Appointment

From: Burch, Julia [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=27B0CD43B0404BAB89AEF0C8D08C165F-BURCH, JULIA]
Sent: 9/21/2017 7:58:27 PM
To: Burch, Julia [Burch.Julia@epa.gov]

Subject: Peer review options for aircraft studies with CG
Attachments: Peer Review Options for Aircraft Products v4b.docx; Example Peer Review Decision Documentation.pdf
Location: 6520

Start: 9/25/2017 6:00:00 PM
End: 9/25/2017 7:00:00 PM
Show Time As: Busy

To: Gregg.Fleming@dot.gov[Gregg.Fleming@dot.gov];
Adrienne.Vanek@faa.gov[Adrienne.Vanek@faa.gov]; asoebagio@icao.int[asoebagio@icao.int];
1983.korolkov@gmail.com[1983.korolkov@gmail.com];
alexandre.filizola@anac.gov.br[alexandre.filizola@anac.gov.br];
amiraa.elsayed@gmail.com[amiraa.elsayed@gmail.com];
andi_ranreng@yahoo.com[andi_ranreng@yahoo.com];
andrea.macera@anac.gov.br[andrea.macera@anac.gov.br];
HardemanA@iata.org[HardemanA@iata.org];
andrew.chuang@boeing.com[andrew.chuang@boeing.com];
Andrew.Gordon@airbus.com[Andrew.Gordon@airbus.com]; mirzoyan@ciam.ru[mirzoyan@ciam.ru];
aude.malige@aviation-civile.gouv.fr[aude.malige@aviation-civile.gouv.fr]; bengt-olov@nace.se[bengt-olov@nace.se]; B.Owen@mmu.ac.uk[B.Owen@mmu.ac.uk];
bill.hemmings@transportenvironment.org[bill.hemmings@transportenvironment.org];
RMPAero@frontier.com[RMPAero@frontier.com];
robert.b.solaimani@boeing.com[robert.b.solaimani@boeing.com];
caio.vianna@anac.gov.br[caio.vianna@anac.gov.br];
camille.sagues@airbus.com[camille.sagues@airbus.com];
catherine.marthe@bazl.admin.ch[catherine.marthe@bazl.admin.ch];
charles.etter@gulfstream.com[charles.etter@gulfstream.com];
chirag.menon@icfi.com[chirag.menon@icfi.com]; chris@limitedskies.com[chris@limitedskies.com];
Christopher.Dorbian@faa.gov[Christopher.Dorbian@faa.gov];
cristiano.villa@anac.gov.br[cristiano.villa@anac.gov.br]; Leggett, Cullen[Leggett.Cullen@epa.gov];
curtis.holsclaw@faa.gov[curtis.holsclaw@faa.gov];
daniel.m.allyn@boeing.com[daniel.m.allyn@boeing.com];
daniel.brown@honeywell.com[daniel.brown@honeywell.com]; dan@theicct.org[dan@theicct.org];
daniel.hiltbrunner@bazl.admin.ch[daniel.hiltbrunner@bazl.admin.ch];
