European Aviation Safety Agency

Terms of Reference

for rulemaking task RMT.0384 (MDM.092)

Open rotor engine and installation

ISSUE 3

Issue/Rationale

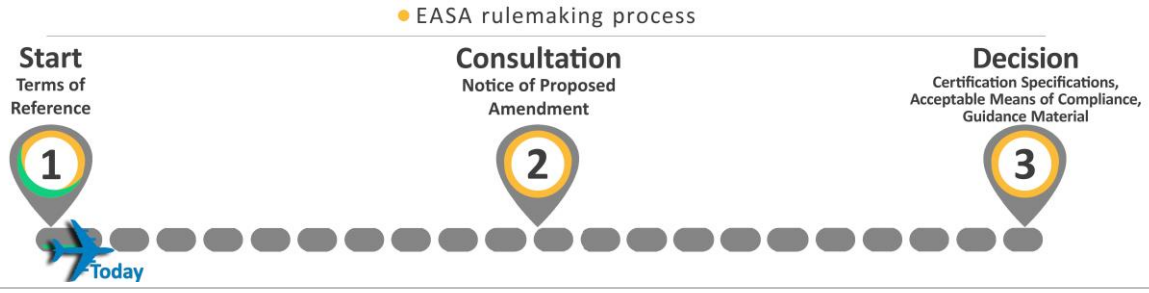
A new engine concept is being proposed to power future large transport aircraft as a means of improving aircraft fuel burn and emissions. This concept is known as the 'open rotor engine'.

The objective of this task is to identify and recommend harmonised draft certification specifications and acceptable means of compliance for CS-E, 14 CFR Part 33, CS-25 and 14 CFR Part 25 to address the novel features inherent in open rotor engine designs and their integration with the aircraft.

Consideration should also be given to the creation of new provisions to provide the required safety objectives based on the unique nature of the open rotor configuration. These new provisions and associated AMC material should ensure that the safety levels of open rotor engine installations are consistent with those of the existing turbofan fleet. These new provisions should also take into consideration the effect of the open engine rotor concept on existing bird ingestion provisions.

Harmonisation with 14 CFR Part 25 and 33 (and/or Special Conditions) is also an objective of this rulemaking task.

Action area	Manufacturers				
Affected rules	ED Decision 2003/9/RM (CS-E); ED Decision 2003/2/RM (CS-25)				
Affected stakeholders	Manufacturers of engines				
Driver	Level playing field	**Reference**	N/a		
Rulemaking group	Yes (SLRMG)	**Impact assessment**	Full	**Procedure**	Standard



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1. Issue and reasoning for regulatory change

A new engine concept is being proposed to power future large transport aircraft as a means of improving aircraft fuel burn and emissions. This concept is known as the Open Rotor engine.

Designs of Open Rotor engines are being considered by a number of engine design organisations. In conjunction, prior to the initiation of this rulemaking activity, industry stakeholder efforts (Airframer, Engine Manufacturers, Research Partners) have led to significant achievements (NACRE, DREAM). These efforts confirm the viability of an Open Rotor (OR) driven aircraft. These efforts will be continued into the future at both the sub-scale level and in product scale engine demonstrator programmes. The culmination of these efforts will be an associated engine demo flying test bed.

The Open Rotor engine concept contains some features of traditional turbine engines and some propeller system features. For certification, engines must comply with the appropriate issue of CS-E, and propellers must comply with CS-P. It has been proposed that the Open Rotor engine concept should be certified to CS-E, but some parts of these provisions are either inadequate or inappropriate due to the novel open rotor engine features. Therefore, CS-E will need to be amended to address these features.

In-conjunction, for certification, aircraft must comply with the appropriate issue of CS-25. Existing provisions assume that an aircraft is powered by either a turbofan or a turboprop engine, therefore, some parts of these provisions are either inadequate or inappropriate due to the novel Open Rotor engine features. Therefore, CS-25 may not be directly applicable to an aircraft powered by an Open Rotor engine.

