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TRANSPORT & ENVIRONMENT

T&E comments on the ICAO standard and EPA ANPR

An efficiency standard is a key element of ICAO's basket of measures and intended to deliver emissions reductions beyond BAU. But on current indications the ICAO standard for new aircraft types will not affect any new aircraft types and will only cover 5% of the world fleet in 2030. T&E believes that the EPA should ensure that any standard adopted ensure efficiency improvements that go beyond business-as-usual.

About Transport & Environment (T&E)

Transport and Environment (T&E) is a not-for-profit non-governmental organization with pan-European members focusing on sustainable transport modes. Our mission is to promote, at EU and global level, a transport policy based on the principles of sustainable development that minimises harmful impacts on the environment and health, maximises efficiency of resources, including energy and land, and guarantees safety and sufficient access for all. Our work is focused on the areas where European and global policies have the potential to achieve the greatest environmental benefits. These include transport pricing so that polluters, not society, pay for pollution, setting standards for the cleanest possible cars, vans, lorries, ships, planes, and fuels, and greening EU investment in transport. We have contributed to a number of high-profile EU policy changes such as binding standards for more fuel efficient cars and vans and more sustainable biofuels; inclusion of aviation in the EU ETS, introduction of green tyre labels, and smarter EU rules on the way lorries can be charged and designed. Credibility is our key asset. Therefore we are politically independent, and we are strong believers in the power of science and evidence in policymaking. We commission and execute numerous pieces of cutting-edge policy research to shape and underpin our views.

T&E is a founding member of the NGO CAEP Observer coalition at ICAO, the International Coalition for Sustainable Aviation (ICSA), and has been involved at expert level in the CAEP work to develop a CO2 standard for new aircraft. T&E regards efficiency standards for transport as an essential element to drive manufacturers to make improvements which, from our experience, would otherwise invariably not occur. This has been the case with CO2 emissions standards for cars in Europe where annual improvements following legislation are now around 4%. In the case of heavy-duty vehicles, truck efficiency in Europe in the absence of such legislation has stagnated over the past 20 years. The IMO set a design efficiency standard (the EEDI) for all new ships built from 2013. But first-time research on historical ship efficiency trends commissioned by T&E found that the baseline was flawed; the design of ships built some 30 years were on average 10% better than those built recently. In our view aviation is no different. While great strides have been made over the past 60 years in improving the performance of jet aircraft it should not be forgotten that today's jet aircraft are about as efficient as the last piston aircraft of the late 1950s[1].

[1] Peeters, Middel, Hoolhorst *Fuel Efficiency of Commercial Aircraft: An overview of historical and future trends* (2005) http://www.transportenvironment.org/sites/te/files/media/2005-12_nlr_aviation_fuel_efficiency.pdf *(retrieved 31/08/2015)*

T&E comments on the CO_2 standard for new aircraft

The CO2 standard for new aircraft was conceived as and remains a central element of ICAO's basket of measures to improve the environmental sustainability of the sector. It is essential that it credibly fulfill its mission agreed by CAEP of delivering emissions reductions that would otherwise not have occurred without the standard. T&E has a number of major concerns with the way the ICAO work has developed.

T&E has taken note of the EPA "Advance Notice of Proposed Rulemaking (ANPR)[2]" and wishes to provide comments as regards to the proposed rulemaking in the context of issues related to the setting of a CO2 standard for new aircraft at the International Civil Aviation Organization (ICAO). First of all, T&E welcomes the general idea of EPA to set a CO2 standard and also the opportunity given to comment on it at this early stage. The goal of ICAO is to establish a global aircraft standard to achieve meaningful reductions in CO2 emissions beyond business as usual (BAU). Provided the EPA promulgates a final endangerment and cause and contribute findings for aircraft engine GHG emissions, EPA will potentially use section 231 of the Clean Air Act to adopt to implement corresponding aircraft engine GHG emission standards domestically.