darren.rhodes@caa.co.uk[darren.rhodes@caa.co.uk];
David.Carruthers@cerc.co.uk[David.Carruthers@cerc.co.uk];
david.w.forsyth@boeing.com[david.w.forsyth@boeing.com];
dmjensen@fedex.com[dmjensen@fedex.com]; D.S.Lee@mmu.ac.uk[D.S.Lee@mmu.ac.uk];
david.lye@aero.bombardier.com[david.lye@aero.bombardier.com];
david.marsh@eurocontrol.int[david.marsh@eurocontrol.int]; David.Pace@dot.gov[David.Pace@dot.gov];
Yen, David[Yen.David@epa.gov]; dick.bergmans@nlr.nl[dick.bergmans@nlr.nl]; rmarchi@aci-na.org[rmarchi@aci-na.org]; domingo.sepulveda@pw.utc.com[domingo.sepulveda@pw.utc.com];
McConnachie_Dominic@bah.com[McConnachie_Dominic@bah.com];
dominique.collin@snecma.fr[dominique.collin@snecma.fr];
dongwook.lim@ae.gatech.edu[dongwook.lim@ae.gatech.edu];
Donald.Scata@faa.gov[Donald.Scata@faa.gov];
donna.perera@infrastructure.gov.au[donna.perera@infrastructure.gov.au];
edward.weston@caa.co.uk[edward.weston@caa.co.uk]; ecotti@nbaa.org[ecotti@nbaa.org];
emanuel.fleuti@zurich-airport.com[emanuel.fleuti@zurich-airport.com]; emilia.suomalainen@env-isa.com[emilia.suomalainen@env-isa.com]; Eric.Boeker@dot.gov[Eric.Boeker@dot.gov];
Eric.Upton@gulfstream.com[Eric.Upton@gulfstream.com];
Fabio.Grandi@faa.gov[Fabio.Grandi@faa.gov];
fabrice.valentin@airbus.com[fabrice.valentin@airbus.com];
flynvanewijk@qantas.com.au[flynvanewijk@qantas.com.au];
Frank.Wetzel@uba.de[Frank.Wetzel@uba.de]; gareth.Horton@ricardo-aea.com[gareth.Horton@ricardo-aea.com]; George.Georgiou@aero.bombardier.com[George.Georgiou@aero.bombardier.com];
gmcdonald@icfi.com[gmcdonald@icfi.com]; gresiak@icao.int[gresiak@icao.int]; hazel.peace@ricardo-aea.com[hazel.peace@ricardo-aea.com]; h-hashimoto@center.aeif.or.jp[h-hashimoto@center.aeif.or.jp];
aviamarket@gosniiga.ru[aviamarket@gosniiga.ru]; mymanikam@yahoo.com[mymanikam@yahoo.com];
ivan.de-lepinay@easa.europa.eu[ivan.de-lepinay@easa.europa.eu];
Jacob.Wishart@dot.gov[Jacob.Wishart@dot.gov]; jean-michel.boiteux@snecma.fr[jean-michel.boiteux@snecma.fr]; jermanto@yahoo.com[jermanto@yahoo.com];
Jia.Yu@utas.utc.com[Jia.Yu@utas.utc.com]; johan.skjal@trafi.fi[johan.skjal@trafi.fi];
Jonathan.Saks@dft.gsi.gov.uk[Jonathan.Saks@dft.gsi.gov.uk]; jon.hart@Rolls-

