European Union Aviation Safety Agency

Advance Notice of Proposed Amendment 2022-05

Environmental protection requirements for supersonic transport aeroplanes

RMT.0733

EXECUTIVE SUMMARY

A new generation of supersonic transport (SST) aeroplanes is being developed for business jet and commercial airline applications, expected to become operational in the late 2020s. These SST aeroplanes are likely to be operated worldwide, including by European operators. As a consequence, EASA may receive applications for certification or validation of new SST aeroplane types.

This Advance Notice of Proposed Amendment (A-NPA) 2022-05 provides initial concepts for the development of environmental protection requirements for SST aeroplanes, with the objective of ensuring a high, uniform level of environmental protection in Europe in the absence of respective International Civil Aviation Organization (ICAO) Standards and Recommended Practices (SARPs). The subjects addressed in A-NPA 2022-05 include landing-and-take-off (LTO) noise and CO_2 emission certification requirements for SST aeroplanes. The proposed LTO noise limits correspond to the existing limits for subsonic jet aeroplanes, which are contained in Chapter 14 of ICAO Annex 16, Volume I. Pending ongoing work towards establishing an appropriate CO_2 limit for SST aeroplanes, provisions for the standardised measurement and reporting of CO_2 emissions are proposed as an interim step.

Feedback provided on this A-NPA 2022-05 will support the development of certification requirements for SST aeroplanes in subsequent rulemaking deliverables.

Domain:	Environmental protection		
Related rules:	— Commission Regulation (EU) No 748/2012 (Initial Airworthiness), — CS-36, and — CS-CO_2.		
Affected stakeholders:	SST airframe and engine manufacturers, Member States (MSs), national competent authorities (NCAs), and operators of SST aeroplanes.		
Driver:	Environment	**Rulemaking group:**	No
Impact assessment:	Yes	**Rulemaking Procedure:**	Standard

EASA rulemaking procedure milestones

Start Terms of Reference	**Public consultation** **Advance** Notice of Proposed Amendment	**Proposal to the Commission** EASA Opinion	**Adoption by the Commission** Implementing Rules	**Decision** Certification Specifications, Acceptable Means of Compliance, Guidance Material
16.12.2021	25.5.2022	TBD	TBD	TBD
	Public consultation Notice of Proposed Amendment			
	TBD			

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1. About this A-NPA

1.1. How this A-NPA was developed

The European Union Aviation Safety Agency (EASA) developed this Advance Notice of Proposed Amendment (A-NPA) 2022-05 in line with Regulation (EU) 2018/1139[1] (the 'Basic Regulation') and the Rulemaking Procedure[2]. This Rulemaking Task (RMT).0733 is included in Volume II of the European Plan for Aviation Safety (EPAS) for 2022-2026. The scope and timescales of the task were defined in the related Terms of Reference (ToR)[3].

EASA developed A-NPA 2022-05 to timely share its proposed initial concepts and receive feedback for the subsequent rulemaking deliverables under RMT.0733. A-NPA 2022-05 was developed with the contribution of key stakeholders. Technical meetings with European aircraft and engine manufacturers were conducted to identify and discuss critical issues and potential solutions. Feedback from those meetings was obtained through a questionnaire, which is contained as an Appendix to this document. Further feedback that was gathered from meetings with Member State (MS) experts[4] has been also considered in this document.

To allow for feedback from a wider audience, including all affected stakeholders, A-NPA 2022-05 is hereby submitted to all interested parties for consultation in accordance with Article 115 of the Basic Regulation, and Article 6(3) of MB Decision No 01-2022 ('Rulemaking Procedure').

The major milestones of this RMT are presented on the cover page.

1.2. How to comment on this A-NPA

Please submit your comments using the automated **Comment-Response Tool (CRT)** available at **http://hub.easa.europa.eu/crt/**[5].

The deadline for the submission of comments is **25 July 2022**.

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1 Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and amending Regulations (EC) No 2111/2005, (EC) No 1008/2008, (EU) No 996/2010, (EU) No 376/2014 and Directives 2014/30/EU and 2014/53/EU of the European Parliament and of the Council, and repealing Regulations (EC) No 552/2004 and (EC) No 216/2008 of the European Parliament and of the Council and Council Regulation (EEC) No 3922/91 (OJ L 212, 22.8.2018, p. 1) (https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1535612134845&uri=CELEX:32018R1139).

2 EASA is bound to follow a structured rulemaking process as required by Article 115(1) of Regulation (EU) 2018/1139. Such a process has been adopted by the EASA Management Board (MB) and is referred to as the 'Rulemaking Procedure'. See MB Decision No 18-2015 of 15 December 2015 replacing Decision 01/2012 concerning the procedure to be applied by EASA for the issuing of opinions, certification specifications and guidance material (http://www.easa.europa.eu/the-agency/management-board/decisions/easa-mb-decision-18-2015-rulemaking-procedure). On 4 May 2022, MB Decision No 18-2015 was repealed and replaced by MB Decision No 1-2022 on the procedure to be applied by EASA for the issuing of opinions, certification specifications and other detailed specifications, acceptable means of compliance and guidance material (https://www.easa.europa.eu/the-agency/management-board/decisions/easa-mb-decision-01-2022-rulemaking-procedure-repealing-mb).

3 https://www.easa.europa.eu/document-library/terms-of-reference-and-group-compositions/tor-rmt0733

4 European Technical Expert Groups (TEGs) for SST aeroplanes in the domains of Noise (N-TEG) and CO_2 Emissions (C-TEG).

5 In case of technical problems, please send an email to crt@easa.europa.eu with a short description.

1.3. The next steps

A regulatory impact assessment (RIA) is planned to be developed using qualitative and/or quantitative input in line with evidence-based policy making and focusing on major and complex items. The RIA is planned to be included in a potential future notice of proposed amendment (NPA).

As presented in the major milestones on the cover page, further rulemaking deliverables may include a related NPA and a subsequent EASA opinion, which will be submitted to the European Commission. Workshops and/or technical meetings with affected stakeholders and state experts may be arranged as necessary to support the development of the NPA. Decisions on additional rulemaking deliverables will consider industry developments, as well as the progress of developing international environmental protection requirements for supersonic transport (SST) aeroplanes within the International Civil Aviation Organization (ICAO) Committee on Aviation Environmental Protection (CAEP).

If the European Commission decides to amend Commission Regulation (EU) No 748/2012[6] and/or issue a new delegated regulation in accordance with Article 19(1)(a) of the Basic Regulation, EASA will publish decisions to issue the related acceptable means of compliance (AMC) and guidance material (GM) and/or certification specifications (CSs).

[6] Commission Regulation (EU) No 748/2012 of 3 August 2012 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations (OJ L 224, 21.8.2012, p. 1) (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32012R0748&qid=1651503862309).

2. Objective and context of this A-NPA

2.1. Why we need to amend the rules – issue/rationale

A new generation of supersonic transport (SST) aeroplanes is being developed for business jet and commercial airline applications, expected to become operational in the late 2020s. These SST aeroplanes are likely to be operated worldwide, including by European operators. As a consequence, EASA may receive applications for certification or validation of new SST aeroplane types. In this context, noise and CO_2 emission requirements for SST aeroplanes are topics that need to be addressed to ensure a high, uniform level of environmental protection.

Since no Standards and Recommended Practices (SARPs) for landing-and-take-off (LTO) noise and CO_2 emissions certification requirements exist in ICAO Annex 16, which would apply to new SST aeroplanes, the environmental protection requirements for such aircraft are only those laid down in Annex III to the Basic Regulation. This A-NPA 2022-05 is published under rulemaking task (RMT).0733. The objective of the task is to implement the essential requirements of the Basic Regulation by developing detailed environmental protection requirements for SST aeroplanes, which cover LTO noise and CO_2 emissions, in accordance with Article 19(1)(a) of the Basic Regulation. Such requirements for SST aeroplanes would be applicable until respective ICAO requirements are developed and become applicable in the European Union through reference to ICAO SARPs in accordance with Article 9(2) first sentence of the Basic Regulation.

Note: operational requirements for SST aeroplanes, including for the purpose of en route noise (sonic boom) mitigation, are being dealt with separately under Subtask 4 of RMT.0476.

Related safety issues

There is no safety recommendation pertinent to the scope of this A-NPA.

ICAO and third-country references relevant to the content of this A-NPA

<u>ICAO</u>

Unlike standards for subsonic aeroplanes, ICAO Annex 16 does not contain LTO noise standards for new SST aeroplane types nor CO_2 emissions standards for SST aeroplanes. The work programme of the ICAO Committee on Aviation Environmental Protection (CAEP) for the CAEP/13 cycle includes a task to develop Standards and Recommended Practices (SARPs) for LTO noise of SST aeroplanes.

<u>FAA</u>

In April 2020, the US Federal Aviation Administration (FAA) proposed a domestic LTO noise standard for SST aeroplanes, which is focused specifically on the business-jet segment. The proposal covers aeroplanes with up to three engines, a maximum take-off weight (MTOW) of up to 150 000 lbs (68 039 kg), and design speeds of up to Mach 1.8. The US-proposed noise limits are between the current (US Stage 5 / ICAO Chapter 14) and previous (US Stage 4 / ICAO Chapter 4) noise standards for subsonic jet aeroplanes. There are currently no CO_2 emission requirements for SST aeroplanes in the US.

2.2. What we want to achieve — objectives

The overall objectives of the EASA system are defined in Article 1 of the Basic Regulation. One of the objectives is to achieve a high, uniform level of environmental protection. The concepts and preliminary draft requirements from this A-NPA 2022-05, together with the subsequent rulemaking deliverables under RMT.0733, will contribute to the achievement of this overall objective by addressing the issues outlined in Section 2.1.

The specific objective of RMT.0733 is to maintain the current high level of environmental protection in Europe, by introducing adequate environmental protection requirements for a new generation of SST aeroplanes, in the absence of applicable ICAO SARPs.

