hold a DOA.

4.5.2 *RESERVED*

4.6 CAD 8106 7.2(b) – Repair Design Approval by the DOA Holder

4.6.1 Approval by the DOA holder

4.6.1.1 Approval of repairs through the use of procedures agreed with CAAM implies that the DOA holder issues the approval without CAAM's involvement. CAAM will monitor the application of this procedure within the surveillance plan for the relevant organisation. When the organisation exercises this privilege, the repair release documentation should clearly show that the approval is issued on the basis of its privilege.

4.6.2 Previously approved data for other applications

4.6.2.1 When it is intended to use previously approved data for other applications, it is expected that an appropriately approved design organisation has checked the applicability and effectiveness of this data. After damage identification, if a repair solution exists in the available approved data, and if the application of this solution to the identified damage remains justified by the previously approved repair design (structural justifications still valid, possible airworthiness limitations unchanged), the solution may be considered to be approved and may be used again.

4.6.3 Temporary repairs

4.6.3.1 These are life-limited repairs to be removed and replaced by permanent repairs after a limited service period. These repairs should be classified under paragraph 7 of CAD 8106, and the service period should be defined when the temporary repair is approved.

4.6.4 Fatigue and damage tolerance

4.6.4.1 An approved design issued before the fatigue- and damage-tolerance evaluation has been completed should specify the limited service period.



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5 Unrepaired Damage (CAD 8106 11)

5.1 CAD 8106 11 – Unrepaired damage

5.1.1 This is not intended to supersede the normal maintenance practices defined by the type-certificate holder, (e.g., blending out corrosion and re-protection, stop drilling cracks, etc.), but addresses specific cases not covered in the manufacturer's documentation.

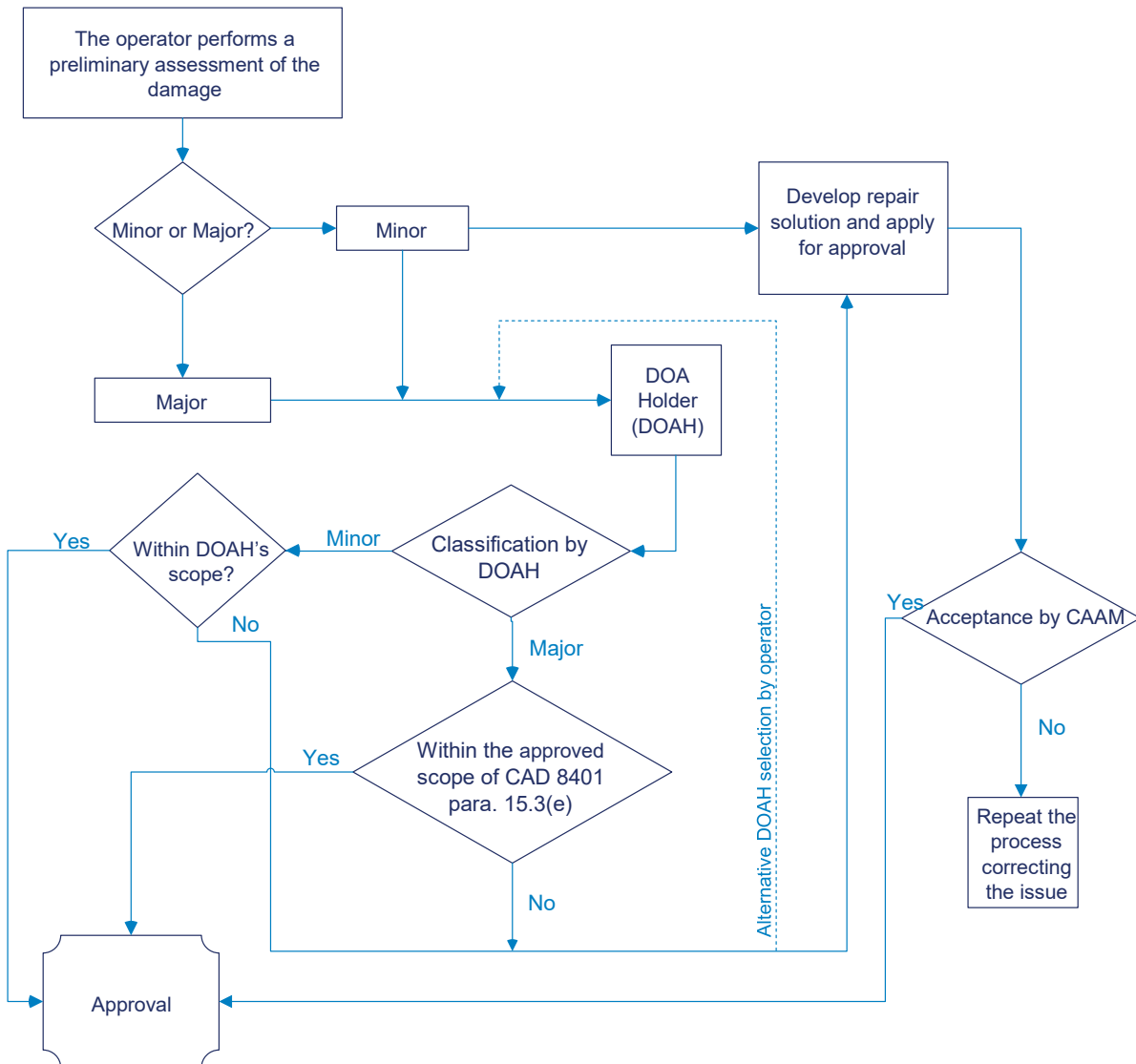


Figure 1: Flowchart of Repair Assessment and Approval



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6 Record Keeping (CAD 8106 12)

Refer paragraph 3.1 of this CAGM.



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