Royce.com[jon.hart@Rolls-Royce.com]; Jorge.Silveira@anac.gov.br[Jorge.Silveira@anac.gov.br];
joseph.zelina@ge.com[joseph.zelina@ge.com]; Julie.Marks@faa.gov[Julie.Marks@faa.gov];
perovicj@iata.org[perovicj@iata.org]; julien.lepoutre@aviation-civile.gouv.fr[julien.lepoutre@aviation-
civile.gouv.fr]; kai.bauer@easa.europa.eu[kai.bauer@easa.europa.eu];
karin@theicct.org[karin@theicct.org]; kazhank@gmail.com[kazhank@gmail.com];
synyka@gmail.com[synyka@gmail.com]; kpreston@aci-na.org[kpreston@aci-na.org];
Kevin.Goddard@airbus.com[Kevin.Goddard@airbus.com]; Kevin.Welsh@faa.gov[Kevin.Welsh@faa.gov];
kevin.guittet@aviation-civile.gouv.fr[kevin.guittet@aviation-civile.gouv.fr];
krisha.nobrega@embraer.com.br[krisha.nobrega@embraer.com.br];
Kristin.Lewis@dot.gov[Kristin.Lewis@dot.gov]; laurence.gray@pw.utc.com[laurence.gray@pw.utc.com];
Laszlo.Windhoffer@faa.gov[Laszlo.Windhoffer@faa.gov];
laurent.box@eurocontrol.int[laurent.box@eurocontrol.int];
laurent.cavadini@eurocontrol.int[laurent.cavadini@eurocontrol.int];
Lourdes.Maurice@faa.gov[Lourdes.Maurice@faa.gov]; xnma@cauc.edu.cn[xnma@cauc.edu.cn];
marc.mounier@gva.ch[marc.mounier@gva.ch];
margaretta.rozetta@gmail.com[margaretta.rozetta@gmail.com];
marie.hankanen@transportstyrelsen.se[marie.hankanen@transportstyrelsen.se];
mark.a.augustyniewicz@boeing.com[mark.a.augustyniewicz@boeing.com];
mark.huising@aero.bombardier.com[mark.huising@aero.bombardier.com];
mark.jackson@cerc.co.uk[mark.jackson@cerc.co.uk];
Mark.Thompson@dft.gsi.gov.uk[Mark.Thompson@dft.gsi.gov.uk];
maryalice.locke@faa.gov[maryalice.locke@faa.gov]; m-sugawara@center.aeif.or.jp[m-
sugawara@center.aeif.or.jp]; adamm@iata.org[adamm@iata.org];
michelle.kirby@ae.gatech.edu[michelle.kirby@ae.gatech.edu];
Mikael.LABY@airbus.com[Mikael.LABY@airbus.com]; mkartyshev@yandex.ru[mkartyshev@yandex.ru];
muni.majjigi@ae.ge.com[muni.majjigi@ae.ge.com]; CMustapha@icao.int[CMustapha@icao.int];
nyoung@airlines.org[nyoung@airlines.org]; nandi_w@rocketmail.com[nandi_w@rocketmail.com];
nicolas@env-isa.com[nicolas@env-isa.com]; oa_kartyshev@mail.ru[oa_kartyshev@mail.ru];
zap@nau.edu.ua[zap@nau.edu.ua]; olivier.husse@airbus.com[olivier.husse@airbus.com];
olivier.penanhoat@snecma.fr[olivier.penanhoat@snecma.fr];
Pascal.Genevieve@aero.bombardier.com[Pascal.Genevieve@aero.bombardier.com];
paul.madden@rolls-royce.com[paul.madden@rolls-royce.com];
paul.peeters1000@gmail.com[paul.peeters1000@gmail.com];
zimm.peter@icfi.com[zimm.peter@icfi.com]; bonnefoy_philippe@bah.com[bonnefoy_philippe@bah.com];
pierre.lempereur@airbus.com[pierre.lempereur@airbus.com];
rachid.tiroual@gmail.com[rachid.tiroual@gmail.com];
rakhmat.komara@dephub.go.id[rakhmat.komara@dephub.go.id];
Ralf.Berghof@dlr.de[Ralf.Berghof@dlr.de]; Ralph.Iovinelli@faa.gov[Ralph.Iovinelli@faa.gov];
raul@inti.gob.ar[raul@inti.gob.ar];
robby.lapointe@aero.bombardier.com[robby.lapointe@aero.bombardier.com];
robin.deransy@eurocontrol.int[robin.deransy@eurocontrol.int];
rodrigo.padilha@anac.gov.br[rodrigo.padilha@anac.gov.br];
roger.schaufele@faa.gov[roger.schaufele@faa.gov];
Roger.worth@dft.gsi.gov.uk[Roger.worth@dft.gsi.gov.uk];
rudolph.dudebout@honeywell.com[rudolph.dudebout@honeywell.com];
S.Balasubramania.CTR@dot.gov[S.Balasubramania.CTR@dot.gov];
Scott.McKibbon@ec.gc.ca[Scott.McKibbon@ec.gc.ca];
sean.a.newsum@boeing.com[sean.a.newsum@boeing.com];
aeroacoustics@mktsagi.ru[aeroacoustics@mktsagi.ru];
shona.rosengren@infrastructure.gov.au[shona.rosengren@infrastructure.gov.au];
stephen.arrowsmith@easa.europa.eu[stephen.arrowsmith@easa.europa.eu];
SMarchand@unfccc.int[SMarchand@unfccc.int]; tthrasher@icao.int[tthrasher@icao.int];
Thierry.NOWACZYK@airbus.com[Thierry.NOWACZYK@airbus.com];
TPohle@airlines.org[TPohle@airlines.org]; uj@janicke.de[uj@janicke.de];
urs.ziegler@bazl.admin.ch[urs.ziegler@bazl.admin.ch];
willem.franken@easa.europa.eu[willem.franken@easa.europa.eu]; Xoh@aci.aero[Xoh@aci.aero]; i-