Against this background, action to address US aviation emissions is essential if we are to have a chance of keeping global warming within 2 degree target identified by Parties to the UNFCCC. US domestic aviation emissions alone exceed all other countries' domestic emissions combined and account for about 20% of global aviation emissions. Indeed North American domestic aviation emissions almost equate to all the international emissions of ICAO's 195 members bar its top 11, while all US aviation emissions account for about one third of the world total. The US Government has also committed to an emissions reduction of 26-28% below 2005 levels and this will be harder to achieve unless effective measures to reduce emissions from domestic aviation are adopted.

T&E wishes to express support for EPA with regard to the following:

1. EPA fully endorses the general goal of the CO2 standard as formulated by ICAO[3] and that countries should implement at least the agreed ICAO stringency but could do more (pages 37762, 37768). T&E would encourage the EPA to seriously consider implementing more stringent options.
2. T&E shares the EPA concerns that a new type (NT) only standard will incur a long delay before it covers a sufficient number of new type aircraft to become effective (37793). T&E agrees that such a long delay will also definitely render the standard ineffective because, as the EPA has also found, there is a baseline trend towards higher fuel efficiency, which means that a fixed standard will after some time have no effect on subsequent new types being developed.
3. The EPA notes that the current ICAO analysis distinguishes between in-production aircraft (InP) and Project Aircraft (PA) but that by the time the standard becomes effective, all current PA are planned to be in production and thus an NT only standard would not have any foreseeable effect. T&E agrees (Annex I).
4. EPA (page 37803) suggests introducing two different stringency levels for InP and NT. T&E supports this approach for two levels of stringencies (NT and InP).

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[2] Proposed Endangerment Finding and Advanced Notice of Proposed Rulemaking for Greenhouse Gas Emissions from Aircraft; 80 Fed. Reg. 37758 (July 1, 2015)

[3] Page 37791: "The purpose of the international CO2 emissions standard be 'to achieve CO2 emissions reductions from the aviation sector beyond expected 'business as usual'—i.e., a standard that achieves CO2 emissions reductions from the aviation sector beyond what would be achieved in the absence of a standard. This would be analyzed using ICAO criteria of technical feasibility, environmental benefit, cost effectiveness, and impacts of interdependencies."

T&E believes the ANPR may need supplemental consideration with regard to two important issues: the impact of metric value (MV) on aircraft designs and non-CO_2/contrail effects. On page 37797, EPA correctly observes that there are three main ways to improve aircraft fuel efficiency: through better engine efficiency, improved aerodynamic efficiency and by a higher construction efficiency - saving airframe weight. However, it cannot be said that the MV as defined by ICAO (see p 37796) is able to regulate all these three ways to improve fuel efficiency (engine, aerodynamics and construction/weight). This because construction/weight is not regulated by the MV equation as it is not included in it. Though there may be a very small indirect effect on MV from a high construction efficiency, the main components remain aerodynamics and engine efficiency. So the MV as currently proposed does not give any incentive to reduce Empty Weight. The ANPR does not acknowledge this flaw in the MV. Furthermore, it could be concluded from the ANPR that EPA may decide to regulate engine emissions only. If that is correct, T&E would ask how the current metric value could be used for such a purpose. An engine only regulation would not only ignore the construction efficiency element but also the aerodynamic efficiency. T&E would suggest that the EPA consider the aircraft weight deficiency of the ICAO MV and how it might be corrected by, for instance, relating MV to payload-range type parameters.

With regard to contrails, the EPA suggests that AR5 shows no net effect of contrails on radiative forcing (p. 37783). However, the AR5 say this: “Persistent contrails from aviation contribute a RF of +0.01 (+0.005 to +0.03) W m–2 for year 2011, and the combined contrail and contrail-cirrus RF from aviation is assessed to be +0.05 (+0.02 to +0.15) W m–2” (IPCC, 2013, p. 574). Though the direct effect of contrails alone is rather small, contrail induced cirrus has a much larger effect and will not develop without contrails. T&E suggests that an effect that could easily double aviation’s historic CO_2-only contribution to RF, cannot be ignored in rulemaking that aims to reduce the impact of aviation on climate change, even though there remains uncertainty about quantifying the phenomenon.