The contents of this A-NPA may also inform and support discussions within the ICAO CAEP, which is working on international SARPs for SST aeroplanes in the field of environmental protection. The A-NPA proposals and feedback thereto that will be received during its consultation may also help to develop project-specific environmental special conditions — in case an application for type certification or validation of an SST aeroplane is received before any detailed environmental protection certification requirements enter into force.

2.3. How we want to achieve it

A stepwise approach is followed under RMT.0733 towards the development of draft requirements for SST aeroplanes in the fields of LTO noise and CO_2 emissions. This A-NPA, as a first step, presents technical concepts to support the definition of certification requirements at a later point in time. The A-NPA also includes preliminary draft requirements based on these concepts, which are limited in their scope and focus on key technical provisions.

As explained in Section 1, the A-NPA and the feedback received on its contents is intended to form the basis of a potential notice of proposed amendment (NPA) to be developed under RMT.0733. The NPA would contain a regulatory proposal including a complete set of draft requirements. The scope and timing of the later NPA will take into account the progress made within ICAO CAEP concerning the development of ICAO SAPRs for SST aeroplanes in the field of environmental protection.

3. Concepts for LTO noise and CO_2 emission requirements for SST aeroplanes

3.1. General approach

The essential requirements for environmental compatibility are set out in **Annex III to the Basic Regulation**, and apply to products, parts, and non-installed equipment to the extent that the provisions of ICAO Annex 16 do not contain environmental protection requirements. Annex III includes the essential requirements for products to be designed to minimise noise and emissions as far as possible, taking into account any trade-offs between the design measures intended to minimise noise and emissions. The concepts described in this A-NPA — to be further developed under RMT.0733 — aim at implementing the essential requirements for SST aeroplanes in the fields of LTO noise and CO_2 emissions.

The environmental protection requirements for LTO noise and CO_2 emissions of subsonic aircraft are contained in **ICAO Annex 16, Volumes I and III**, which are referred to in Article 9(2) of the Basic Regulation. The concepts and preliminary draft requirements for SST aeroplanes that are presented in this A-NPA are based on the aforementioned ICAO SARPs for subsonic aircraft. The existing requirements for subsonic aircraft were adapted, as necessary, to reflect the specifics of SST aeroplanes, while maintaining compatibility in terms of metrics and procedures as far as possible.

For **LTO noise**, the same noise limits as prescribed in **Chapter 14** of **ICAO Annex 16**, **Volume I** for subsonic jet aeroplanes are proposed for SST aeroplanes. Design differences between SST aeroplanes and subsonic jet aeroplanes, resulting for example in a different range of operational speeds, are considered in the definition of the take-off reference procedure for noise measurements. Furthermore, the potential use of variable noise reduction systems (VNRS) during take-off is considered, to allow SST-specific take-off procedures for noise certification.

The concepts and preliminary draft requirements for **CO_2 emissions** of SST aeroplanes include measurement and reporting provisions, while the need for further technical assessments has been identified, to define an appropriate CO_2 limit for such aircraft. The characteristics of SST aeroplanes compared to subsonic aeroplanes are considered in the definition of the reference mass points, as well as in the provisions for reference speeds at which the specific air range (SAR) is measured. For comparability with the CO_2 metrics for subsonic aeroplanes, the CO_2 metric value (MV) definition is proposed to remain unchanged.

3.2. Concepts for LTO noise requirements for SST aeroplanes

3.2.1. Introduction: noise standards for subsonic aeroplanes and adaptations for SST aeroplanes

For subsonic aeroplanes, the certification requirements for landing-and-take-off (LTO) noise are contained in ICAO Annex 16, Volume I, which is referred to in Article 9(2) of the Basic Regulation. During type certification, the LTO noise of subsonic jet aeroplanes is measured at three measurement points (approach, lateral, and flyover, see Figure 1 below), to characterise the aircraft noise around an airport. The certified noise levels are measured in effective perceived noise decibels (EPNdB), which is a metric that represents the human ear’s perception of aircraft noise.

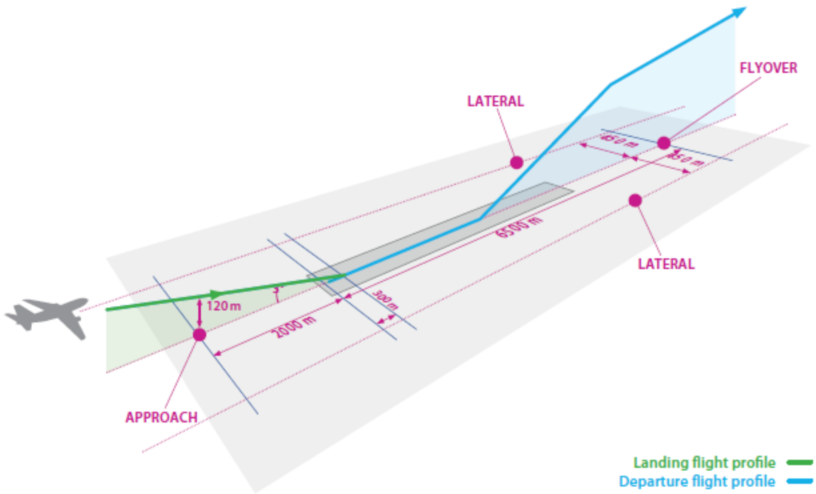

Figure 1 — Schematic of LTO noise certification measurement points

The ICAO certification requirements define noise limits that must not be exceeded at each of the three measurement points; the latest noise standards define an additional limit based on the sum of the three noise levels (cumulative limit). Increasingly stringent noise limits have been developed over time for subsonic aeroplanes; Chapter 14 of ICAO Annex 16, Volume I contains the most recent requirements. The noise limits in ICAO Annex 16, Volume I, Section 14.4 depend on the maximum take-off mass (MTOM) of the aircraft and the number of engines. The margin to the cumulative limit can be seen as a measure of noise performance from an aircraft technology/design perspective.

As mentioned in Section 3.1, the preliminary draft LTO noise requirements that are proposed for SST aeroplanes in this document are based on the methods and limits of Chapter 14 of and Appendix 2 to ICAO Annex 16, Volume I. Adaptations to account for design differences between SST aeroplanes and subsonic jet aeroplanes are considered, in particular concerning the use of advanced take-off procedures. Similarities with, as well as differences from, the requirements for subsonic jet aeroplanes are described in the following sections.

3.2.2. Applicability, metrics, and measurement points

The preliminary draft noise requirements that are described in this A-NPA are proposed to apply to all SST aeroplanes, regardless of MTOM, number of engines, maximum operating Mach number (MMO) or required runway length. The procedures and evaluation methods represent generic concepts that can be equally applied to all SST aeroplane designs. A proposed wording for applicability provisions can be found in Section 4.2, Proposal N-1.

The effective perceived noise level (EPNL) in units of EPNdB for subsonic jet aeroplanes can be reused as the noise evaluation measure for SST aeroplanes. Similarly, the same noise measurement reference points as specified in Chapter 14 for subsonic jet aeroplanes are proposed to be used (see Proposals N-2 and N-3 in Section 4.2). This approach allows for comparability of measurement results between subsonic jet aeroplanes and SST aeroplanes.

3.2.3. Maximum noise levels

The maximum noise levels ('noise limits') for subsonic jet aeroplanes are defined in Chapter 14 of ICAO Annex 16, Volume I, and depend on the MTOM of the aircraft and the number of engines. It is proposed to apply the same noise limits to SST aeroplanes. This way, the current level of environmental protection in Europe would be maintained, and a level playing field between subsonic jet aeroplanes and SST aeroplanes is ensured.

Considering the specifics of SST aeroplane designs, meeting those limits appears to be challenging but technologically feasible, as indicated by results from research studies[7]. Using Chapter-14 limits for SST aeroplanes, while allowing for advanced procedures (e.g. VNRS) during noise certification, is also in line with the latest industry position expressed within the ICAO CAEP[8]. A proposed wording specifying the maximum noise levels for SST aeroplanes can be found in Section 4.2, Proposal N-4.

Without Chapter-14 limits in place, SST aeroplanes would significantly increase noise exposures around airports; in the future, this would potentially outweigh the advantages of more silent subsonic aircraft when looking at noise contours around airports[9]. Therefore, it is worth mentioning that the latest subsonic jet aeroplane types have a cumulative margin of at least 5 EPNdB against the Chapter-14 limits, which reflects the inherent advantages of subsonic aircraft designs in environmental protection, when compared to supersonic aircraft designs.

3.2.4. Noise certification reference procedures

The specifics of potential SST aeroplane designs need to be considered concerning the noise certification reference procedures, which specify further requirements for the flight path, aircraft configuration, thrust, and speeds of the aircraft for the purpose of noise measurements.

Variable noise reduction systems (VNRS) are integral design features, or subsystems, that are expected to be used in future SST aeroplane types to reduce noise. VNRS may include a programmed lapse rate (PLR), i.e. a dynamically controlled thrust reduction after take-off, as well as programmed aeroplane configuration changes. To consider VNRS that may be installed on SST aeroplanes, the preliminary draft LTO noise requirements for SST aeroplanes include the following two **take-off reference procedures**:

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[7] Dassault Aviation, *HISAC Publishable Activity Report*, Report No HISAC-T-6-26-1, 2018.

[8] ICAO CAEP, Working Paper CAEP/12-WP/68: *Position on Supersonic LTO Noise SARP in CAEP/13 Future Work Programme*, February 2022.

[9] EASA, *Position Paper on Environmental Compatibility of Supersonic Transport Aeroplanes (SST)*, IP No AI 7 of MAB 2020-02, May 2020, and ICAO CAEP, Working Paper CAEP/12-WP/39: *Supersonic Exploratory Study Report*: Final Report, February 2022.