yamada@aeif.or.jp[i-yamada@aeif.or.jp]; yongchang.li@ae.gatech.edu[yongchang.li@ae.gatech.edu]; yuriy.medved@gmail.com[yuriy.medved@gmail.com]; mrashwan@egyptair.com[mrashwan@egyptair.com]
From: maryalice.locke@faa.gov
Sent: Tue 11/17/2015 10:39:54 PM
Subject: For 18-Nov call: CO2ma IP/06 [CLEAN]
CAEP10_IP-06_MDG-FESG_CO2ma-Report_2015-11-17_clean.docx

Attached is a clean version of the draft CO_2 Main Analysis IP as of this Nov-17 email.

(The track change version will be circulated in a separate message.)

18-NOV: Joint MDG/FESG-STG call on CO2ma documentation at **10**am EST

Teleconference Line

Ex. 6 - Personal Privacy

Webinar

Ex. 6 - Personal Privacy

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Regards

Maryalice Locke

Aviation Emissions Division, AEE-300

Office of Environment and Energy

U.S. Federal Aviation Administration

800 Independence Avenue SW, Washington DC 20591

Phone: 202-267-3495

Email: Maryalice.Locke@FAA.gov

To: Manning, Bryan[manning.bryan@epa.gov]
From: Zimm, Peter
Sent: Thur 2/23/2017 4:07:31 PM
Subject: RE: Do you have 15 minutes to talk today or tomorrow?

Bryan, I'm free from noon-1 and after 2:30pm ET today. What's good for you?

PETER C. ZIMM | Principal | +1.347.843.9746 mobile | peter.zimm@icf.com

ICF | 630 Third Avenue, 11th Floor, New York, NY 10017 USA | icf.com/aviation

Learn how ICF makes big things possible for its clients.

From: Manning, Bryan [mailto:manning.bryan@epa.gov]
Sent: Thursday, February 23, 2017 10:35 AM
To: Zimm, Peter <Peter.Zimm@icf.com>
Subject: Do you have 15 minutes to talk today or tomorrow?

Hi Peter,

Do you have 15 minutes for a phone call today or tomorrow? If so, what time(s) would work best for you?

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Zimm, Peter [mailto:Peter.Zimm@icf.com]
Sent: Wednesday, February 22, 2017 11:13 AM
To: Manning, Bryan <manning.bryan@epa.gov>
Subject: RE: Follow-up from call: ICAO metric value database

OK, understood. I just wanted you to be aware of the timing implications. We'll proceed with the parametric approach, be as expeditious as possible, and keep in touch with you on schedule.

Best regards,

PETER C. ZIMM | Principal | +1.347.843.9746 mobile | peter.zimm@icf.com

ICF | 630 Third Avenue, 11th Floor, New York, NY 10017 USA | icf.com/aviation

Learn how ICF makes big things possible for its clients.

From: Manning, Bryan [mailto:manning.bryan@epa.gov]
Sent: Wednesday, February 22, 2017 11:11 AM
To: Zimm, Peter <Peter.Zimm@icf.com>
Subject: RE: Follow-up from call: ICAO metric value database

Hi Peter,

I would prefer to try and send the draft report to the peer reviewers in about 6-8 weeks from now, but if you need more time properly complete your analysis and write up the report, I understand. Also, we still need to brief the new administration, and the timing on this may delay things (or it may not delay things). Thus, our schedule is not 100% solid right now, and I am bit reluctant to give you a very hard deadline when I am not certain about our schedule at this point.

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Zimm, Peter [mailto:Peter.Zimm@icf.com]
Sent: Wednesday, February 22, 2017 11:01 AM
To: Manning, Bryan <manning.bryan@epa.gov>
Subject: RE: Follow-up from call: ICAO metric value database

YW. That timing is OK for you?

PETER C. ZIMM | Principal | +1.347.843.9746 mobile | peter.zimm@icf.com

ICF | 630 Third Avenue, 11th Floor, New York, NY 10017 USA | icf.com/aviation

Learn how ICF makes big things possible for its clients.