One particular issue of note is the consequences of Uncontained Engine Rotor Failure (UERF). Since CS 25.903(d)(1) is applicable to engine installations, the issue arises as to whether and to what extent CS 25.903(d)(1) can be applied to the installation of the whole Open Rotor engine. The failure model defined in AMC 20-128A as acceptable means of compliance with CS 25.903(d)(1) does not appear to be applicable to the Open Rotor novel features. Since the Open Rotor failure model to be considered will heavily depend on the Open Rotor engine failure analysis, engine manufacturers will need to be involved in the rulemaking activity for this installation issue.

Industry first presented this project during the SSCC meeting on 14 November 2007, leading to the creation of task E.013 (Engine Open Rotor) in the European Aviation Safety Agency (EASA) 4-year Rulemaking Programme. Task E.013 has since been on the EASA rulemaking inventory without resource or programme.

A second presentation was made to the SSCC Meeting on 25 May 2010, where it was proposed that task E.013 should become an active rulemaking task and that there should be a new task to address the UERF issue. However, it was recognised that EASA rulemaking resource may not allow this to be completed within the timescales required by the engine and aircraft design organisations. Therefore, these tasks have been proposed as rulemaking tasks which will be led by stakeholders in accordance with the new framework proposed by EASA.

Subsequent to the SSCC Meeting, EASA recommended that there should only be one task covering both of the above issues. Therefore, this proposed task replaces E.013 and incorporates the UERF installation issue.

The EASA and Federal Aviation Administration (FAA) Certification Directorates have agreed to participate in this task.

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During the development of the engine certification specifications for the new Open Rotor engine concept, it was originally envisaged to review the complete engine provisions, including the bird ingestion provisions (CS-E 800). Some changes to CS-E 800 are proposed in the Open Rotor NPA (NPA 2015-22 (RMT.0384 (MDM.092))), however, the stakeholder-led rulemaking group (SLRMG) recognised that in order to complete the work on CS-E 800, a deeper analysis involving bird ingestion specialists would be required. Furthermore, in April 2014, the FAA created an ARAC rulemaking task to review the bird ingestion provisions in the light of the Hudson River event (N106US A320-214, 15 January 2009); the Agency contributes to this task and participates therein. In the context of new technology, the created ARAC Bird III RMG identified some key bird ingestion issues that would need to be addressed for Open Rotor engines, without proposing detailed new provisions.

SLRMG RMT.0384 agreed that the bird ingestion provisions should be technically coordinated and consistent with the ARAC Bird III RMG recommendations, therefore, SLRGM RMT.0384 considered that the scope of this ToR should be expanded to complement the current NPA 2015-22 (Open Rotor engine), without impacting the NPA approval process.

In order to have a complete set of Open Rotor certification specifications (CSs), it is vital to complement NPA 2015-22 with the CSs that address the threat of bird ingestion. Without dedicated bird ingestion CSs for Open Rotor engines, the relevance of the proposed NPA 2015-22 could be at risk. Open Rotor engines are significantly different to existing engine designs due to the presence of external contra-rotating blade stages of a large diameter with no containment casing. NPA 2015-22 proposes that the Open Rotor external blades are categorised as being critical parts (CS-E 515), as per the engine safety analysis criterion (CS-E 510). The effects of a bird ingestion on these critical parts needs to be assessed and tested in order to avoid any adverse safety impact as a result of a failure of the external blades.

It is proposed that the scope of RMT.0384 is expanded and this ToR is amended as Issue 2 in order to develop dedicated CSs to address the threat of bird ingestion for Open Rotor engines. This approach is supported by stakeholders from industry and authorities (the Agency & FAA), from both SLRMG RMT.0384 and FAA ARAC Bird III RMG. When established, the Subgroup will be comprised of a selection of experts coming from the two existing Agency and FAA RMGs. This will ensure consistency with the existing NPA 2015-22 and ARAC Bird III RMG proposed provisions, as well as shorten the duration of this rulemaking activity.

2. Objectives

The objective of the rulemaking working group is to identify and recommend EASA/FAA harmonised draft provisions and advisory material for respectively engine (14 CFR Part 33/CS-E) and aircraft (14 CFR Part 25/CS-25) and/or Special Conditions to address the novel features inherent in Open Rotor engine designs and their integration with the aircraft.