(a) Take-off reference procedure without VNRS

This procedure intended for SST aeroplanes without VNRS is similar to the take-off reference procedure in Chapter 14 of ICAO Annex 16, Volume I, but with modified reference speeds. The range of the take-off reference speed needs to be adapted for SST aeroplanes due to a lower lift-to-drag relationship that can be expected of supersonic designs. A reference speed range of 'at least V_2 + 65 km/h (V_2 + 35 kt), but not greater than V_2 + 102 km/h (V_2 + 55 kt)' is therefore proposed (see Section 4.2, Proposal N-5.2). In addition, a maximum allowable speed of 463 km/h (250 kt) is defined.

Initial consultation with European industry as well as assessments performed by contractors on behalf of EASA have confirmed that the proposed speed range for take-off is appropriate for various SST aeroplane designs.

(b) Take-off reference procedure with VNRS

In addition to the different speed range described under (a), the following requirements are imposed for the alternative reference procedure for aircraft with VNRS:

(1) The VNRS configuration that produces the highest noise level must be used.

It has been discussed that a VNRS for SST aeroplanes may comprise more than one procedure that could be selected operationally on an aerodrome-by-aerodrome basis. The above requirement addresses the potential implementation of such a concept.

(2) Any thrust reduction that is initiated by the VNRS (PLR) before the final 'power cutback' point must not result in a thrust lower than 75 % of the maximum available thrust. This condition is intended to prevent the VNRS from bypassing the final 'power cutback point'.

(3) The take-off reference path needs to be calculated by synthesis based on segments of constant aircraft configuration.

These concepts could be implemented in preliminary draft requirements as presented in Section 4.2, Proposals N-5.1 through N-5.3. It is worth noting that if any pilot action is necessary to activate, or select the use of, an automatically controlled noise reduction system, or if such system can be deactivated by the pilot, that system is not considered a VNRS in the context of this A-NPA.

While the use of VNRS is mostly referred to as a means to optimise noise performance during take-off, such technology could also be considered for the approach. However, based on initial feedback from industry, it is currently not expected that the VNRS of SST aeroplanes would be active during the approach segment. The **approach reference procedure** for SST aeroplanes in this document is therefore proposed to be identical to the one for subsonic jet aeroplanes (see Section 4.2, Proposal N-5.4).

3.2.5. Test procedures

The test procedures include provisions about deviations between the conditions for noise measurements and the reference procedures, as well as limitations for such deviations. Most limitations on the test procedures are proposed to remain unchanged compared to those of Chapter 14 for subsonic jet aeroplanes (see Section 4.2, Proposal N-6). Regarding the lateral measurement point, the provisions for the allowed variation in speed need to be adapted to the segmented reference path that is described above for the take-off reference procedure with VNRS. The allowed variation in speed itself is the same as in Chapter 14 for subsonic aircraft, but the average airspeed is linked to the individual segments of the take-off reference flight path. Such method is not considered to be required for the flyover condition, as it is assumed that the VNRS will be deactivated well before the aircraft reaches a point on the flight track that is relevant for establishing the flyover noise level.

3.2.6. Evaluation methods

The noise evaluation methods for subsonic jet aeroplanes in Appendix 2 of ICAO Annex 16, Volume I, include further details of the noise certification test, the allowed measurement conditions, and the calculation of the noise levels in the EPNL, including adjustments from test to reference conditions. The noise evaluation method for SST aircraft is proposed to be based on the contents of Appendix 2 for subsonic jet aeroplanes. Based on an initial assessment of the Appendix 2 contents and pending further rulemaking to be performed before a potential NPA is issued, the following adaptations of the evaluation methods are proposed for use with SST aircraft:

— If take-off noise levels are established with an active VNRS system, the integrated method of adjustment must be used to calculate the EPNL[10]. The alternative simplified method is limited to aeroplane types that do not change configuration over the flight path.

— The specifics for noise evaluations of helicopters and heavy propeller-driven aeroplanes as contained in Appendix 2 can be removed to create an equivalent Appendix but for SST aeroplanes only.

See also Section 4.2, Proposal N-7.

Furthermore, in the absence of any approved (or proposed) **equivalent procedures for SST aeroplanes**, it is assumed that the noise levels of SST aeroplanes will be established based on actual take-offs – in contrast to the intercept procedures that are common practice as an equivalent procedure for the noise certification of subsonic aeroplane types.

[10] The FAA-proposed domestic LTO noise standard also prescribes the integrated method (see Section 2.1).

3.3. Concepts for CO_2 emission requirements for SST aeroplanes

3.3.1. Introduction: CO_2 standard for subsonic aeroplanes and adaptations for SST aeroplanes

For subsonic aeroplanes, the certification requirements for CO_2 emissions are contained in ICAO Annex 16, Volume III, which is referred to in Article 9(2) of the Basic Regulation. The CO_2 emissions evaluation for subsonic aeroplanes is essentially a fuel-efficiency analysis. This analysis is based on the specific air range (SAR) (in units of km per kg fuel) that is measured at three reference points in cruise flight, and considering a reference geometric factor (RGF) as a measure of fuselage size (and, hence, transport capability). Figure 2 shows a schematic of the three reference points. As explained below, the existing requirements for subsonic aeroplanes combine the aforementioned parameters into a CO_2 metric value (MV), to compare it to an MTOM-dependent limit. The margin to the limit can be seen as a fuel-efficiency measure from an aircraft technology/design perspective.

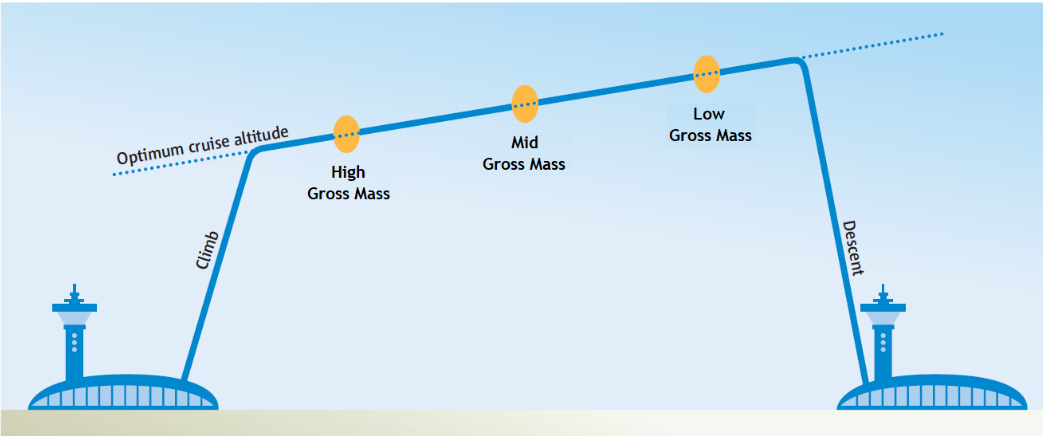

Figure 2 — Illustrative example of the three SAR measurement points for CO_2 emission evaluation

Considering the specifics of SST aeroplanes, in particular the high fuel fraction of supersonic designs, their performance characteristics, as well as the achievable fuel efficiency at high speeds, adaptations to the requirements for subsonic aeroplanes were considered required. The following subsections detail the key adaptations proposed in this document and explain which elements are proposed to remain unchanged compared to the requirements for subsonic aeroplanes.

3.3.2. Reference masses for SAR measurement

The CO_2 requirements for subsonic aeroplanes provide for SAR measurements by means of flight tests at three reference mass points: the high gross mass, mid gross mass, and low gross mass. Those masses are defined as a function of the maximum take-off mass (MTOM) in ICAO Annex 16, Volume III, Part II, Section 2.3. The reference mass point definitions in the subsonic requirements were found unsuitable for SST aeroplanes, due to the higher fuel fraction of supersonic aeroplane designs. The high gross mass point as defined in ICAO Annex 16, Volume III would not be a valid cruise point for some SST aeroplane designs, while the low gross mass point would not be representative of a gross mass at the end of a cruise segment. These findings are in line with the results from a feasibility study that was conducted by the ICAO CAEP Working Group 3 during the CAEP/12 cycle[11].

Different workarounds have been explored using performance models of conceptual SST aeroplanes, and have been discussed with European key manufacturers. The definition of reference gross masses as a function of the MTOM appears challenging in the short term, especially concerning the low gross mass point. More data would be required for further analyses to ensure that a low gross mass point that is defined as a function of the MTOM is representative of end-of-cruise conditions across different SST aeroplane designs. Specifying the reference masses based on maximum zero-fuel mass (MZFM) and MTOM could be an alternative for further assessment. However, evaluating such approach requires robust data and more detailed insights into SST aeroplane design considerations.

To allow for reference mass points that are representative of cruise conditions and tailored to each SST design, a 'design-mission' approach is proposed instead. In this approach, the applicant must select high and low gross masses that are representative of initial-cruise and end-of-cruise conditions, based on the aeroplane's design mission. The design mission in the context of such a requirement is proposed by the applicant, and is expected to be a generic flight mission at supersonic (design) cruise speed with the following characteristics:

— take-off at MTOM,

— design payload on board,

— ICAO standard atmospheric conditions, and

— over-the-maximum operational range possible for these conditions.

As in the current CO_2 requirements for subsonic aeroplanes, the mid gross mass is proposed to be defined as the arithmetic average of the high and low gross masses. Proposal CO_2-5 in Section 4.3 contains a draft wording for defining the reference masses accordingly.

3.3.3. Reference altitudes and speeds for SAR measurement

In the CO_2 requirements for subsonic aeroplanes, the altitude and airspeed combinations for SAR measurements are for the applicant to select (see ICAO Annex 16, Volume III, Part II, Section 2.5.1(b)). This principle was established assuming that SAR-optimal combinations of airspeed and altitude are likely to be chosen, and that alternatives, other than optimum conditions, would be to the detriment of the applicant because the SAR value would be adversely affected. Modifications to this approach were found to be required for SST aeroplanes, for the following reasons:

(a) SAR-optimal cruise speeds of some SST aeroplane designs may occur at subsonic speed, and therefore at a speed that is significantly different from the supersonic cruise speed that the aeroplane is designed for. This finding is in line with the results from a feasibility study that was conducted by the ICAO CAEP Working Group 3 during the CAEP/12 cycle[12].