From: Manning, Bryan [mailto:manning.bryan@epa.gov]
Sent: Wednesday, February 22, 2017 11:00 AM
To: Zimm, Peter <Peter.Zimm@icf.com>
Subject: RE: Follow-up from call: ICAO metric value database

Okay, Peter. Thank you for confirming things.

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Zimm, Peter [mailto:Peter.Zimm@icf.com]
Sent: Wednesday, February 22, 2017 10:44 AM
To: Manning, Bryan <manning.bryan@epa.gov>
Subject: RE: Follow-up from call: ICAO metric value database

Bryan,

Your interpretation is correct. Again, assuming we do the parametric treatment of the 2030 / 2040 forecast extension.

PETER C. ZIMM | Principal | +1.347.843.9746 mobile | peter.zimm@icf.com

ICF | 630 Third Avenue, 11th Floor, New York, NY 10017 USA | icf.com/aviation

Learn how ICF makes big things possible for its clients.

From: Manning, Bryan [mailto:manning.bryan@epa.gov]
Sent: Wednesday, February 22, 2017 10:18 AM

To: Zimm, Peter <Peter.Zimm@icf.com>
Subject: RE: Follow-up from call: ICAO metric value database

Thank you for the reply, Peter. I am glad to hear you are going to add the other aircraft to the model. In regard to completing the analysis in 4-6 weeks and the write up after that, are you indicating that in about 2 months from now we (EPA) will see the first draft reports for tasks 1 and 2? Thus, the peer reviewers would be anticipated to receive the second draft reports in 2-3 weeks after that (early- to mid-May?). Is my interpretation of the timing correct?

Thanks again,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Zimm, Peter [mailto:Peter.Zimm@icf.com]
Sent: Tuesday, February 21, 2017 8:53 PM
To: Manning, Bryan <manning.bryan@epa.gov>
Subject: RE: Follow-up from call: ICAO metric value database

Bryan,

Early read is, we should be able to add the other aircraft variants to the model if they aren't in there already. We'll have more details as we progress but that's the early read.

Regarding pushing the forecast to 2040, we reckon that applying the parametric method we talked about two weeks ago will take ~3-4 weeks to implement, at which point we'd have data to show you, get your feedback, and make any additional corrections. Of course, once the analysis is complete, then we have the clay with which to make the bricks for the paper. Does that fit your timetable for the paper? I.e., analysis complete in 4-6 weeks and the write-up after that. Please advise.

Thanks and best regards,

PETER C. ZIMM | Principal | +1.347.843.9746 mobile | peter.zimm@icf.com

ICF | 630 Third Avenue, 11th Floor, New York, NY 10017 USA | icf.com/aviation

Learn how ICF makes big things possible for its clients.

From: Manning, Bryan [mailto:manning.bryan@epa.gov]
Sent: Tuesday, February 21, 2017 4:20 PM
To: Zimm, Peter <Peter.Zimm@icf.com>; Harli, Kent <Kent.Harli@icf.com>; Joaquim R.R.A. Martins <jrram@umich.edu>; glenn.h.mcdonald@gmail.com
Cc: Yen, David <Yen.David@epa.gov>; Leggett, Cullen <Leggett.Cullen@epa.gov>; Mueller, John <mueller.john@epa.gov>; Wolfe, Philip <wolfe.philip@epa.gov>; Maeroff, Bruce <Maeroff.Bruce@epa.gov>
Subject: Follow-up from call: ICAO metric value database

Hi Peter, Joaquim, Kent, and Glenn,

Ex. 5 - Deliberative Process

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Yen, David
Sent: Wednesday, January 11, 2017 5:26 PM
To: Glenn McDonald (glenn.h.mcdonald@gmail.com) <glenn.h.mcdonald@gmail.com>; Zimm, Peter <Peter.Zimm@icfi.com>; Harli, Kent <Kent.Harli@icf.com>
Cc: Manning, Bryan <manning.bryan@epa.gov>; Leggett, Cullen <Leggett.Cullen@epa.gov>; Maeroff, Bruce <Maeroff.Bruce@epa.gov>; Mueller, John <mueller.john@epa.gov>; Wolfe, Philip <wolfe.philip@epa.gov>; Samulski, Michael <samulski.michael@epa.gov>
Subject: RE: A few questions from ICF for aircraft CO2 analysis

Hi Glenn, Peter and Kent,

Ex. 5 - Deliberative Process

A brief description of the data provided is as follows. Feel free to contact me if you have any questions or comments.