Consideration should also be given for the creation of new provisions to provide the required safety objectives based on the unique nature of the open rotor configuration. These new provisions and associated AMC material should ensure that the safety levels of Open Rotor engine installations are consistent with those of the existing turbofan fleet.

Environmental protection aspects are excluded from this task. These are currently being addressed in ICAO Committee on Aviation Environmental Protection.

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3. Activities

The necessary certification specifications should be developed to address Open Rotor engine design features. CS-E, CS-25, 14 CFR Part 33 and 14 CFR Part 25 regulations should be amended as necessary to address Open Rotor engine installation on large aeroplanes.

The following tasks should be developed, in the perspective of the Open Rotor configuration and installation:

— establish the unique attributes of the Open Rotor configuration and aircraft installation;

— review current engine, propeller and aircraft provisions as may be applicable;

— recommend a set of draft provisions and AMC where appropriate to address the unique features of the Open Rotor engine concepts; and

— recommend a set of draft provisions and AMC where appropriate to address the unique features of the installation of an aircraft and Open Rotor engine including addressing UERF and the development of an engine failure model to define aircraft level design precautions, minimisation means and safety objective.

In addition to the tasks above, the threat of bird ingestion to an Open Rotor engine (14 CFR Part 33.76/CS-E 800) should be considered separately, as a complementary subtask, after the publication of the NPA for the aspects above.

The engine bird ingestion CCs, CS-E 800 and 14 CFR Part 33.76 should be revised and developed to address Open Rotor engine design features. The following complementary tasks should be developed:

— to review current engine and propeller bird ingestion provisions as they may be applicable;

— to review the FAA/ARAC Bird III RMG ingestion report recommendations; and

— to recommend a set of draft provisions and AMC, where appropriate, to address the unique features of the Open Rotor engine concepts.

This activity should fully take into consideration the ARAC Bird III RMG ingestion report recommendations (February 2015) along with any other criteria specific to Open Rotor engines, including the following issues:

— very low fan blade solidity: the low solidity of Open Rotor fans could allow a bird to pass between the fan blades with minimal, or zero contact;

— contra-rotating fan rotors: the potential for a bird to impact the first stage of a contra-rotating fan, be propelled at very high velocity aft and outwards, and then impact the second fan stage exists;

— core ingestion bird weight: the core ingestion bird weight is currently based on the inlet throat area and may not be appropriate for the Open Rotor engine core due to the fact that the bypass ratio of Open rotor engines is much higher than that of equivalent thrust class turbofans, which would result in a much lower bird weight demonstration in the core for engines with a similar thrust class;

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— the large single bird (LSB) test: it may be appropriate for Open Rotor engines to require a critical LSB speed in order to have a valid comparison between the 'blade out' test and the LSB test due to the fact that there is no containment case; and

— a Monte-Carlo analysis may be required to prove that an equivalent level of safety is ensured.

4. Deliverables

The following deliverables are expected from this RMT:

Phase 1 — Engine design features and engine integration:

— an NPA proposing amendments to CS-E and CS-25; and

— a CRD to NPA;

Phase 2 — Bird ingestion:

— an NPA proposing amendments to CS-E;

— a CRD to NPA; and

— an ED Decision amending CS-E and CS-25.

5. Profile and contribution of the rulemaking group

In order to carry out the tasks defined above, it is envisaged that three dedicated Subgroups will be formed:

Subgroup 1 (Installation) shall address the engine and aircraft integration issues and recommend draft provisions for CS-25 harmonised with 14 CFR Part 25 and where appropriate CS-E harmonised with 14 CFR Part 33.This Subgroup should be composed of aircraft and engine manufacturers as well as EASA certification experts. Involvement of the FAA is expected. In addition to engine and power plant installation specialists, it is likely that structures specialists will need to be involved.

Subgroup 2 (Engine certification) shall address engine design issues and recommend draft provisions for CS-E harmonised with 14 CFR Part 33.This Subgroup should be composed of engine manufacturers and EASA certification experts. Involvement of the FAA is expected.