[11] See ICAO CAEP, Working Paper CAEP/12-WP/31: *ESTG – CO2 (Remit E.13)*, November 2021, and ICAO CAEP WG3, Information Paper CAEP/12-WG3/3-ESTG/3-IP/01: *CO_2 Metric Value Estimation for NASA 55t SST*, February 2020.

[12] See ICAO CAEP, Working Paper CAEP/12-WP/31: *ESTG – CO_2 (Remit E.13)*, November 2021.

(b) The upcoming new generation of SST aeroplanes is expected to operate at supersonic cruise speed over sea, but at subsonic cruise speed when flying over land, to avoid unacceptable situations for the public due to sonic booms.

Issue (a) is proposed to be addressed by additional boundary conditions for the airspeed at which the SAR is measured, while aspect (b) is proposed to be addressed by introducing two separate sets of measurement conditions covering supersonic speed and subsonic speed respectively.

SAR measurements in supersonic reference conditions are proposed to be performed at combinations of altitude and airspeed selected by the applicant, with the additional condition that the airspeed must be supersonic and within 10 % of the airspeed corresponding to the maximum operating Mach number (MMO) of the aeroplane. This way it is ensured that the SAR is measured sufficiently close to the aeroplane's supersonic design Mach number. Within those boundaries, it is assumed that SAR-optimal combinations of altitude and airspeed are likely to be chosen by the applicants, as otherwise the resulting SAR values would be adversely affected.

SAR measurements at subsonic speed are proposed to be obligatory in addition to measurements at supersonic cruise speed, to reflect the aeroplane's subsonic fuel efficiency that is relevant for operations over land. For such measurements, it is proposed to reuse the same reference masses as for the supersonic measurements, and to retain the flexibility for the applicant to select combinations of altitude and subsonic airspeed for these additional SAR points.

A proposed wording for the requirements for reference altitudes and speeds can be found in Section 4.3, Proposals CO_2-2 through CO_2-4.

3.3.4. Further reference conditions, test procedures, reference geometric factor (RGF)

While aircraft mass, altitude, and speed are the primary influencing factors that determine an aircraft's SAR on a point-performance basis, the **definition of reference conditions** needs to include **further parameters** to ensure repeatability and comparability of SAR measurements. This includes, for example, requirements for atmospheric conditions. For subsonic aircraft, reference conditions beyond mass, altitude, and airspeed are defined in ICAO Annex 16, Volume III, Part II, Section 2.5.1(c) through 2.5.1(l). No need to deviate from these requirements was identified, and it is proposed to reuse these subsonic requirements (see Section 4.3, Proposal CO_2-6).

Similarly, the requirements for **test procedures** in ICAO Annex 16, Volume III, Part II, Section 2.6 for subsonic aeroplanes could remain unchanged for use in SST aeroplane certification, as proposed in Section 4.3, Proposal CO_2-7. Those provisions for subsonic aeroplanes refer to Appendix 1 to ICAO Annex 16, Volume III, which contains further provisions for SAR test and measurement conditions. While no need for major updates to Appendix 1 was identified to ensure compatibility with SST aeroplanes, it is proposed to conduct an in-depth review of the Appendix 1 contents, including an assessment of required stability conditions for SAR measurement and of the requirements for the accuracy of the SAR measurement system (see Section 4.3, Proposal CO_2-10). The proposed assessments are expected to be conducted under RMT.0733, and completed by the time of publication of a potential related NPA.

A **reference geometric factor (RGF)** is defined in Appendix 2 to ICAO Annex 16, Volume III, and is required for calculating a CO_2 metric value (MV) for subsonic aeroplanes. RGF is a generic measure of usable space in the cabin, and within the metric system, it represents a proxy for payload capability.

The RGF, which is a dimensionless parameter, can be determined with acceptable effort even for complex fuselage/cabin geometries, and no need to modify the RGF definition for SST aeroplanes was identified. It is therefore proposed to reuse specifications from Appendix 2 to calculate the RGF for SST aeroplanes (see Section 4.3, Proposal CO_2-11).

3.3.5. CO_2 metric-value definition

For subsonic aeroplanes and according to ICAO Annex 16, Volume III, a measured SAR is combined with an RGF to obtain a CO_2 emission evaluation metric value (MV) as follows:

$$CO2\ MV = \frac{\left(\frac{1}{SAR}\right)_{AVG}}{(RGF)^{0.24}}$$

The **CO_2 metric value (MV)** is defined as the reciprocal value of the SAR (averaged for the three reference points and measured in units of kg fuel per km range) divided by an RGF with an exponent. The exponent of 0.24 in the denominator of the MV definition is there to balance the effects of aircraft capacity (RGF) against range (MTOM) within the metric system[13].

Different views and concepts were brought forward in pre-consultation meetings on whether this MV definition should be retained for SST aeroplanes. Two options were identified in principle, which are summarised below as Option 1 and Option 2:

— Option 1: the existing MV definition for subsonic aircraft is applied without changes.

As the CO_2 MV is based on SAR (as a measure of fuel consumption) and RGF (as a measure of cabin size or, more generally, transport capability), it represents a valid measure of fuel efficiency for any aircraft design.

An advantage of Option 1 is the resulting comparability of CO_2 MVs between subsonic and supersonic aeroplane designs, while the impact of the design speed on fuel-efficiency would have to be considered separately when defining a CO_2 limit.

— Option 2: the MV definition is adapted to SST aeroplanes by integrating a speed parameter.

In this approach, the CO_2 MV definition is modified for use with SST aeroplanes by integrating a speed parameter into the MV. Such approach considers the dependency between design speed and achievable fuel-efficiency directly in the MV, such that aircraft with different design speeds, but similar technology level, would reach similar CO_2 MVs. This may simplify the definition of a technologically feasible CO_2 limit. Disadvantages of Option 2 are the lack of available data to assess alternative MV definitions in the short term, and the resulting disconnection between CO_2 MV of SST aeroplanes and their actual fuel efficiency.

Option 1 is proposed in this A-NPA to establish initial CO_2 requirements to ensure comparability of CO_2 MVs between subsonic and supersonic designs. This does not exclude further assessments of potential modifications to the MV definition, which could be performed once data for different SST aeroplane designs becomes available.

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[13] The exponent was defined based on information on a wide range of subsonic aeroplane types. Adapting the exponent specifically to SST aeroplanes would require data for different SST aeroplane designs, which is not available.

As can be seen from Proposal CO_2-8 (see Section 4.3), two separate MVs are proposed to be calculated, based on measured SARs at supersonic and subsonic speeds respectively. For transparency reasons, the proposal includes the requirement for EASA to publish the MVs.

3.3.6. Maximum permitted CO_2 emissions

The maximum permitted CO_2 emissions metric value (MV) (the 'CO_2 limit') is specified for subsonic aircraft as a function of the MTOM in ICAO Annex 16, Volume III, Part II, Section 2.4. Similarly, a CO_2 limit for SST aeroplanes should be defined by also considering the dependency between design speed and achievable fuel efficiency (see Proposal CO_2-9). For SST aeroplanes, such limit could apply to the supersonic CO_2 MV, which represents fuel efficiency at design conditions, while the subsonic CO_2 MV would serve as an additional reporting parameter that is provided for information.

Unlike the LTO noise levels, where existing Chapter 14 limits for subsonic aircraft are within reach also for supersonic aeroplane designs, the CO_2 MVs of supersonic aircraft are expected to be approximately 2–3 times higher than the CO_2 limit for new subsonic aeroplane types. The definition of a specific CO_2 limit for SST aeroplanes without robust reference data would be lacking the level of technical robustness, which is expected from a regulatory requirement. Therefore, further work is proposed on this matter, and no specific CO_2 Limit for SST aeroplanes is proposed in this A-NPA. More robust data covering a range of different SST aeroplane designs is required to assess the technological feasibility of potential CO_2 limits, and to further evaluate trade-offs between noise and CO_2 emissions, as required by Annex III to the Basic Regulation.

The provisions for the measurement and reporting of SAR, RGF, and CO_2 MVs for SST aeroplanes contained in this A-NPA, can be seen as an interim step towards a full CO_2 standard equivalent to the requirements for subsonic aeroplanes in ICAO Annex 16, Volume III. This interim step allows for standardised measurement and data provision by the manufacturers of SST aeroplanes, with the objective to increase transparency in the fuel efficiency and CO_2 emissions of such aircraft. The concepts and preliminary draft requirements proposed in this A-NPA also support further work towards defining a CO_2 limit for SST aeroplanes in the longer term.

4. How the proposed concepts could be reflected in draft regulatory material

4.1. Scope of the preliminary draft requirements

Initial proposals for how this concept may be reflected later in draft certification requirements for LTO noise and CO_2 emissions of SST aeroplanes are presented in Sections 4.2 and 4.3. In line with the scope of this A-NPA, as described in Section 2.2 the below sections do not represent a complete set of regulatory material, which typically includes requirements, acceptable means of compliance (AMC) and guidance material (GM). Instead, their scope is limited to key technical provisions, as those contained in similar form for subsonic aircraft in ICAO Annex 16, Volumes I and III, and to implementing the concepts and adaptations for SST aeroplanes, as described in Chapter 4 of this A-NPA. For subsonic aeroplanes, the corresponding ICAO Annex 16 chapters and appendices are referenced as environmental protection requirements for a type certificate or restricted type certificate in point 21.B.85 of Annex I (Part 21) to Regulation (EU) No 748/2012. Applicants for a type certificate (e.g. aircraft manufacturers) must demonstrate compliance with such requirements during type certification.

As explained, the below proposals represent a first step towards environmental protection requirements for SST aeroplanes, to be further developed in subsequent rulemaking steps. They may also inform and support discussions within the ICAO CAEP, which is working towards international SARPs for SST aeroplanes, as stated in Section 2.2.

