AMC 25-13 Reduced and derated take-off thrust (power) procedures

ED Decision 2021/015/R

1 *Purpose*

This acceptable means of compliance (AMC) provides guidance for the certification and use of reduced thrust (power) for take-off and derated take-off thrust (power) on turbine powered transport category aeroplanes. It consolidates CS guidance concerning this subject and serves as a ready reference for those involved with aeroplane certification and operation. These procedures should be considered during aeroplane type certification and supplemental type certification activities when less than engine rated take-off thrust (power) is used for take-off.

2 *Related Certification Specifications (CS)*

The applicable regulations are CS 25.101, 25.1521 and 25.1581.

3 *Background*

Take-off operations conducted at thrust (power) settings less than the maximum take-off thrust (power) available may provide substantial benefits in terms of engine reliability, maintenance, and operating costs. These take-off operations generally fall into two categories; those with a specific derated thrust (power) level, and those using the reduced thrust (power) concept, which provides a lower thrust (power) level that may vary for different take-off operations. Both methods can be approved for use, provided certain limitations are observed. The subjects discussed herein do not pertain to in-flight thrust cutback procedures that may be employed for noise abatement purposes.

4 *Definitions*

Customarily, the terms ‘thrust’ and ‘power’ are used, respectively, in reference to turbojet and turboprop installations. For simplicity, only the term ‘thrust’ is used throughout this AMC. For turboprop installations, the term ‘power’ should be substituted. For purposes of this AMC the following definitions apply:

a. Take-off Thrust

(1) Rated take-off thrust, for a turbojet engine, is the approved engine thrust, within the operating limits, including associated time limits, established by the engine type certificate for use during take-off operations.

(2) Take-off thrust, for an aeroplane, is normally the engine rated take-off thrust, corrected for any installation losses and effects that is established for the aeroplane under CS-25. Some aeroplanes use a take-off thrust setting that is defined at a level that is less than that based on the engine rated take-off thrust. CS 25.1521 requires that the take-off thrust rating established for the aeroplane must not exceed the take-off thrust rating limits established for the engine under the engine type certificate. The value of the take-off thrust setting parameter is presented in the Aeroplane Flight Manual (AFM) and is considered a normal take-off operating limit.

b. Derated take-off thrust, for an aeroplane, is a take-off thrust less than the maximum take-off thrust, for which exists in the AFM a set of separate and independent, or clearly distinguishable, take-off limitations and performance data that complies with all the take-off requirements of CS-25. When operating with a derated take-off thrust, the value of the thrust setting parameter, which establishes thrust for take-off, is presented in the AFM and is considered a normal take-off operating limit.

c. Reduced take-off thrust, for an aeroplane, is a take-off thrust less than the take-off (or derated take-off) thrust. The aeroplane take-off performance and thrust setting are established by approved simple methods, such as adjustments, or by corrections to the take-off or derated take-off thrust setting and performance. When operating with a reduced take-off thrust, the thrust setting parameter, which establishes thrust for take-off, is not considered a take-off operating limit.

d. A 'wet runway' is one whose surface is covered by any visible dampness or water up to, and including, 3 mm deep within the intended area of use.

e. A 'contaminated runway' is a runway where a significant portion of the runway surface area (whether in isolated areas or not) within the length and width being used is covered by one or more of the following substances:

— compacted snow,

— dry snow more than 3 mm deep,

— heavy frost,

— ice,

— slush more than 3 mm deep,

— standing water more than 3 mm deep, and

— wet snow more than 3 mm deep.

For the definitions of the contaminants, refer to Section 4 of AMC 25.1591.

f. A 'slippery wet runway' is a wet runway where the surface friction characteristics on a significant portion of the runway have been determined to be degraded.

5 *Reduced Thrust*: (Acceptable Means of Compliance)

Under CS 25.101(c), 25.101(f), and 25.101(h), it is acceptable to establish and use a take-off thrust setting that is less than the take-off or derated take-off thrust if –

a. The reduced take-off thrust setting –

(1) Does not result in loss of systems or functions that are normally operative for take-off such as automatic spoilers, engine failure warning, configuration warning, systems dependent on engine bleed air, or any other required safety related system.

(2) Is based on an approved take-off thrust rating or derating for which complete aeroplane performance data is provided.