There are several additional issues T&E would wish to comment on:

1. EPA does mention the difference between in production (InP) and new aircraft types (NT) and the fact that the ICAO main analysis considers project aircraft (PA) that are all planned to be InP by the time the standard will take effect (2020 or later). An unfortunate aspect of the ICAO modeling is that a distinction has been made between InP and project aircraft (PA.) For InP it is assumed that most aircraft can be improved by a technology response. For PA this has been assumed not to be possible. This may be correct for early stage project aircraft that have an estimated entry into service (EIS) date just at the time the standard is introduced on or after 2020. But 24% of current PA are flying or even being delivered already and over 50% will be have an EIS before or in 2017. It is likely this 75% of current PA in the analysis will receive their first production updates and ‘pimps’ by 2020, the first year the standard may come into force. T&E suggests that the EPA take this into account. In addition, due to uncertainty among manufacturers about the final certified fuel efficiency of PA in the ICAO analysis, some ‘safety margins’ have been added, as the industry considered – understandably - a failure to certify a multi-billion dollar new aircraft program too risky. The combined effect of these safety margins has been assessed by ICSA to result in some 5% additional margin (MV’s in the calculations being higher than the average expected values). This results in the highest stringency option under consideration being out of bounds of the modeling system, while, without such conservative assumptions, this option could have been analyzed along with all the others. Moreover such an analysis would have shown the second most stringent option to be more favorable than the third. The PAs flying will have exact measurements to base the MV on, while the others may have so by 2016. Normally first flight precedes EIS by 2-3 years. Therefore, T&E suggests that the EPA collect measured data of at least 75% of all PA and re-assess the impact of those types before deciding on stringency levels.

2. In general, the EPA, just as ICAO CAEP, considers creating more fuel efficient aircraft to be the result of applying new technologies – a new wingtip device for example, an engine with a higher bypass ratio, or a geared fan. But different aircraft design teams starting with exactly the same on-the-shelf technologies may end up with aircraft with very differing fuel efficiencies just by their having made different trade-offs between, for instance, fuel efficiency, DOC, payload-range and field performance. By ignoring this important factor in generating fuel efficiency gains, another conservative element was introduced into the ICAO CAEP main analysis. These ideas, among others, have been advocated by the US aircraft designer Daniel Raymer (Raymer, 2002; Raymer, 2012). T&E wonders why this kind of fuel efficiency optimization would appear not to have been considered by the EPA and whether EPA is intending to recognize this kind of technology optimization in assessing the best level of stringency at least for NT, but in the case of some larger technology responses, for InP as well?

3. The EPA has not given an indication of the stringency level they would like to see agreed by CAEP. For NT, T&E supports agreeing the most stringent option under consideration by ICAO, and at least the third most stringent option for InP. The lack of any ICAO CAEP analysis data on the highest stringency option in the base case is caused mainly by the conservative assumptions for project aircraft regarding tech response and MV that we have mentioned. They should not stand in the way of assessing and selecting the most stringent option. Moreover, because of the observable continued improvement in fuel efficiency due to economic and performance drivers, a lower stringency than the highest for NT would render the standard ineffective within a couple of years.

Some further points.

1. How to tackle the problem that the standard is a constant, while the fuel efficiency of new aircraft design trends to improve, thus making the standard to lose its effectiveness over time? T&E recommends to consider short periods between evaluation and adjustments of the standard.

2. The lack of any decision to date on regulating InP aircraft risks the standard's credibility. The firm written view of key members has been submitted that InP aircraft should be regulated. This must be the final outcome and members should press strongly for things to move in this direction i.e. work and analysis continue such that CAEP 10 in February 2016 could have all the information needed to take a decision at that time on InP applicability.

3. CO2 Analysis: Even though the standard is intended to regulate new aircraft types, so far no new aircraft types have been modelled in the stringency analysis. The analysis is based on ICAO's Growth and Replacement aircraft database (GRdb). This database contains InP and 'project aircraft' but these latter aircraft will all be certified by 2020 as is also noted by EPA. So by definition, all aircraft types in the GRdb, including the project aircraft, will be InP aircraft by the time the standard is implemented – earliest 2020. This means that the ICAO stringency analysis so far conducted is an InP analysis that does not take into account any NT aircraft and thus the results are derived from assumptions of how the standard might affect InP aircraft, not new types (NT). From the project aircraft data, we derived a trend over time based on the estimated entry into service dates, which shows that by somewhere between 2024 and 2026, all new types to be brought to the market will pass the highest stringency option under consideration. A lower NT stringency level will thus have virtually no effect at all. This also because currently there are **no NT expected to be launched between 2020 and 2024**. And after that date, NT will easily pass the standard if it is set at less than the highest stringency level.