4.2. Preliminary draft requirements for LTO noise of SST aeroplanes

Unless otherwise stated, references to other sections in the preliminary draft noise requirements below should be understood as cross-references within these draft noise requirements.

Proposal N-1 Applicability

1.1 The requirements shall be applicable to all supersonic jet aeroplanes[14], including their derived versions, for which the application for a type certificate was submitted on or after *[date to be defined]*.

1.2 Notwithstanding 1.1, the following situations do not require demonstration of compliance with the provisions of these Noise Requirements:

(a) gear down flight with one or more retractable landing gear down during the entire flight;

(b) spare engine and nacelle carriage external to the skin of the aeroplane (and return of the pylon or other external mount); and

(c) time-limited engine and/or nacelle changes, where the change in type design specifies that the aeroplane may not be operated for a period of more than 90 days unless compliance with the provisions of this standard is shown for that change in type design. This applies only to changes resulting from a required maintenance action.

Rationale

The preliminary draft requirements for LTO noise certification of SST aeroplanes are intended to apply to all supersonic jet aeroplanes, independent of their number of engines, MTOM, or design speed (see Section 3.2.1 of this A-NPA).

Proposal N-2 Noise measurements

2.1 Noise evaluation measure

The noise evaluation measure shall be the effective perceived noise level in EPNdB as described in the Appendix.

Rationale

Using the same noise evaluation measure as for subsonic jet aeroplanes allows for a direct comparison of noise levels between subsonic and supersonic aircraft (see Section 3.2.2 of this A-NPA).

Proposal N-3 Noise measurement points

3.1 An aeroplane, when tested in accordance with this requirement, shall not exceed the maximum noise levels specified in Section 4 at the following points:

[14] A supersonic aeroplane is capable of sustaining level flight at speeds exceeding a Mach number of 1.

(a) lateral full-power reference noise measurement point for jet-powered aeroplanes: the point on a line parallel to and 450 m from the runway centre line, where the noise level is a maximum during take-off;

(b) flyover reference noise measurement point: the point on the extended centre line of the runway and at a distance of 6 500 m from the start of roll; and

(c) approach reference noise measurement point: the point on the ground, on the extended centre line of the runway, 2 000 m from the threshold. On level ground this corresponds to a position 120 m (394 ft) vertically below the 3° descent path originating from a point 300 m beyond the threshold.

3.2 Test noise measurement points

3.2.1 If the test noise measurement points are not located at the reference noise measurement points, any corrections for the difference in position shall be made in the same manner as the corrections for the differences between test and reference flight paths as described in the Appendix.

3.2.2 Sufficient lateral test noise measurement points shall be used to demonstrate that the maximum noise level on the appropriate lateral line has been clearly determined. Simultaneous measurements shall be made at the test noise measurement point for which the maximum noise level occurs at a symmetrical position on the other side of the runway.

Rationale

Using the same noise measurement points as for subsonic jet aeroplanes allows for a direct comparison of the resulting noise levels (see Section 3.2.2 of this A-NPA).

Proposal N-4 Maximum noise levels

4.1 The maximum noise levels shall not exceed the following:

4.1.1 At the lateral full-power reference noise measurement point:

103 EPNdB for aeroplanes with maximum certificated take-off mass, at which the noise certification is requested, of 400 000 kg and over, decreasing linearly with the logarithm of the mass down to 94 EPNdB at 35 000 kg, after which the limit is constant to 8 618 kg, where it decreases linearly with the logarithm of the mass down to 88.6 EPNdB at 2 000 kg, after which the limit is constant.

4.1.2 At the flyover reference noise measurement point:

(a) Aeroplanes with two engines or less:

101 EPNdB for aeroplanes with maximum certificated take-off mass, at which the noise certification is requested, of 385 000 kg and over, decreasing linearly with the logarithm of the mass at the rate of 4 EPNdB per halving of mass down to 89 EPNdB, after which the limit is constant to 8 618 kg, where it decreases linearly

with the logarithm of the mass at a rate of 4 EPNdB per halving of mass down to 2 000 kg, after which the limit is constant.

(b) Aeroplanes with three engines:

As under (a) but with 104 EPNdB for aeroplanes with maximum certificated take-off mass of 385 000 kg and over.

(c) Aeroplanes with four engines or more:

As under (a) but with 106 EPNdB for aeroplanes with maximum certificated take-off mass of 385 000 kg and over.

4.1.3 At the approach reference noise measurement point:

105 EPNdB for aeroplanes with maximum certificated take-off mass, at which the noise certification is requested, of 280 000 kg and over, decreasing linearly with the logarithm of the mass down to 98 EPNdB at 35 000 kg, after which the limit is constant to 8 618 kg, where it decreases linearly with the logarithm of the mass down to 93.1 EPNdB at 2 000 kg, after which the limit is constant.

4.1.4 The sum of the differences at all three measurement points between the maximum noise levels and the maximum permitted noise levels specified in 4.1.1, 4.1.2 and 4.1.3, shall not be less than 17 EPNdB.

4.1.5 The maximum noise level at each of the three measurement points shall not be less than 1 EPNdB below the corresponding maximum permitted noise level specified in 4.1.1, 4.1.2 and 4.1.3.

4.1.6 Table 1 lists the equations to be used for calculating the maximum noise level at each of the three measurement points:

<table>
<tr><th colspan="2">M = Maximum take-off mass in 1 000 kg</th><th>0</th><th>2</th><th>8.618</th><th>20.234</th><th>28.615</th><th>35</th><th>48.125</th><th>280</th><th>385</th><th>400</th></tr>
<tr><td colspan="2">Lateral full-power noise level (EPNdB)
All aeroplanes</td><td>88.6</td><td>86.03754 + 8.512295 log M</td><td colspan="3">94</td><td colspan="4">80.86511 + 8.50668 log M</td><td>103</td></tr>
<tr><td colspan="2">Approach noise level (EPNdB)
All aeroplanes</td><td>93.1</td><td>90.77481 + 7.72412 log M</td><td colspan="3">98</td><td colspan="2">86.03167 + 7.75117 log M</td><td colspan="3">105</td></tr>
<tr><td rowspan="3">Flyover noise levels (EPNdB)</td><td>2 engines or less</td><td rowspan="3">80.6</td><td rowspan="3">76.57059 + 13.28771 log M</td><td colspan="4">89</td><td colspan="2">66.64514 + 13.28771 log M</td><td colspan="2">101</td></tr>
<tr><td>3 engines</td><td colspan="2">89</td><td colspan="4">69.64514 + 13.28771 log M</td><td colspan="2">104</td></tr>
<tr><td>4 engines or more</td><td>89</td><td colspan="5">71.64514 + 13.28771 log M</td><td colspan="2">106</td></tr>
</table>

Table 1 — Equations for calculating the noise limits for individual maximum take-off masses

Rationale

The noise limits correspond to the noise limits for subsonic jet aeroplanes in Chapter 14 of ICAO Annex 16, Volume I, in order to maintain the current level of environmental protection in Europe, and ensure a level playing field between subsonic and supersonic jet aircraft (see Section 3.2.3 of this A-NPA).

Proposal N-5.1 Noise certification reference procedures — General conditions

5.1 General conditions

5.1.1 The reference procedures shall comply with the appropriate airworthiness requirements.

5.1.2 The calculations of reference procedures and flight paths shall be approved by the European Union Aviation Safety Agency (EASA).

5.1.3 Except in conditions specified in 5.1.4, the take-off procedures shall be those defined in 5.2 or 5.3, and the approach reference procedure shall be that defined in 5.4.

5.1.4 When it is shown by the applicant that the design characteristics of the aeroplane would prevent flight being conducted in accordance with 5.2, 5.3 and 5.4, the reference procedures shall:

(a) depart from the reference procedures defined in 5.2, 5.3 and 5.4 only to the extent demanded by those design characteristics which make compliance with the procedures impossible; and

(b) be approved by EASA.

5.1.5 The reference procedures as specified in points 5.2, 5.3, and 5.4 shall be calculated under the following reference atmospheric conditions:

(a) atmospheric pressure at sea level of 1 013.25 hPa, decreasing with altitude at a rate defined by the ICAO Standard Atmosphere;

(b) ambient air temperature at sea level of 25 °C, decreasing with altitude at a rate defined by the ICAO Standard Atmosphere (i.e. 0.65 °C per 100 m);

(c) constant relative humidity of 70 per cent;

(d) zero wind;

(e) for the purpose of defining the reference take-off profiles for both take-off and lateral noise measurements, the runway gradient is zero; and

(f) the reference atmosphere in terms of temperature and relative humidity is considered to be homogeneous (i.e. ambient temperature 25 °C and relative humidity 70 per cent) for the purpose of calculating:

(i) the reference sound attenuation rate due to atmospheric absorption; and

(ii) the reference speed of sound used in the calculation of the reference sound propagation geometry.

Rationale

The preliminary draft requirements correspond to those for subsonic jet aeroplanes, with the exception of the take-off reference procedures that are specified in Proposals N-5.2 and N-5.3 (see Section 3.2.4 of this A-NPA).

Proposal N-5.2 Noise certification reference procedures — Take-off reference procedure without VNRS

5.2 Take-off reference procedure without variable noise reduction systems (VNRS)

5.2.1 The take-off reference flight path shall be calculated as follows:

(a) average engine take-off thrust shall be used from the start of take-off to the point where at least the following height above runway level is reached:

(1) aeroplanes with two engines or less — 300 m (984 ft);

(2) aeroplanes with three engines — 260 m (853 ft);

(3) aeroplanes with four engines or more — 210 m (689 ft);

the take-off thrust to be used in this phase shall be the maximum available for normal operations as scheduled in the performance section of the aeroplane flight manual for the reference atmospheric conditions defined in 5.1.5;

(b) upon reaching the height specified in (a) above, the thrust shall not be reduced below that required to maintain:

(1) a climb gradient of 4 per cent; or

(2) in the case of multi-engined aeroplanes, level flight with one engine inoperative,

whichever thrust is greater;

(c) for the purpose of determining the lateral full-power noise level, the reference flight path shall be calculated on the basis of using the maximum available take-off thrust throughout without a thrust reduction;

(d) the speed:

(1) shall be the all-engines operating take-off climb speed selected by the applicant for use in normal operation, which shall be at least V2 + 65 km/h (V2 + 35 kt) but not greater than V2 + 102 km/h (V2 + 55 kt) and which shall be attained as soon as practicable after lift-off and be maintained throughout the take-off noise certification test. The increment applied to V2 shall be the same for all reference masses of an aeroplane model unless a difference in increment is substantiated based on performance characteristics of the aeroplane; and

Note: V2 is defined in accordance with the applicable airworthiness requirements as the minimum airspeed for a safe take-off approved by EASA.