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Best regards,

David

From: Manning, Bryan
Sent: Tuesday, January 10, 2017 3:39 PM
To: Zimm, Peter <Peter.Zimm@icfi.com>
Cc: Glenn McDonald (glenn.h.mcdonald@gmail.com) <glenn.h.mcdonald@gmail.com>; Harli, Kent <Kent.Harli@icf.com>; Leggett, Cullen <Leggett.Cullen@epa.gov>; Yen, David <Yen.David@epa.gov>; Maeroff, Bruce <Maeroff.Bruce@epa.gov>; Mueller, John <mueller.john@epa.gov>
Subject: A few questions from ICF for aircraft CO2 analysis

Hi Peter,

Happy New Year! Thanks for the questions. Below are my responses in CAPS/red font. I am currently available tomorrow to discuss, except 9:30-11:00 ET. Let me know what time(s) works for you tomorrow.

Thanks again,

Bryan

From: Zimm, Peter [mailto:Peter.Zimm@icf.com]
Sent: Tuesday, January 10, 2017 3:19 PM
To: Manning, Bryan <manning.bryan@epa.gov>
Cc: Glenn McDonald (glenn.h.mcdonald@gmail.com) <glenn.h.mcdonald@gmail.com>; Harli, Kent <Kent.Harli@icf.com>
Subject: Discuss a few questions?

Bryan,

For our update call next week, we will report out

- The specific technology and cost updates uncovered by our research
- The implied changes to the model
- The updated results due to the changes

All of this points to a preview of changes to the PG version of the paper which is to be submitted later this month.

However, looking at the scope and kickoff input from EPA, we have some questions:

Ex. 5 - Deliberative Process

Option Description

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Would you have some time to discuss today or tomorrow? YES, I AM CURRENTLY AVAILABLE TOMORROW (JAN 11) EXCEPT 9:30-11:00 ET.

Thanks and best regards,

PETER C. ZIMM | Principal | +1.347.843.9746 mobile | peter.zimm@icf.com

ICF | 630 Third Avenue, 11th Floor, New York, NY 10017 USA | icf.com/aviation

Learn how ICF makes big things possible for its clients.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
National Vehicle and Fuel Emissions Laboratory
2000 Traverwood Drive
Ann Arbor, Michigan 48105-2498

June 6, 2016

MEMORANDUM

SUBJECT: Discussion with the Boeing Company Regarding the Proposed Aircraft GHG Emissions Findings and ANPR and International CO_2 Standard - October 23, 2015

FROM: Bryan J. Manning, Mechanical Engineer
Assessment and Standards Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

TO: The Air and Radiation Docket
Docket No. EPA-HQ-OAR-2014-0828

This memorandum documents a meeting held on October 23, 2015 between representatives of the Boeing Company and the Environmental Protection Agency (EPA) to discuss the agency's proposed aircraft greenhouse gas (GHG) emissions findings and Advance Notice of Proposed Rulemaking (ANPR)[1] -- and the aircraft CO_2 standards that were under development in the International Civil Aviation Organization's (ICAO's) Committee on Aviation Environmental Protection (CAEP).

The meeting attendees from the Boeing Company included:

- Dan Allyn
- Peter Pagano
- Sean Newsum
- Bob Peterson (RMPAero, LLC a contractor for the Boeing Company)

The meeting attendees from the EPA included:

- Lucie Audette
- Bill Charmley
- Mike Samulski
- Bryan Manning

[1] U.S. EPA, 2015: *Proposed Finding That Greenhouse Gas Emissions From Aircraft Cause or Contribute to Air Pollution That May Reasonably Be Anticipated To Endanger Public Health and Welfare and Advance Notice of Proposed Rulemaking*; Notice of Proposed Rulemaking (NPRM) and ANPR, 80 FR 37758 (July 1, 2015).