4. New standard for new aircraft types will not affect new aircraft types.

Regulating NT aircraft at the highest stringency level currently considered by ICAO will virtually have no impact on their fuel efficiency – i.e. it will not generate emissions reductions beyond business as usual. By CAEP deciding last year that TRL8 should be the maximum technology level to be used to set the standard stringencies, the result is that the standard cannot be technologically more stringent than what technology is on aircraft in 2016. All this for a standard not due to start until 2020 earliest. For instance, a major new type development is expected for the B757 range of aircraft[4]. The expectation is that specific fuel consumption would be improved by between 20% and 45%. From our own estimates, today's B757 fails the highest stringency option currently considered for the standard by between 20-25%. As a new engine will be fitted to a blank sheet new airframe, that will also present opportunities for a better aerodynamic efficiency. As a consequence, the 2025 new aircraft will easily pass all current stringency levels being considered and the standard will not have had the slightest impact on this likely first major new aircraft type to fall under NT regulation.

5. Despite the fact that average annual improvements in new aircraft efficiency over the past 60 years are evident to everyone, the ICAO standard is intended to be a straight line. A straight line that will regulate a dynamic, constantly improving parameter. If this cannot be changed, then the next version of the standard must be both significantly more stringent and arrive soon.

6. The graph below shows that ICSA estimates that the number of NT aircraft likely to be regulated by the standard in 2030 is 5%. That does not, however, mean that the fuel efficiency of these 5% NT aircraft will have necessarily been influenced by the standard. There is every likelihood that the standard will have been surpassed and irrelevant by the time they fly.

7. Why is industry not applying the best technology available?
Currently available aircraft technology is not being used to the maximum. The ICAO technology scenarios show much faster improvement rates (0.96, 1.12%/yr) than reality (0.7%/yr). Still, the scenarios are based on technologies that are available and can technically be implemented. These technologies comprise, geared fans, ultra-high bypass ratios, high speed propeller engines, ultra-high aspect ratio wings, higher temperature and pressure ratios by using heat resistant turbine blade materials, etc., etc. These are all technologies that in principle have been demonstrated in practice. Failure to deploy them has to do with the following: aircraft types are optimised for lowest cost, which means that fuel is only one, though important, factor that is weighed against other performance parameters and properties of the aircraft. This for instance means that the wing span is not optimised for best fuel, but for lowest direct operating cost and including spatial constraints at airports (in the case of the A380, its suboptimal wingspan -20m short - has resulted in a penalty of about 10% versus its technically attainable fuel efficiency).

Most new aircraft types are not making use of maximum technology to minimise direct operating cost. This is because the introduction of new technologies – such as new materials or a new propulsion system - is very costly and therefore very risky. We accept that the costs and risks can be high. But there are ways to manage the regulatory risk – e.g. through binning/fleet averaging as is used in other modes. But this option was ruled out. It remains the case that a stringent standard will reduce the relative risk and bring all manufacturers onto the same risk level. This will help them to take a bit more risk in developing better and more fuel efficient aircraft. A highest as possible stringency for the standard will require manufacturers to take more risk. It will also reduce relative risk, because all manufacturers will have to adopt certain new technologies, while without a standard they will wait for each other, slowing down the pace of technology renewal.

8. What ICAO's 2010 Independent Expert Fuel Burn Technology[5] review experts said;
Technology on its own is not able to deliver the reductions which are judged to be required by ICAO the 2020/2030 and the 2% per annum by 2020 efficiency goals.
Efficiency goals & technology must be pushed for further improvements beyond 2030.
The rate of change in gains from technology **appears to be diminishing** with time.

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[4] See Flight International article TRIMBLE, S. 2015. Middle Riddle. Flight International. Sutton, Surrey, UK: Flightglobal.