(3) Enables compliance with the applicable engine operating and aeroplane controllability requirements in the event that take-off thrust, or derated take-off thrust (if such is the performance basis), is applied at any point in the take-off path.

(4) Is at least 60% of the maximum take-off thrust (no derate) for the existing ambient conditions, with no further reduction below 60% resulting from Automatic Take-off Thrust Control System (ATTCS) credit. Consequently the amount of reduced thrust permitted is reduced when combined with the use of derated thrust so that the overall thrust reduction remains at least 60 % of the maximum take-off thrust. For reduced thrust operations, compliance with the applicable performance and

handling requirements should be demonstrated as thoroughly as for an approved take-off rating.

(5) For turboprop installations, is predicated on an appropriate analysis of propeller efficiency variation at all applicable conditions and is limited to at least 75% take-off thrust.

(6) Enables compliance with CS-25 Appendix I in the event of an engine failure during take-off, for aeroplanes equipped with an ATTCS.

b. Relevant speeds (V_{EF}, V_{MC}, V_R, and V_2) used for reduced thrust take-offs are not less than those which will comply with the required airworthiness controllability criteria when using the take-off thrust (or derated take-off thrust, if such is the performance basis) for the ambient conditions, including the effects of an ATTCS. It should be noted, as stated in paragraph c. below, that in determining the take-off weight limits, credit can be given for an operable ATTCS.

c. The aeroplane complies with all applicable performance requirements, including the criteria in paragraphs a. and b. above, within the range of approved take-off weights, with the operating engines at the thrust available for the reduced thrust setting selected for take-off. However, the thrust settings used to show compliance with the take-off flight path requirements of CS 25.115 and the final take-off climb performance requirements of CS 25.121(c) should not be greater than that established by the initial thrust setting. In determining the take-off weight limits, credit can be given for an operable ATTCS.

d. Appropriate limitations, procedures, and performance information are established and are included in the AFM. The reduced thrust procedures must ensure that there is no significant increase in cockpit workload, and no significant change to take-off procedures.

e. A periodic take-off demonstration is conducted using the aeroplane's take-off thrust setting without ATTCS, if fitted, and the event is logged in the aeroplane's permanent records. An approved engine maintenance procedure or an approved engine condition-monitoring programme may be used to extend the time interval between take-off demonstrations.

f. The AFM states, as a limitation, that take-offs utilising reduced take-off thrust settings:

(1) Are not authorised on runways contaminated with standing water, snow, slush, or ice, and are not authorised on wet runways, including slippery wet runways, unless suitable performance accountability is made for the increased stopping distance on the wet surface.

(2) Are not authorised where items affecting performance cause significant increase in crew workload.

Examples of these are –

Inoperative Equipment: Inoperative engine gauges, reversers, anti-skid systems or engine systems resulting in the need for additional performance corrections.

Engine Intermix: Mixed engine configurations resulting in an increase in the normal number of power setting values.

Non-standard operations: Any situation requiring a non-standard take-off technique.

(3) Are not authorised unless the operator establishes a means to verify the availability of take-off or derated take-off thrust to ensure that engine deterioration does not exceed authorised limits.

(4) Are authorised for aeroplanes equipped with an ATTCS, whether operating or not.

g. The AFM states that –

(1) Application of reduced take-off thrust in service is always at the discretion of the pilot.

(2) When conducting a take-off using reduced take-off thrust, take-off thrust or derated take-off thrust if such is the performance basis may be selected at any time during the take-off operation.

h. Procedures for reliably determining and applying the value of the reduced take-off thrust setting and determining the associated required aeroplane performance are simple (such as the assumed temperature method). Additionally, the pilot is provided with information to enable him to obtain both the reduced take-off thrust and take-off thrust, or derated take-off thrust if such is the performance basis, for each ambient condition.

i. Training procedures are developed by the operator for the use of reduced take-off thrust.

6 *Derated Thrust* (Acceptable Means Of Compliance)

For approval of derated take-off thrust provisions, the limitations, procedures, and other information prescribed by CS 25.1581, as applicable for approval of a change in thrust, should be included as a separate Appendix in the AFM. The AFM limitations section should indicate that when operating with derated thrust, the thrust setting parameter should be considered a take-off operating limit. However, in-flight take-off thrust (based on the maximum take-off thrust specified in the basic AFM) may be used in showing compliance with the landing and approach climb requirements of CS 25.119 and 25.121(d), provided that the availability of take-off thrust upon demand is confirmed by using the thrust-verification checks specified in paragraph 5.e. above.

