【欧州】【航空】

Aviation – Gas emissions: ACI calls on ICAO to develop standards for supersonic aircraft, including noise and emission standards

Andrea Antolini　Former Researcher JTTRI

【概要：Summary】

The first era of supersonic jets ended with the Concorde's last commercial flight in 2003. However, in recent years, some aircraft manufacturers and start-up companies have considered the introduction of a new generation of supersonic aircraft. Advances in aerodynamic design, materials and propulsion have also increased the feasibility of a revival of supersonic passenger flights. There are several types of new civil supersonic aircraft under development, and they could be ready to become operational by the mid-2020s.

However, there exist public and political concerns about these supersonic jets' GHG emissions, air pollution and noise. The fear is that such a new generation of supersonic aircraft could become the worst polluters regarding their amount of CO2 emissions per passenger. The Airports Council International (ACI) World is concerned that the reintroduction of the next generation of supersonic aircraft could occur without having appropriate environmental and operational standards and practices in place. Therefore, the ACI called on the International Civil Aviation Organization (ICAO) to properly address the supersonic jets' potential impact on the environment, airport operations and the public. Considering that there is strong pressure on airports to reduce their noise and emissions footprints, and generally reduce the impact of aviation on their communities, ACI insists that the re-introduction of supersonic aircraft should be accompanied with measures for the supersonic aircraft to meet the latest ICAO standards for their subsonic counterparts. Accordingly, since existing rules for civil supersonic air travel are out-dated, the ICAO should introduce new emission and noise standards for the new generation of supersonic jets before they enter the market.

The ACI calls on the ICAO for introducing appropriate standards and practices for supersonic aircraft to properly address their potential impact on the environment and airport operations. The aviation industry needs to focus on the sustainability aspect of their supersonic aircraft, including alternative fuels and new engine technology, rather than new speed records.

【記事：Article】

1. Background of the supersonic jet's revival

The French-British jointly developed supersonic jet Concorde is as turbojet-powered supersonic passenger aircraft, which was operated by Air France and British Airways from 1976 until 2003. The Concorde planes had a maximum speed of Mach 2.04, with seating for 92 to 128 passengers. In total, 20 Concorde supersonic jets were built, including two prototypes, two development aircraft and 16 production aircraft. Out of the sixteen production aircraft, two did not enter commercial service and eight remained in service until April 2003. All but two of these aircraft are preserved. One of the two that are not preserved are F-BVFD (cn 211), which was a spare-parts source since

1982 and was scrapped in 1994. The other was F-BTSC (cn 203), which crashed in an accident near Paris after take-off on 25 July 2000, killing 100 passengers, 9 crewmembers, and 4 people on the ground. The accident was seen as the cause of discontinuing the operation of Concorde. However, in fact it was a combination of reasons, which led to the discontinuation of the Concorde aircraft's commercial flights, including the increasing maintenance costs, lack of technology development, accidents as well as commercial failure due to high operational costs and operating restrictions linked to its sonic boom.
Besides the Concorde there existed the Tupolev Tu-144 supersonic passenger jet. It was in fact the world's first commercial super sonic transport aircraft (SST), with its maiden flight on 31 December 1968, some months ahead of the Concorde's maiden flight on 2 March 1969. However, the Tupolev Tu-144 aircraft's commercial service lasted only some years, after it was introduced into commercial passenger service on 26 December 1975. The aircraft remained in use as a cargo aircraft until 1983, when the Tu-144 commercial fleet was grounded. Later, the Tu-144 aircraft were used for pilot training of the Buran spacecraft, and by NASA for supersonic research until 26 June 1999.
However, after the grounding of the Concorde in 2003, there emerged ideas to develop, plan and operate a second generation of supersonic aircraft and several concepts have emerged since then.