(2) shall be not greater than 463 km/h (250 kt).

(e) a constant take-off configuration selected by the applicant shall be maintained throughout the take-off reference procedure except that the landing gear may be retracted. Configuration shall be interpreted as meaning the conditions of the systems and centre of gravity position and shall include the position of lift augmentation devices used, whether the APU is operating, and whether air bleeds are operating;

(f) the mass of the aeroplane at the brake release shall be the maximum take-off mass at which the noise certification is requested; and

(g) the average engine shall be defined by the average of all the certification-compliant engines used during the aeroplane flight tests up to and during certification when operated to the limitations and procedures given in the flight manual. This will establish a technical standard including the relationship of thrust to control parameters (e.g. N1 or EPR). Noise measurements made during certification tests shall be corrected to this standard.

Rationale

The take-off procedure without VNRS corresponds to the take-off procedure for subsonic jet aeroplanes, but with adapted speeds. This procedure is envisaged for SST aeroplanes without VNRS systems installed (see Section 3.2.4 of this A-NPA).

Proposal N-5.3 Noise certification reference procedures — Take-off reference procedure with VNRS

5.3 Take-off reference procedure with variable noise reduction systems (VNRS)

5.3.1 The take-off reference flight path using VNRS shall be calculated as follows:

(a) the most critical (that which produces the highest noise level) configuration shall be used;

(b) average engine take-off thrust shall be used from the start of take-off to the point where the applicant's VNRS design provides input to the controls of the aeroplane. Any reduction of the thrust through the VNRS design shall not result in a thrust lower than 75 per cent of the maximum available take-of thrust;

(c) by synthesis from segments as defined by the applicant's VNRS design using the reference atmospheric conditions stated in 5.1.5 above:

(1) the segments shall be related to the changes in the configuration (engine or airframe), thrust, and/or speed, including transition time for any engine and control surface configuration changes commanded by the VNRS design approved by EASA. The segments shall be approved by EASA; and

(2) configuration changes, and the thrust profiles must be determined by the applicant's VNRS design corresponding to the mass of the aeroplane and approved by EASA;

(d) upon reaching a height above runway of at least:

(1) for aeroplanes with two engines or less — 300 m (984 ft);

(2) for aeroplanes with three engines — 260 m (853 ft);

(3) for aeroplanes with four engines or more — 210 m (689 ft);

the thrust might be reduced to that required to maintain:

(i) a climb gradient of 4 per cent; or

(ii) in the case of multi-engined aeroplanes, level flight with one engine inoperative,

whichever thrust is greater;

(e) if thrust cutback as defined under d) above is used, the configuration of the aeroplane shall not be changed after thrust cutback;

(f) take-off thrust used shall be the maximum available for normal operations as scheduled in the performance section of the aeroplane flight manual for the reference atmospheric conditions defined in 5.1.5;

(g) the speed shall be based on the applicant's VNRS design; the speed for each segment shall be at least V2 + 65 km/h (V2 + 35 kt) but not greater than V2 + 102 km/h (V2 + 55 kt). In any case the speed shall be not greater than 463 km/h (250 kt);

Note: V2 is defined in accordance with the applicable airworthiness requirements as the minimum airspeed for a safe take-off.

(h) the mass of the aeroplane at the brake release shall be the maximum take-off mass at which the noise certification is requested; and

(i) the average engine shall be defined by the average of all the certification compliant engines used during the aeroplane flight tests up to and during certification when operated to the limitations and procedures given in the flight manual; this will establish a technical standard including the relationship of thrust to control parameters (e.g. N1 or EPR); noise measurements made during certification tests shall be corrected to this standard.

Rationale

The take-off procedure with VNRS is envisaged for SST aeroplanes with VNRS installed (see Section 3.2.4 of this A-NPA).

Proposal N-5.4 Noise certification reference procedures — Approach reference procedure

5.4 Approach reference procedure

The approach reference flight path shall be calculated as follows:

(a) the aeroplane shall be stabilised and following a 3° glide path;

(b) a steady approach speed of VREF + 19 km/h (VREF + 10 kt), with thrust stabilised, shall be maintained over the measurement point;

Note: in airworthiness terms VREF is defined as the 'reference landing speed'. Under this definition reference landing speed means 'the speed of the aeroplane, in a specified *landing configuration, at the point where it descends through the landing screen height in the determination of the landing distance for manual landings'.*

(c) the constant approach configuration as used in the airworthiness certification tests, but with the landing gear down, shall be maintained throughout the approach reference procedure;

(d) the mass of the aeroplane at the touchdown shall be the maximum landing mass permitted in the approach configuration defined in 5.4(c) at which noise certification is requested; and

(e) the most critical (that which produces the highest noise level) configuration with deployment of aerodynamic control surfaces including lift and drag producing devices that is approved by EASA, at the mass at which certification is requested shall be used; this configuration includes all those items listed in the Appendix, that will contribute to the noisiest continuous state at the maximum landing mass in normal operation.

Rationale

The approach reference procedure corresponds to the respective procedure for subsonic aeroplanes (see Section 3.2.4 of this A-NPA).

Proposal N-6 Test procedures

6.1 The test procedures and noise measurements shall be conducted and processed in an approved manner to yield the noise evaluation measure designated as effective perceived noise level, EPNL, in units of EPNdB, as described in the Appendix.

6.2 Acoustic data shall be adjusted by the methods outlined in the Appendix to the reference conditions specified in this requirement. Adjustments for speed and thrust shall be made as described in the Appendix.

6.3 If the mass during the test is different from the mass at which the noise certification is requested, the necessary EPNL adjustment shall not exceed 2 EPNdB for take-offs and 1 EPNdB for approaches. Data accepted by EASA in the applicable noise test plan and noise test report shall be used to determine the variation of EPNL with mass for both take-off and approach test conditions. Similarly, the necessary EPNL adjustment for variations in approach flight path from the reference flight path shall not exceed 2 EPNdB.

6.4 All test procedures different from the reference procedures and all methods for adjusting the results to the reference procedures shall be accepted by EASA in the applicable noise test plan and noise test report. The amounts of the adjustments shall not exceed 16 EPNdB on take-off and 8 EPNdB on approach, and if the adjustments are more than 8 EPNdB and 4 EPNdB, respectively, the resulting numbers shall be more than 2 EPNdB below the noise limits specified in Section 4.

6.5 For take-off and approach conditions, the variation in instantaneous indicated airspeed of the aeroplane must be maintained within ±3 per cent of the average airspeed between the 10 dB-down points. This shall be determined by reference to the pilot's airspeed indicator. However, when the instantaneous indicated airspeed varies from the average airspeed over the

10 dB-down points by more than ±5.5 km/h (±3 kt), and this is judged by the certificating authority representative on the flight deck to be due to atmospheric turbulence, then the flight so affected shall be rejected for noise certification purposes.

6.6 For lateral conditions the variation in instantaneous indicated airspeed of the aeroplane must be maintained within ±3 per cent of the average airspeed over each segment of constant configuration contributing to the 10 dB-down points. This shall be determined by reference to the pilot's airspeed indicator. However, when the instantaneous indicated airspeed varies from the average airspeed within a segment by more than ±5.5 km/h (±3 kt), and this is judged by the certificating authority representative on the flight deck to be due to atmospheric turbulence, then the flight so affected shall be rejected for noise certification purposes.

Rationale

The test procedures correspond to those for subsonic aeroplanes, with adapted provisions for the limitations on lateral conditions (see Section 3.2.5 of this A-NPA).

Proposal N-7 Appendix

Reserved

Next steps and rationale

The contents of this Appendix are proposed to correspond to the technical contents of Appendix 2 to ICAO Annex 16, Volume I, with the following exceptions:

— If take-off noise levels are established with an active VNRS system, the integrated method of adjustment shall be used to calculate the EPNL. The alternative simplified method is limited to aeroplane types that do not change the configuration over the flight path.

— The specifics for noise evaluations of helicopters and heavy propeller-driven aeroplanes as contained in Appendix 2 can be removed.

The above adaptations were identified in an initial assessment, pending an in-depth assessment of Appendix 2 contents to be performed before a potential NPA is issued (see Section 3.2.6 of this A-NPA).

4.3. Preliminary draft requirements for CO_2 emissions of SST aeroplanes

Unless otherwise stated, references to other sections in the preliminary draft CO_2 requirements below should be understood as cross-references within these draft CO_2 requirements.

Proposal CO_2-1 Applicability

1.1 The requirements shall be applicable to all supersonic jet aeroplanes, including their derived versions, for which the application for a type certificate was submitted on or after *[date to be defined]*.

1.2 Notwithstanding 1.1, time-limited engine and/or nacelle changes do not require demonstration of compliance with the provisions of this requirement, where the change in type design specifies that the aeroplane may not be operated for a period of more than 90 days unless compliance with the provisions of this standard is shown for that change in type design. This applies only to changes resulting from a required maintenance action.

Rationale

The proposed preliminary draft requirements for CO_2 emission certification of SST aeroplanes include provisions for measurement and reporting of CO_2 emissions, and are intended to apply to all supersonic jet aeroplanes, independent of their number of engines, MTOM, or design speed.