[Amdt No: 25/2]
[Amdt No: 25/13]
[Amdt No: 25/27]

AMC 25-19 Certification Maintenance Requirements

ED Decision 2018/005/R

1 P*URPOSE*

This Acceptable Means of Compliance (AMC) provides guidance on the selection, documentation and control of Certification Maintenance Requirements (CMRs). This AMC also provides a rational basis for coordinating the CMR selection process and the Maintenance Review Board (MRB) process if the latter is used. The applicant should ensure that the maintenance tasks and intervals identified in the system safety analyses to support compliance with CS 25.1309 and other system safety requirements (such as CS 25.671, CS 25.783, CS 25.901, and CS 25.933) are protected in service. For those aeroplanes whose initial maintenance programme is developed under a different process than the MRB process, the coordination and document aspects have to be adapted to the particular case. This AMC describes an acceptable means, but not the only means, for selecting, documenting and managing CMRs. Terms such as ‘shall’ and ‘must’ are used only in the sense of ensuring applicability of this acceptable means of compliance.

2 *RELATED CERTIFICATION SPECIFICATIONS*

a. CS 25.671 Control Systems — General

b. CS 25.783 Fuselage Doors

c. CS 25.901 Powerplant — Installation

d. CS 25.933 Reversing systems

e. CS 25.1309 Equipment, systems and installations

f. CS 25.1529 Instructions for Continued Airworthiness

3 *RELATED DOCUMENTS*

a. Airlines for America (A4A), MSG–3, Operator/Manufacturer Scheduled Maintenance Development Document.

b. International Maintenance Review Board/Maintenance Type Board Process Standard (IMPS)

4 *NOT USED*

5 CERTIFICATION MAINTENANCE REQUIREMENTS (*CMR) DEFINITION*

A CMR is a required scheduled maintenance task, established during the design certification of the aeroplane systems as an airworthiness limitation of the type certificate (TC) or supplemental type certificate (STC). The CMRs are a subset of the Instructions for Continued Airworthiness (ICA) identified during the certification process. A CMR usually result from a formal, numerical analysis conducted to show compliance with the requirements applicable to catastrophic and hazardous failure conditions as defined in paragraph 6e, below. A CMR may also result from a qualitative, engineering judgment-based analysis.

a. The CMRs are required tasks, and associated intervals, developed to achieve compliance with CS 25.1309 and other requirements requiring safety analyses (such as CS 25.671, 25.783, 25.901, and 25.933). A CMR is usually intended to detect latent failures that would, in combination with one or more other specific failures or events, result in a Hazardous or Catastrophic Failure Condition. A CMR can also be used to establish a required task to detect an impending wear out of an item whose failure is associated with a hazardous or catastrophic failure condition. A CMR may also be used to detect a latent failure that would, in combination with one specific failure or event, result in a major failure condition, where the SSA identifies the need for a scheduled maintenance task.

b. CMRs are derived from a fundamentally different analysis process than the maintenance tasks and intervals that result from MSG–3 analysis associated with MRB activities (if the MRB process is used). Although both types of analysis may produce equivalent maintenance tasks and intervals, it is not always appropriate to address a Candidate Certification Maintenance Requirement (CCMR) with a Maintenance Review Board Report (MRBR) task.

c. CMRs verify that a certain failure has or has not occurred, indicate that corrective maintenance or repair is necessary if the item has failed, or identify the need to inspect for impending failures (e.g. wear out or leakage). Because the exposure time to a latent failure is a key element in the calculations used in a safety analysis, limiting the exposure time will have a significant effect on the resultant overall failure probability of the system. The intervals for CMR tasks interval should be designated in terms of flight hours, cycles, or calendar time, as appropriate.

d. The type certification process assumes that the aeroplane will be maintained in a condition or airworthiness equal to its certified condition. The process described in this AMC is not intended to establish routine maintenance tasks (e.g. greasing, fluid-level checks, etc.) that should be defined through the MSG–3 analysis process. Also, this process is not intended to establish CMRs for the purpose of providing supplemental margins of safety for concerns arising late in the type design approval process. Such concerns should be resolved by appropriate means, which are unlikely to include CMRs not established via normal safety analyses.

e. CMRs should not be confused with required structural inspection programmes, that are developed by the TC applicant to meet the inspection requirements for damage tolerance, as required by CS 25.571 or CS 25.1529, and Appendix H25.4 (Airworthiness Limitations Section). CMRs are to be developed and managed separately from any structural inspection programs.