Subgroup 3 (Bird ingestion) shall address bird ingestion issues and draft appropriate provisions for CS-E, harmonised with 14 CFR Part 33. This Subgroup should be composed of members coming from the existing SLRMG RMT.0384 and FAA ARAC Bird III RMG, and include engine and aircraft manufacturers, as well as EASA and FAA propulsion and power plant certification experts.

Coordination among the three Subgroups is required for this task.

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6. Annex I: Reference documents

6.1. Affected regulations

N/a

6.2. Affected decisions

— Decision No. 2003/9/RM of the Executive Director of the Agency of 24 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for engines ('CS-E')

— Decision No. 2003/2/RM of the Executive Director of the Agency of 17 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for large aeroplanes ('CS-25')

6.3. Reference documents

N/a

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7. Annex II: Stakeholder-led Rulemaking Group Composition

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Subgroup 1 — Installation

Members:

Richard Lorenz	Boeing (Chair)
Walter Drew	Airbus (Vice Chair)
Charlie Rulleau	Airbus
Olivier Lacomme	Airbus
Mark Chatterton	Rolls-Royce
Kenneth Mackie	Rolls-Royce
Didier Escure	CFM/Snecma
Les Mc Vey	CFM/GE and GE Aviation
Rodrigo De la Fuente	Embraer
Giovani Cerino	Alenia Aeronautica
Geoffrey Armstrong	Bombardier Aerospace
Dominique Bouvier	CFM/Snecma
Sarah Knife	CFM/GE and GE Aviation
Robert Benjamin	Pratt & Whitney
Karl Hoier	EASA
Laurent Gruz	EASA
Jay Turnberg	FAA
Mike Dostert	FAA

Secretary:

Charlie Rulleau	Airbus

Subgroup 2 — Engine certification

Members:

Dominique Bouvier	CFM/Snecma (Chair)
Mark Chatterton	Rolls-Royce (Vice-chair)
Kenneth Mackie	Rolls-Royce

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Didier Escure	CFM/Snecma
Allan Van De Wall	CFM/GE and GE Aviation
Sarah Knife	CFM/GE and GE Aviation
Karl Hoier	EASA
Jay Turnberg	FAA
Robert Benjamin	Pratt & Whitney

Secretary:

Dominique Bouvier	CFM/Snecma (Chair)

Additional members for Review Group for NPA 201X-XX

Antoine Pilon	Airbus
Olivier Lacomme	Airbus
Frédéric Loup	Airbus
John Ostic	Boeing
Terry Tritz	Boeing
Rodrigo De la Fuente	Embraer
Giovani Cerino	Alenia Aeronautica
Geoffrey Armstrong	Bombardier Aerospace
Mark Chatterton	Rolls-Royce
Julian Reed	Rolls-Royce
Dominique Bouvier	CFM/Snecma
Didier Escure	CFM/Snecma
Allan Van De Wall	CFM/GE and GE Aviation
Sarah Knife	CFM/GE and GE Aviation
Robert Benjamin	Pratt & Whitney
Karl Hoier	EASA
Laurent Gruz	EASA
Jay Turnberg	FAA
Mike Dostert	FAA
Carl Garvie	EASA

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Subgroup 3 — Bird ingestion

Members:

Dominique Bouvier	CFM/Snecma (Chair)
Julian Reed	Rolls-Royce (Vice-Chair)
Frédéric Loup	Airbus
John Ostic	Boeing
Terry Tritz	Boeing
Tom Dwier	Cessna
Didier Escure	CFM/Snecma
Robert Benjamin	Pratt & Whitney
Chris Demers	Pratt & Whitney
Angus Abrams	EASA
Karl Hoier	EASA
Laurent Gruz	EASA
Alan Strom	FAA
Jay Turnberg	FAA
Zhiwei Wang	TCCA
Bryan Lesko	ALPA
Sarah Knife	CFM/GE & GE Aviation
Antoine Pilon	Airbus
Olivier Lacomme	Airbus
Carl Garvie	EASA

Secretary:

Allan VanDewall	CFM/GE & GE Aviation

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