[5] *Report of the Independent Experts on the Medium and Long Term Goals for Aviation Fuel Burn Reduction from Technology* (ICAO, 2010)

Other approaches, including further consideration of **aircraft configuration** and **mission specification**, must be introduced, along with **air traffic management and operational improvements** and possibly sustainable fuels and market measures.

It has become clear that past technology improvements have partly been used to increase performance, primarily design range. Because of this, the reductions in fuel burn have been smaller than they might have been, particularly for long-range twin-aisle aircraft.

In assessing future reductions in fuel burn and the potential for these, it is important to include the effect of the specified design range **the majority of flights for both the single-aisle and twin-aisle aircraft are substantially below the maximum payload range of the aircraft.**

Both manufacturers and airlines have opted for long range since a long range aircraft can always operate a short flight, but not the other way around.

Design for long range comes at a substantial price in terms of minimum fuel burn.

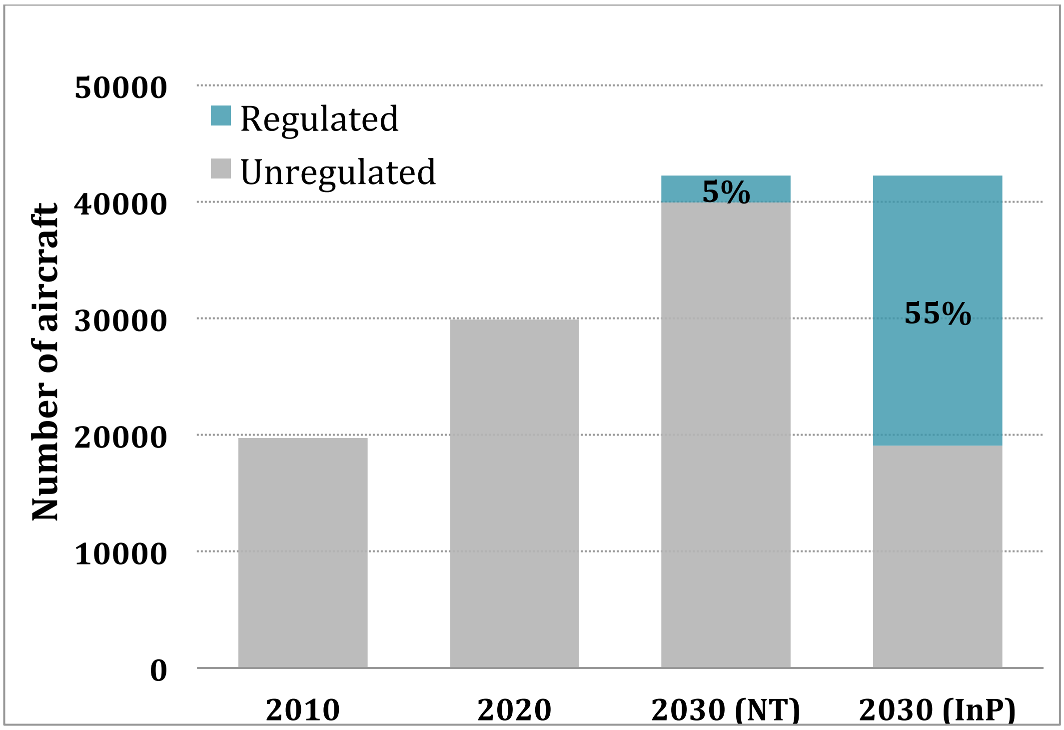
9. Assistance to Aircraft Manufacturers.

As things stand, North American and European aircraft manufacturers receive considerable financial support from governments which covers R&D and development of new aircraft types. This includes launch investment aid, repayable if the aircraft developed is a commercial success. This reduces the risk in developing new aircraft types. The argument is that such financial support shifts the 'business as usual' scenario further along. However as tax payer money is at stake, this shift should be guaranteed through a realistic and credible binding efficiency target. Otherwise the value of this aid is questionable.

Annex I

Impact of inclusion or non-inclusion of In-Production aircraft

	Number of aircraft			
	2010	2020	2030 (NT)	2030 (InP)
Unregulated	19,732	29,872	39,921	19,089
Regulated			2,321	23,153
% Regulated			5%	55%



Further information

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Endnotes

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