6 *OTHER DEFINITIONS*

The following terms apply to the system design and analysis requirements of CS 25.1309(b) and (c), and to the guidance material provided in this AMC. (for a complete definition of these terms, refer to the applicable specifications and acceptable means of compliance, (e.g. CS and AMC 25.1309)).

a. Catastrophic. Refer to AMC 25.1309.

b. Compatible MRBR task. An MRBR task whose intent addresses the CCMR task intent and whose interval is equal to or lower than the interval that would otherwise be required by a CMR.

c. Crew. The cabin crew, or flight crew, as applicable.

d. Failure. Refer to AMC 25.1309.

e. Failure Condition. Refer to AMC 25.1309.

f. Failure Effect Category 5 task (FEC5). Refer to MSG-3, Operator/Manufacturer Scheduled Maintenance Development.

g. Failure Effect Category 8 task (FEC8). Refer to MSG-3, Operator/Manufacturer Scheduled Maintenance Development.

h. Hazardous. Refer to AMC 25.1309.

i. Latent Failure. Refer to AMC 25.1309.

j. Major. Refer to AMC 25.1309.

k. Qualitative. Refer to AMC 25.1309.

l. Quantitative. Refer to AMC 25.1309.

m. Significant Latent Failure. A latent failure that would, in combination with one or more other specific failures or events, result in a hazardous or catastrophic failure condition.

n. Task. Short description (e.g. descriptive title) of what is to be accomplished by a procedure. Example: ‘Operational check of the static inverter’.

o. Wear out. A condition where a component is worn beyond a predetermined limit.

7 *SYSTEM SAFETY ASSESSMENTS (SSA)*

a. CS 25.1309(b) specifies required safety levels in qualitative terms, and a safety assessment must be conducted to show compliance. Various assessment techniques have been developed to help applicants and EASA in determining that a logical and acceptable inverse relationship exists between the probability and the severity of each Failure Condition. These techniques include the use of service experience data of similar, previously approved systems, and thorough qualitative and quantitative analyses.

b. In addition, difficulties have been experienced in assessing the acceptability of some designs, especially those of systems, or parts of systems, that are complex, that have a high degree of integration, that use new technology, or that perform safety-critical functions. These difficulties led to the selective use of rational analyses to estimate quantitative probabilities, and the development of related criteria based on historical data of accidents and hazardous incidents caused or contributed to by failures. These criteria, expressed as numerical probability ranges associated with the terms used in CS 25.1309(b), became commonly accepted for evaluating the quantitative analyses that are often used in such cases to support experienced engineering and operational judgement and to supplement qualitative analyses and tests.

NOTE: See AMC 25.1309 for a complete description of the inverse relationship between the probability and severity of Failure Conditions, and the various methods of showing compliance with CS 25.1309.