Proposal CO_2-2 Reporting of SAR and RGF

2.1 The CO_2 emissions evaluation is based on the reciprocal of specific air range (SAR) in cruise conditions, and a reference geometric factor (RGF) as a measure of fuselage size.

2.2 The applicant shall report the following parameters measured or computed in accordance with the provisions of this document:

(a) SAR at supersonic reference conditions, as specified in Section 3;

(b) SAR at subsonic reference conditions, as specified in Section 4;

(c) RGF, as defined in Appendix 2; and

(d) CO_2 emissions evaluation metric values derived from SAR and RGF, as specified in Section 8.

Note: both supersonic and subsonic reference conditions are defined for CO_2 emissions evaluation, as aeroplanes designed for supersonic speed may be required to fly at subsonic speed over land, depending on applicable speed restrictions.

Rationale

Reporting parameters correspond to those required for subsonic aeroplanes, with the addition of SAR in supersonic reference conditions (see Section 3.3.3 of this A-NPA).

Proposal CO_2-3 Supersonic reference conditions

3.1 Supersonic reference conditions shall consist of the following conditions within the approved normal operating envelope of the aeroplane:

(a) the aeroplane gross masses defined in Section 5;

(b) a combination of altitude and supersonic airspeed selected by the applicant;
The supersonic airspeed shall be within 10 % of the airspeed corresponding to the maximum operating Mach number (MMO) of the aeroplane at the selected altitude.

Note: These conditions are generally expected to be the combination of altitude and airspeed that results in the highest SAR value in supersonic flight close to the aeroplane's design cruise speed. The selection of conditions other than optimum conditions will be to the detriment of the applicant because the SAR value will be adversely affected.

(c) the further reference conditions as defined in Section 6.

3.2 If test conditions in supersonic flight are not the same as the supersonic reference conditions, then corrections for the differences between test and reference conditions shall be applied as described in Appendix 1.

Rationale

Reference conditions at supersonic airspeed are defined to measure SAR in favourable conditions close to the design speed of SST aeroplanes (see Section 3.3.3 of this A-NPA).

Proposal CO_2-4 Subsonic reference conditions

4.1 Subsonic reference conditions shall consist of the following conditions within the approved normal operating envelope of the aeroplane:

(a) the aeroplane gross masses defined in Section 5;

(b) a combination of altitude and subsonic airspeed selected by the applicant;

Note: these conditions are generally expected to be the combination of altitude and airspeed that results in the highest SAR value in subsonic flight. The selection of conditions other than optimum conditions will be to the detriment of the applicant because the SAR value will be adversely affected.

(c) the further reference conditions as defined in Section 6.

4.2 If test conditions in subsonic flight are not the same as the subsonic reference conditions, then corrections for the differences between test and reference conditions shall be applied as described in Appendix 1.

Rationale

Reference conditions at subsonic airspeed are defined to reflect subsonic cruise flights of SST aeroplanes over land (see Section 3.3.3 of this A-NPA).

Proposal CO_2-5 Reference aeroplane masses

5.1 The SAR values shall be established at each of the following three reference aeroplane masses, when tested in accordance with the CO_2 requirements:

(a) high gross mass: a gross mass selected by the applicant representative for initial cruise conditions on the aeroplane's design mission;

(b) mid gross mass: simple arithmetic average of high gross mass and low gross mass; and

(c) low gross mass: a gross mass selected by the applicant representative for end of cruise conditions on the aeroplane's design mission.

Note: gross mass is expressed in kilograms; the aeroplane's design mission in the context of this standard is generally expected to be a generic flight mission at supersonic cruise speed (equivalent to the aeroplane's design Mach number) and in ICAO standard atmospheric conditions, with take-off at MTOM, design payload on board, and over the maximum operational range possible for these conditions.

5.2 CO_2 emissions certification for MTOM also represents the certification of CO_2 emissions for take-off masses less than MTOM. However, in addition to the mandatory certification of CO_2 metric values for MTOM, applicants may voluntarily apply for the approval of CO_2 metric values for take-off masses less than MTOM.

Rationale

The three reference aeroplane masses are intended to cover the full range of cruise gross masses for each SST aeroplane design (see Section 3.3.2 of this A-NPA).

Proposal CO_2-6 Additional reference conditions for determining aeroplane specific range

6.1 The further reference conditions shall consist of the following conditions within the approved normal operating envelope of the aeroplane:

(a) steady (unaccelerated), straight and level flight;

(b) aeroplane in longitudinal and lateral trim;

(c) ICAO standard day atmosphere;

(d) gravitational acceleration for the aeroplane travelling in the direction of true north in still air at the reference altitude and a geodetic latitude of 45.5 degrees, based on g_0;

(e) fuel lower heating value equal to 43.217 MJ/kg (18 580 BTU/lb);

(f) a reference aeroplane centre of gravity (CG) position selected by the applicant to be representative of a mid-CG point relevant to design cruise performance at each of the three reference aeroplane masses;

Note: for an aeroplane equipped with a longitudinal CG control system, the reference CG position may be selected to take advantage of this feature.

(g) a wing structural loading condition selected by the applicant for representative operations conducted in accordance with the aeroplane's payload capability and manufacturer standard fuel management practices;

(h) applicant selected electrical and mechanical power extraction and bleed flow relevant to design cruise performance and in accordance with manufacturer recommended procedures;

Note: power extraction and bleed flow due to the use of optional equipment such as passenger entertainment systems need not be included.

(i) engine handling/stability bleeds operating according to the nominal design of the engine performance model for the specified conditions; and

(j) engine deterioration level selected by the applicant to be representative of the initial deterioration level (a minimum of 15 take-offs or 50 engine flight hours).

Rationale

The additional reference conditions (beyond mass, speed, and altitude) are specified here, and correspond to those for subsonic aeroplanes (see Section 3.3.4 of this A-NPA).

Proposal CO_2-7 Test procedures

7.1 The SAR values shall be established either directly from flight tests or from a performance model validated by flight tests.

7.2 The test aeroplane shall be representative of the configuration type design for which certification is requested.

7.3 The test and analysis procedures shall be conducted in an approved manner as described in Appendix 1. These procedures shall address the entire flight test and data analysis process, from pre-flight actions to post-flight data analysis.

Note: the fuel used for each flight test should meet the specification defined in either ASTM D1655-15[15]*, DEF STAN 91-91 Issue 7, Amendment 3*[16]*, or equivalent.*

Rationale

The preliminary draft requirements for test procedures correspond to those for subsonic aeroplanes (see Section 3.3.4 of this A-NPA).

Proposal CO_2-8 CO_2 emissions evaluation metric values

8.1 CO_2 emissions evaluation metric values (MVs) for supersonic and subsonic speeds shall be defined in terms of the average of the 1/SAR values for the three reference masses defined in

[15] ASTM D1655-15, *Standard Specification for Aviation Turbine Fuels*.

[16] Defence Standard 91-91, Issue 7, Amendment 3, *Turbine Fuel, Kerosene Type, Jet A-1*.

Section 5 and the RGF defined in Appendix 2. The metric values shall be calculated according to the following formulas:

$$CO2\ MV\ Supersonic = \frac{\left(\frac{1}{SAR}\right)_{AVG,Supersonic}}{(RGF)^{0.24}}$$

$$CO2\ MV\ Subsonic = \frac{\left(\frac{1}{SAR}\right)_{AVG,Subsonic}}{(RGF)^{0.24}}$$

Note: the metric values are quantified in units of kg/km. The CO_2 emissions evaluation metric is a specific air range (SAR)-based metric adjusted to take into account fuselage size.

8.2 The CO_2 emissions evaluation metric values shall be determined in accordance with the evaluation methods described in Appendix 1.

8.3 EASA shall publish the certified CO_2 emissions evaluation metric values.

Rationale

The definition of the CO_2 MV corresponds to the existing definition for subsonic aeroplanes (see Section 3.3.5 of this A-NPA). Two separate MVs are required to be established, representing cruise performance at supersonic and subsonic speeds respectively.

Proposal CO_2-9 Maximum permitted CO_2 emission evaluation metric values

Note: maximum permitted CO_2 emission evaluation metric values are not yet established.

Rationale

The current preliminary draft requirements for CO_2 emissions do not yet contain a CO_2 limit. Further work is required to define such a limit, as explained in Section 3.3.6 of this A-NPA.

Proposal CO_2-10 Appendix 1 — Determination of the aeroplane CO_2 emissions evaluation metric value

Reserved

Next steps and rationale

The contents of Appendix 1 are proposed to be based on the technical contents of Appendix 1 to ICAO Annex 16, Volume III, pending further assessment.

While no need for major updates to the contents of Appendix 1 has been identified, an in-depth review is proposed before an NPA is issued, to further assess the suitability of the Appendix 1 contents for SST aeroplanes, including in particular the stability conditions for the SAR measurement, and the requirements for the accuracy of the SAR measurement system, as explained in Section 3.3.4 of this A-NPA.

Proposal CO_2-11 Appendix 2 — Reference geometric factor (RGF)

Reserved

Next steps and rationale

The contents of Appendix 2 are proposed to correspond to the contents of Appendix 2 to ICAO Annex 16, Volume III. The reference geometric factor (RGF) as defined in Appendix 2 represents a universal measure of cabin size, as explained in Section 3.3.4 of this A-NPA.

5. Impact assessment (IA)

A regulatory impact assessment (RIA) is planned to be developed, using qualitative and/or quantitative input in line with evidence-based policymaking, and focusing on major and complex items. The RIA is planned to be included in a potential future NPA, which will also assess trade-offs between LTO noise and CO_2 emission performance of supersonic aeroplane designs.