2. The manufacturers' concepts of next-generation supersonic aircraft

High cost and high ticket prices, the technology development along with limited routes have to be considered as issues that could put into question the market entry of a new type of supersonic or hypersonic jets. However, some aircraft manufacturers believe there could exist a market for the next generation of supersonic jets, as there might be passengers willing to pay for the extra fast services. Currently, there exist several aircraft manufacturers with the ambition to develop a supersonic jet. The civil supersonic business aircraft are developed by several manufacturers. The non-exhaustive list of mentioned manufacturers gives a general overview over the several types of supersonic jets in development. Various supersonic developers are still some years away from fielding prototype aircraft.
Since its founding 16 years ago, Aerion had announced partnerships with several major aerospace entities, including Airbus, Lockheed Martin, Spirit Aerosystems, and GE and currently, is has started a partnership with Boeing. In February 2019, the two companies announced that Boeing had acquired 40% of Aerion. Boeing as leading manufacturer of commercial airplanes and defence will provide engineering, manufacturing and flight-test resources in order to bring Aerion's AS2 supersonic business jet to market. Under the agreement, Boeing will provide engineering, manufacturing, flight-test resources, and "strategic vertical content" for the supersonic plane Aerion AS2. Boeing invests in Aerion to accelerate technology development for next-generation of supersonic aircraft. Aerion introduced its AS2 12-passenger business jet design in 2014, but it has yet to produce a flying prototype of a supersonic jet, which is envisaged for 2023. The company unveiled the AS2's GE Affinity engine design in 2018. The planned AS2 will be a supersonic jet with a range of at least 5,000 nm and a maximum speed is Mach 1.6. However, the aircraft is designed to cruise efficiently at Mach 0.95 to comply with existing supersonic over-flight bans.
Lockheed Martin, together with NASA, is producing the X-59 Low-Boom Flight Demonstrator aircraft. The shape of this aircraft will enable it to travel at Mach 1.4 while creating only a gentle sonic boom. Flight tests of the X-59 are planned to begin in 2022.
The HyperMach SonicStar is a hypersonic aircraft type, with an envisaged top speed of Mach 5.5, a range of 8,300 nm, seating for 32 passengers, and the first flight is now planned for 2025 with a certification target of 2028.
Spike Aerospace is building the Spike Aerospace S-512, with a range of 6,200 nm and a cruise speed of Mach 1.6. It would seat up to 18 passengers. The company has partnerships with Siemens, Quartus, Aernnova,

Greenpoint, BRPH, and others. The Spike S-512 is expected to be the only supersonic jet in development that will fly at twice the speed of other jets without creating a loud sonic boom. The company continues to search for additional funding for the $1 billion program and estimates a market for 600 aircraft between 2020 and 2030. Spike's goal is to bring an aircraft to market by 2022.

The Boom Supersonic company has revised and renamed its tri-jet supersonic design, now called "Overture". The Boom aircraft would have a long-range cruise speed of Mach 2.2, and a range of 4,500 nm. The aircraft is designed to accommodate 55-75 passengers in airline configuration. The Boom Supersonic company is currently building a one-third scale technology demonstration aircraft, the XB-1 "Baby Boom." The scale aircraft will be used to evaluate the larger aircraft's delta wing, carbon-fibre fuselage design and other elements. Boom holds orders for 30 aircraft from Japan Airlines and Virgin Group.

Also Russia's United Aircraft Corporation (UAC) has started a new research program aimed at developing a 16- to 19-passenger aircraft capable of speeds up to Mach 2.5. Range and price are unknown, but UAC states that a production prototype could be flying by 2026.

These new supersonic jets types and the recent advances in supersonic technology, including the ability to travel faster than the speed of sound (Mach 1.0) without causing a loud sonic boom, is expected to deliver an environmentally responsible supersonic aircraft. However, the main problem will be to consider the technical viability of a new generation of supersonic jets and the ecologic and emission requirements the new planes will have to fulfil.