8 *DESIGN CONSIDERATIONS RELATED TO* SIGNIFICANT LATENT FAILURES

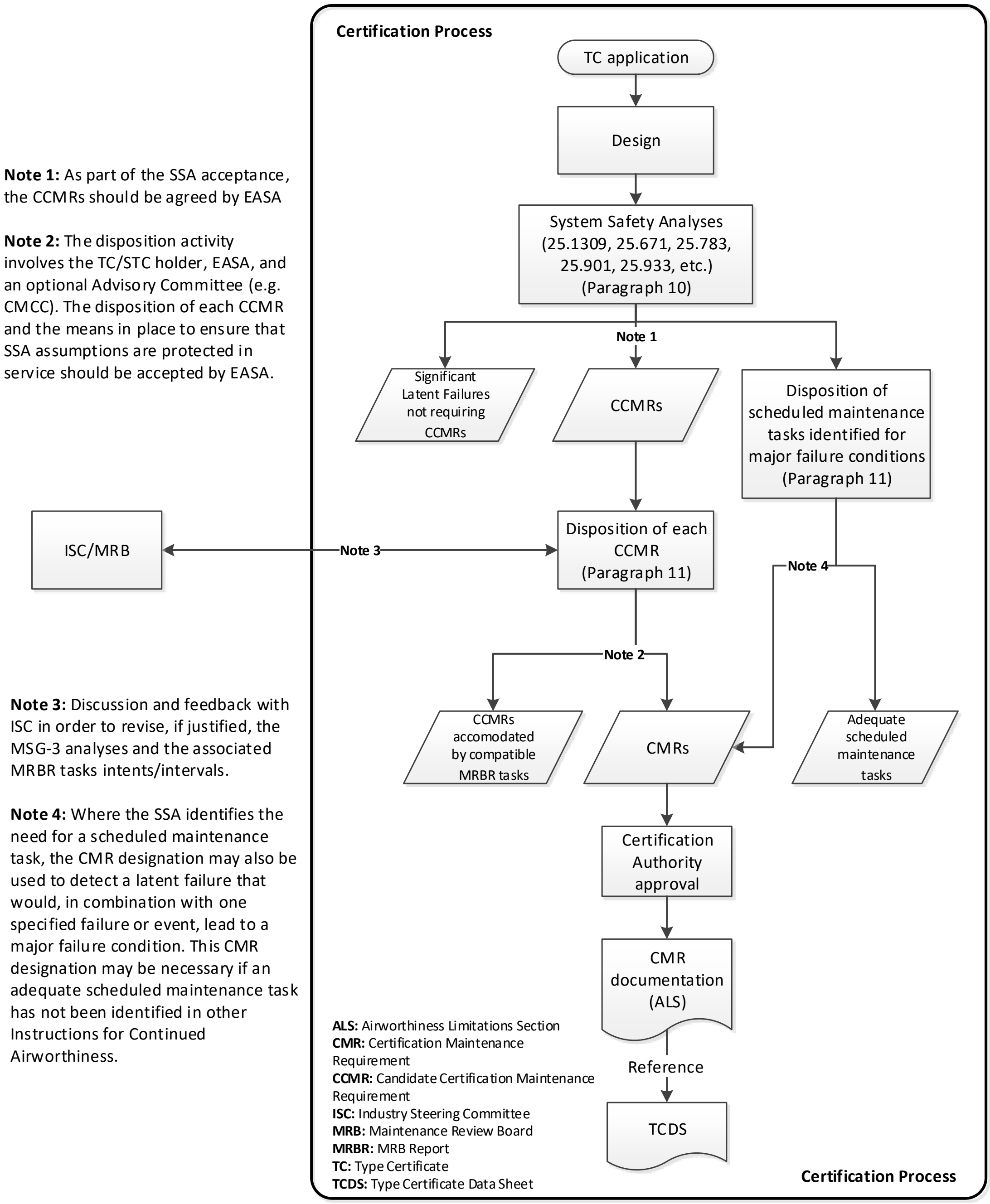
a. The applicant should implement practical and reliable failure monitoring and flight crew indication systems to detect failures that would otherwise be significant latent failures. A reliable failure monitoring and flight crew indication system should utilise current state-of-the-art technology to minimise the probability of falsely detecting and indicating non-existent failures. Experience and judgement should be applied when determining whether or not a failure monitoring and flight crew indication system would be practical and reliable. Comparison with similar, previously approved systems is sometimes helpful.

b. Supplemental design considerations are provided in Appendix 1 to this AMC.

9 OVERVIEW OF THE CERTIFICATION MAINTENANCE REQUIREMENTS DEVELOPMENT PROCESS

a. Figure 1 shows the development process of CMRs. The details of the process to be followed in defining, documenting, and handling CMRs are given in paragraphs 10 through 13.

Figure 1 — CMR development process



10 IDENTIFICATION OF CANDIDATE CMRs (CCMRs)

a. The SSA should address all significant latent failures.

b. Credit may be taken for correct flight crew performance of the periodic checks required to demonstrate compliance with CS 25.1309(b). Unless these flight crew actions are accepted as normal airmanship, they should be included in the approved Aeroplane Flight

Manual procedures. Similarly, credit may be taken from self-initiated checks (e.g. power-up built-in tests). In both cases, these significant latent failures do not need a CCMR.

c. Tasks that are candidates for selection as CMRs come from safety analyses (e.g. SSAs), which establish whether there is a need for tasks to be carried out periodically to comply with CS 25.1309, and other requirements (such as CS 25.671, CS 25.783, CS 25.901, and CS 25.933) requiring this type of analysis. The SSA should identify as CCMRs the maintenance tasks intended to detect significant latent failures. Tasks may also be selected from those intended to inspect for impending failures due to wear out.