6. References

6.1. Related EU regulations

Commission Regulation (EU) No 748/2012 of 3 August 2012 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations (OJ L 224, 21.8.2012, p. 1)

6.2. Related EASA decisions

— Decision No. 2003/4/RM of the Executive Director of the Agency of 17 October 2003 on certification specifications providing for acceptable means of compliance for aircraft noise (CS-36)

— Executive Director Decision 2019/016/R of 29 July 2019 issuing the Certification Specifications, Acceptable Means of Compliance and Guidance Material for Aeroplane CO_2 Emissions (CS-CO_2) 'CS-CO_2 — Issue 1'

6.3. Other references

— Dassault Aviation, *HISAC Publishable Activity Report*, Report No HISAC-T-6-26-1, 2018

— European Union Aviation Safety Agency (EASA), *Position Paper on Environmental Compatibility of Supersonic Transport Aeroplanes (SST)*, IP No AI 7 of MAB 2020-02, May 2020

— Federal Aviation Administration (FAA), *Proposed Rule for Noise Certification of Supersonic Airplanes*, April 2020

— International Civil Aviation Organization (ICAO), Annex 16 to the Convention on International Civil Aviation, Environmental Protection, Volume I —Aircraft Noise, Eighth Edition/Amendment 13, July 2020

— ICAO, Annex 16 to the Convention on International Civil Aviation, Environmental Protection, Volume III — Aeroplane CO_2 Emissions, First Edition/Amendment 1, July 2020

— ICAO CAEP, Working Paper CAEP/12-WP/31: ESTG – CO_2 (Remit E.13), November 2021,

— ICAO CAEP, Working Paper CAEP/12-WP/39: Supersonic Exploratory Study Report: Final Report, February 2022

— ICAO CAEP, Working Paper CAEP/12-WP/68 by the International Coordinating Council of Aerospace Industries Associations (ICCAIA): *Position on Supersonic LTO Noise SARP in CAEP/13 Future Work Programme*, February 2022

— ICAO CAEP, Working Group 3 (WG3), Information Paper CAEP/12-WG3/3-ESTG/3-IP/01 by EASA: *CO_2 Metric Value Estimation for NASA 55t SST*, February 2020

7. List of abbreviations

The following is a list of abbreviations used in this document:

A-NPA	Advance notice of proposed amendment
AMC	Acceptable means of compliance
CG	Centre of gravity
CRT	Comment-Response Tool
CAEP	Committee on Aviation Environmental Protection
CS	Certification specification
EPNdB	Effective perceived noise decibels
EPNL	Effective perceived noise level
EPR	Engine pressure ratio
EASA	European Union Aviation Safety Agency
FAA	Federal Aviation Administration
g_0	Standard acceleration due to gravity at sea level and a geodetic latitude of 45.5 degrees, 9.80665 (m/s^2)
GM	Guidance material
IA	Impact assessment
ICAO	International Civil Aviation Organization
ICCAIA	International Coordinating Council of Aerospace Industries Associations
LTO	Landing-and-take-off
MB	Management Board
MMO	Maximum operating Mach number
MTOM	Maximum take-off mass
MTOW	Maximum take-off weight
MZFM	Maximum zero-fuel mass
MS	Member State
MV	Metric value

N1	Compressor speed: the turbine engine low pressure compressor first stage fan speed
NCA	National competent authority
NPA	Notice of proposed amendment
PLR	Programmed lapse rate
RGF	Reference geometric factor
RIA	Regulatory impact assessment
RMT	Rulemaking task
SAR	Specific air range
SARPs	Standards and Recommended Practices
SST	Supersonic transport
TEG	Technical Expert Group
ToR	Terms of reference
VNRS	Variable noise reduction system(s)
WG3	Working Group 3 (Emissions) of ICAO CAEP

8. Appendix

EASA RMT.0733 – Questionnaire for OEMs

1. General Questions concerning SST Projects

Please reply to the following general questions:

(1) Please provide specifications of your current civil supersonic aeroplane designs, if any, or designs you contribute to (including number of engines, MTOM, MLW, range, payload/passenger capacity, maximum operating range and design Mach numbers, engine manufacturer (if selected)).

(2) Can you provide conceptual studies or project-based data that quantify LTO noise and fuel-efficiency/CO_2 emissions of civil supersonic designs?

(3) Which design targets for supersonic aeroplanes do you consider appropriate regarding fuel-efficiency/CO_2 emissions and LTO noise while striving to meet Chapter 14 noise limits?

(4) Are LTO noise, fuel efficiency/CO_2 emissions and engine emissions interrelated? Can you quantify any trade-offs between these domains?

2. Questions concerning LTO Noise of SST Aeroplanes

Please reply to the following noise-related questions:

(1) Which noise mitigation technologies do you consider appropriate for a new generation SST aeroplane design? Which additional noise mitigation technologies are available, but challenging to implement, and why?

(2) Regarding procedures and conditions for LTO noise measurements, which aspects of current provisions from ICAO Annex 16 Volume I for subsonic aircraft do you consider a priority for being adapted for supersonics?

(3) Lateral noise measurement point:

It is EASA's position that the same lateral noise measurement point should be used for supersonic aircraft as for subsonic aircraft. The lateral noise measurement point is associated to the point where the maximum noise level occurs during take-off. To establish the aircraft height at which the lateral maximum noise level occurs, the applicants generally conduct an equivalent procedure flying the aircraft at different heights.

Question 3A: Can it be assumed that the lateral noise level for supersonic aircraft can be established based on equivalent procedures similar to those for subsonic aircraft?

Question 3B: Do you expect the typical height for the maximum noise level at lateral to be substantially different for SST in comparison to subsonic aeroplanes? Can it be excluded that the maximum lateral noise level occurs while the aircraft accelerates on the runway prior to PLR application?

(4) Take-off thrust cutback for fly-over noise measurement point:

Question: Annex 16 Volume I for the fly-over certification point allows a thrust cutback during take-off when the aircraft reaches a specific height (e.g. 300m for two engine aeroplanes). Can it be assumed that a thrust cutback procedure will be used by the applicants for supersonic aircraft?

(5) Programmed Lapse Rate (PLR):

Question 5A: How do you foresee that PLR might be introduced for supersonic aircraft? (When, to which percent of max thrust, in one step or in more?). Are there any limitations/requirements from the airworthiness side that have to be considered?

Question 5B: What could be a standardised PLR reference procedure for noise certification?

(6) Take-off thrust:

Question: In normal operating conditions, can it be expected that thrust will increase again after PLR has reduced the thrust during take-off? If so, please explain.

(7) Take-off reference speed:

Annex 16 Volume I stipulates a reference speed (a speed range) needs to be specified for take-off noise measurement.

Question: What is an appropriate speed range in terms of V2 + x for an SST? Is it likely that the SST will change the speed during take-off (e.g. “accelerated climb”)?

(8) Take-off reference configuration:

For subsonic aeroplanes a constant configuration in terms of flap/slat setting has to be chosen.

Questions: How likely do you consider the case that flap/slat setting changes need to be accounted for during take-off noise certification of supersonic aircraft? Are there any other configuration changes specific to SST to be accounted for?

(9) Approach reference configuration:

Questions: Should noise requirements for supersonics take into consideration Variable Noise Reduction Systems (VNRS) systems during approach? If so, which ones? What could be standardised reference conditions for noise certification, associated to such VNRS schedules?

(10) Approach reference speed:

Question: Is VREF + 10 kt an appropriate speed for SST during landing?

3. Questions concerning CO_2 Emissions of SST Aeroplanes

Please reply to the following CO_2-related questions:

(1) Which technologies for fuel efficiency improvement and mitigation of CO_2 emissions do you consider appropriate for a new generation SST aeroplane design? Which additional technologies for fuel efficiency/CO_2 improvements are available, but challenging to implement, and why?

(2) Regarding procedures and conditions for SAR measurement and RGF determination, which aspects of current provisions from ICAO Annex 16 Volume III for subsonic aeroplanes do you consider a priority for being adapted for supersonics?

(3) Which type of fuel (which fuel specifications) do you foresee to be used for the next generation of civil supersonic aeroplane designs?

(4) Reference masses for SAR measurement:

EASA considers the reference mass definitions from Annex 16 Volume III not fully suitable for supersonic aeroplane designs.

Question 4A: How could reference masses representative for cruise conditions be defined for supersonic aeroplanes?

Question 4B: Could high gross mass / low gross mass be defined as masses selected by the applicant corresponding to initial / final cruise masses on the aeroplane's design mission?

(5) Reference speeds and altitudes for SAR measurement:

ICAO Annex 16 Volume III for subsonic aeroplanes leaves the selection of altitude and airspeed for SAR measurements up to the applicant, with the assumption that the applicant will measure at SAR-optimal combinations of speed and altitude.

Question 5A: Do you consider the same principle to be feasible for supersonic aeroplanes, with the additional requirement that reference speeds shall be supersonic?

Question 5B: What is the relation between design speed, the speed of maximum supersonic SAR and the maximum operating speed of civil supersonic aeroplanes?

(6) SAR measurement:

Appendix 1 of ICAO Annex 16 Volume III lays out in sections 2 through 6 detailed flight test and measurement provisions for SAR, including requirements for the measurement system, corrections to reference conditions, and validity of results.

Question: Do you see the need for adapting provisions from Appendix 1, sections 2-6, for the purpose of determining SAR for supersonic aeroplanes? If so, which provisions should be adapted and how?

(7) Reference Geometric Factor (RGF):

ICAO Annex 16 Volume III defines a reference geometric factor (RGF) as a measure of fuselage size.

Question: Do you see the need for adapting provisions from ICAO Annex 16 Volume III and its Appendix 2 concerning the RGF for SSTs? If so, how would the provisions need to be adapted?

(8) Metric Value definition:

ICAO Annex 16 Volume III in section 2.2 defines a CO_2 emissions evaluation metric value, for the purpose of comparison to an MTOM-dependent limit.

Question: Do you see the need for adapting the CO_2 metric value definition for supersonic aeroplanes? What are consequences if it was used without adaptation?

(9) Fuel efficiency, CO_2 limit:

Question 9A: What is the expected fuel efficiency of supersonic aeroplane designs compared to subsonic aeroplanes with similar technology level and payload-range performance?

Question 9B: How could a CO_2 limit for supersonic aeroplanes be defined?