3. Environmental concerns regarding supersonic aircraft

Supersonic jets will meet mainly two challenges besides developing a new supersonic aircraft type, which is to design a jet with a low-boom that would meet noise restrictions for supersonic passenger flights over land, and which will not result in a heavy carbon footprint. Although the planned future supersonic jets for civil aviation are expected to be more fuel-efficient than the Concorde, the GHG emissions are still expected to be higher in comparison with current subsonic aircraft of a similar size because of the speed increase. Furthermore, the supersonic aircraft will operate at higher cruise altitudes and place their GHG emissions and air pollutants in the sensitive high troposphere and stratosphere. The non-CO2 effects of supersonic jets could be higher than from subsonic aeroplanes. However, there is disagreement about whether the altitudes supersonics would fly at would add to the jets' environmental impact. The noise and emissions produced from supersonic aircraft operations in and around airports is also a critical aspect.

While some aircraft manufacturers are developing a new generation of supersonic aircraft, in its working paper entitled "Noise and climate impacts of an unconstrained commercial supersonic network", the International Council on Clean Transportation (ICCT) estimates that a supersonic passenger aircraft would burn 5 to 7 times more fuel per passenger than a conventional aircraft, which underlines the strong negative environmental impact of supersonic aircraft. According to ICCT, a fleet of an estimated 2,000 international supersonic commercial aircraft with around 5,000 supersonic flights per day at 160 airports in operation by 2035 could have severe environmental and health impacts. The estimated 2,000 supersonic jets in 2035 would emit around 96 million metric tons of CO2 per year. Besides, the noise-exposed area around airports could double, compared to existing subsonic aircraft of the same size. Given that around 87% of projected supersonic flights would be international, ICAO needs to be involved in order to create standards for landing and take-off (LTO) noise, air pollution, sonic boom noise and CO2 emissions, and a full set of standards would be needed to be finalised by 2025 and take effect before 2030, in order to create the regulation basis for supersonic aircraft construction.

The new supersonic jets would have to overcome the cost, commercial use and ecologic deficiencies of the

Concorde and prevent environmental impacts. A new generation of supersonic jets must be no louder than existing planes or risk exacerbating existing complaints over noise from air traffic, according to Airports Council International (ACI)'s director Angela Gittens. She also pointed out that supersonic jets should not get "a free pass" to generate more noise than subsonic planes or fail to meet global CO2 emission standards for new aircraft.

Meanwhile, the start-up company Boom announced its sustainable alternative fuel partnership with Prometheus Fuels. According to Boom, alternative fuel testing with its planned demonstrator XB-1 allowed the company to minimize the carbon impact of supersonic flight by operating the demonstrator engine with a pure biofuel formulation. Based on the one-third scale XB-1 demonstrator aircraft, Boom plans to develop its 75-seat, Mach 2.2 commercial jetliner Overture. Boom hopes that the alternative fuels will reduce the Overture's carbon footprint by around 80%.

However, although these latest supersonic jets in development are supposedly quieter and more fuel efficient than the Concorde, they still could have difficulties meeting the existing rules on noise levels and the CO2 emissions standards of conventional planes, due to engine constraints and higher fuel burn, caused by higher speed. Regarding the CO2 emissions, it could help that some of the companies like Boom will focus on sustainable alternative fuels for their engines in order to fly the jets with pure biofuels. The start up companies Boom Supersonic, Aerion and Spike Aerospace are planning to start delivering jets in the mid-2020s.

ICCT researchers assessed noise and climate impacts of the planned commercial supersonic aircraft of Boom as a reference point. Although the exact engine configuration for Boom's Overture jet is yet to be announced, it is known that the XB-1 demonstrator will be powered by three General Electric J85-15 small turbojet engines. Modified engines will emit 40% more nitrogen and 70% more CO2, exceeding global limits for new subsonic jets. Non-carbon emission factors, including, NOx, but also water vapour, black carbon, and aviation-induced cloudiness are also expected to be significant due to the high cruise altitude of supersonic jets.