d. As the safety analysis may be qualitative or quantitative, some task intervals may be derived in a qualitative manner (e.g. engineering judgment and service experience). As per AMC 25.1309, numerical analysis supplements, but does not replace, qualitative engineering and operational judgment. Therefore, other tasks that are not derived from numerical analysis of significant latent failures, but are based on properly justified engineering judgment, can also be candidates for CMRs. The justification should include the logic leading to identification of CCMRs, and the data and experience base supporting the logic.

e. In some situations, a Catastrophic or Hazardous Failure Condition might meet the quantitative probability objective, yet it might contain one or more components that, as per the quantitative analysis, do not require a periodic maintenance task to meet that objective (i.e. could be failed latent for the life of the aeroplane). In such cases, the SSA should include a qualitative assessment to determine whether a periodic maintenance task is needed.

Unless otherwise substantiated, a CCMR should be identified to:

— reduce exposure to a single failure or event that would cause the failure condition,

— ensure the availability of backup or emergency systems, and

— ensure the availability of equipment/systems required to be installed as per CS-25.

f. For failure conditions involving multiple significant latent failures, the SSA should identify a CCMR for each significant latent failure unless otherwise justified (e.g. one CCMR may cover multiple significant latent failures, or the significant latent failure could exist for the life of the aeroplane without compromising compliance with the safety objectives and paragraph 10.e considerations).

g. For each identified CCMR, the applicant should indicate:

— the failure mode to be detected,

— the failure condition of concern,

— the intended maintenance task, and

— the task interval (the allowable value coming from the SSA or other relevant analysis).

11 *SELECTION OF CMRs*

a. Each CCMR should be reviewed and a determination made as to whether or not it should be a CMR.

Criteria and guidance are provided below for CMR selection or non-selection. The applicant may seek additional input from an advisory committee, as described in Appendix 2, before proposing CMRs to EASA for final review and approval.

b. The applicant should provide sufficient information to enable an understanding of the Failure Conditions and the failure or event combinations that result in the CCMRs. CCMRs are evaluated in the context of the Failure Conditions in which they are involved, e.g. whether the significant latent failure is part of a dual failure, a triple failure, or more.

c. The CMR designation should be applied in the case of catastrophic dual failures where one failure is latent. The CMR designation should also be applied to tasks that address wear out of a component involved in a Catastrophic Failure Condition that results from two failures.

d. In all other cases, the CMR designation may not be necessary if there is a compatible MRBR task to accommodate the CCMR, provided that the applicant has the means in place to ensure that the CCMRs are protected in service. Appendix 3 provides examples of acceptable means of protection. Any means should be presented to EASA for acceptance.

These means of protection should address future evolutions of the compatible MRBR task proposed by the applicant or by the operator. In this respect, these means should ensure that in service:

— the compatible MRBR task would not be changed to the extent that the CCMR task intent is adversely affected, and

— the compatible MRBR task would not be escalated beyond the interval that would otherwise be required by a CMR.

The TC applicant should adequately describe the selected means of protection in the associated technical publication in order for the operator to be aware of the process to be followed if there are modifications to any compatible MRBR tasks that are included in the operator's aeroplane maintenance program (AMP).

e. The rationale for the disposition of each CCMR should be presented to EASA for acceptance.

f. Since the MSG-3 logic may not consider a Failure Condition containing three or more failures, it is possible that a CCMR might not have any identified MRBR tasks. In this case, a CMR will be required.

g. Where the SSA identifies the need for a scheduled maintenance task, the CMR designation may also be used to detect a latent failure that would, in combination with one specified failure or event, lead to a Major Failure Condition. This CMR designation may be necessary if no adequate scheduled maintenance task has been identified in any other Instructions for Continued Airworthiness.

h. If the SSA does not specify an interval shorter than the life of the aeroplane, an interval may be established by considering the factors that influence the outcome of the Failure Condition, such as the nature of the fault, the system(s) affected, field experience, or task characteristics.

12 *DOCUMENTATION AND HANDLING OF CMRs*

a. CMRs are considered functionally equal to airworthiness limitations, therefore they should be included in the Airworthiness Limitations Section of the Instructions for Continued Airworthiness.

b. The CMR data location should be referenced in the type certificate data sheet (TCDS). The latest version of the applicant's CMR documentation should be controlled by a log of