4. The necessity to introduce international noise and emission standards for supersonic jets

In the past decades, governments, airports and industry have invested globally to improve aircraft technology, in order to reduce the noise level of aircraft, like optimising the flight paths for landing and take-off in order to mitigate public disturbance near airports. In order to allow international flights of commercial supersonic aircraft, the ICAO will have to consider the introduction of special standards for the new generation of supersonic jets. A lack of international standards would mean no transatlantic travel, which would deprive the supersonic aircraft from the ideal market of flights between the US and Europe.

Already in the times of the Concorde, the prohibition of overland sonic booms in the US, as a major aviation market, limited the supersonic aircraft operations. With increasing concerns about the environmental impact of new supersonic aircraft, it will need sustainable global standards to make the introduction of supersonic aircraft economically and ecologically feasible.

The ICAO confirmed it would study supersonic jets, but it has not yet created new standards for these planes. The ICAO has made some progress during the CAEP/11 cycle (2016-2019) regarding the certification measurement locations for assessing sonic boom noise on the ground; selecting an appropriate noise metric for use in a standard that assesses sonic boom noise in correlation between outdoor measurement and indoor human response; and evaluating the benefits of using sonic boom predictions in supersonic noise certification in addition to physical measurements. Regarding landing and take-off (LTO) noise, CAEP recommended that an exploratory study using currently

available data should be undertaken during the CAEP/12 cycle (2019-2022). The ICAO's environmental committee agreed on "an exploratory study" on the technology over the next three years. The review would cover the potential effects of supersonic aircraft on noise, air and the climate, and whether current landing and take-off regulations for subsonic aircraft should apply to supersonic aircraft. The results of the study are intended to provide a better understanding of airport noise impacts resulting from the introduction of supersonic aircraft. The goal is to establish technical flight test procedures for en route noise (sonic boom) certification. This would add to the certification requirements for the landing and take-off (LTO) conditions. However, the ICAO would only start making new rules after the completion of the review after 2022.

Meanwhile, during the ICAO Assembly from 24 September to 4 October 2019, also the Airports Council International (ACI) World called for appropriate standards and practices for supersonic aircraft to properly address their potential impact on the environment, airport operations, and the public. As the reintroduction of supersonic aircraft could take place in about five years, the ACI is concerned that those manufacturers have not been able to present evidence that their new supersonic aircraft would meet the existing ICAO standards for subsonic aircraft. Considering the strong pressure on airports to reduce their noise and emissions footprints, and generally reduce the negative impact of aviation on their communities, ACI insists that the re-introduction of supersonic aircraft should not undermine the efforts and achievements in the field of noise and emission reduction. According to ACI World Director General Angela Gittens, supersonic aircraft must not be noisier than comparable subsonic aircraft of the same Maximum Take Off Mass (MTOM). Therefore, the ACI invited the ICAO Assembly to develop noise and emissions standards and recommended practices for supersonic aircraft in order to promote their sustainable development within international aviation. The ACI has given its views on the development of appropriate ICAO Standards and Recommended Practices (SARPs). Although ACI acknowledges the challenges to develop SARPs when there are no supersonic aircraft in operation, ICAO should take proper account of the problems, which go far beyond the sonic boom issue, and affect airports and communities surrounding them.

In particular, the ICAO needs to extend the Resolution A39-1, Appendix G regarding the "Supersonic aircraft – The problem of sonic boom" to also apply to the Landing and Take-Off (LTO) SARPs development.

Considering the US American companies' interest to reintroduce supersonic aircraft, American negotiators put forward a proposal in the ICAO to revise international rules on supersonic travel, but the European representatives rejected legislation that could have allowed the speedy return of supersonic air travel. European representatives were concerned about the greater noise and emissions that may come from supersonic jets.

In the light of expectations that certification of supersonic aircraft could occur in the 2020-2025 timeframe, the ICAO recognised its responsibility towards developing standards for the new generation of supersonic aircraft. Discussions will continue on the application of noise standards, the sonic boom measurement schemes and procedures as well as on emission standards, and recommended practices for supersonic aircraft.

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