The discussion topics included an overview by the Boeing Company of the ICAO/CAEP aircraft CO_2 standards and their CO_2 emissions reduction strategy. This overview was followed by clarifying questions about the EPA's proposed aircraft GHG emissions findings/ANPR, including next steps and schedule, and the ICAO/CAEP aircraft CO_2 standards.

Attachments:

- Boeing draft meeting agenda
- Boeing Commercial Airplanes Overview
- Boeing ICAO CO_2 Emissions Standard Overview

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
National Vehicle and Fuel Emissions Laboratory
2000 Traverwood Drive
Ann Arbor, Michigan 48105-2498

June 3, 2016

MEMORANDUM

SUBJECT: Discussion with the Boeing Company Regarding the Proposed Aircraft GHG Emissions Findings and ANPR and International CO_2 Standard - October 23, 2015

FROM: Bryan J. Manning, Mechanical Engineer,
Assessment and Standards Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

TO: The Air and Radiation Docket
Docket No. EPA-HQ-OAR-2014-0828

This memorandum dockets a meeting held on October 23, 2015 between representatives of the Boeing Company and the Environmental Protection Agency (EPA) to discuss the agency's proposed aircraft greenhouse gas (GHG) emissions endangerment and contribution findings and Advance Notice of Proposed Rulemaking (ANPR)[1] -- and the aircraft CO_2 standards that were under development in the International Civil Aviation Organization's Committee on Aviation Environmental Protection (CAEP).

The meeting attendees from the Boeing Company included:

- Dan Allyn
- Peter Pagano
- Sean Newsum
- Bob Peterson (RMPAero, LLC a contractor for the Boeing Company)

The meeting attendees from the EPA included:

- Lucie Audette
- Bill Charmley
- Mike Samulski
- Bryan Manning

[1] U.S. EPA, 2015: *Proposed Finding That Greenhouse Gas Emissions From Aircraft Cause or Contribute to Air Pollution That May Reasonably Be Anticipated To Endanger Public Health and Welfare and Advance Notice of Proposed Rulemaking*; Notice of Proposed Rulemaking (NPRM) and ANPR, 80 FR 37758 (July 1, 2015).

The meeting included an overview by the Boeing Company of the CAEP aircraft CO_2 standards and their CO_2 emissions reduction strategy. This overview was followed by clarifying questions about the EPA's proposed aircraft GHG emissions findings and ANPR, including next steps, and the CAEP aircraft CO_2 standards.

Attachments:

- Boeing Commercial Airplanes Overview
- Boeing's ICAO CO_2 Emissions Standard Overview

To: Audette, Lucie[audette.lucie@epa.gov]
From: Manning, Bryan
Sent: Thur 6/30/2016 6:55:23 PM
Subject: RE: Splitting of SAN 5773 into 5773.1 for GHG Aircraft Engine Standards NPRM

Lucie,

Bruce may have mentioned this to you already. We talked with Chris Brunner this morning, and it should be no problem to keep the same docket number for the CO2 standards NPRM/FRM as the endangerment finding NPRM/FRM. The docket folks can create different stages – as we figured (e.g., Proposal stage for endangerment NPRM, Final stage for endangerment FRM, Proposal2 stage for CO2 Standard FRM, and Final2 stage for CO2 Standard FRM). It is just a matter of talking with the docket folks, and this should not be a problem.

We very much appreciate your help with splitting the SAN numbers and working to get the CO2 standard NPRM on the Fall regulatory agenda.

Thank you,

Bryan

From: Audette, Lucie
Sent: Thursday, June 30, 2016 2:38 PM
To: Jutras, Nathaniel <Jutras.Nathaniel@epa.gov>
Cc: Scoville, Pat <Scoville.Pat@epa.gov>; Sutton, Tia <sutton.tia@epa.gov>; Farrar, Wanda <farrar.wanda@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>
Subject: RE: Splitting of SAN 5773 into 5773.1 for GHG Aircraft Engine Standards NPRM

Hi Nate, I just reviewed the split SAN, it looks good. I had only one change to request, I should be the Primary Point of Contact not Lesley Jantarasami (OAR/OAP). Now that we are in the standard setting phase (OAR/OTAQ) will assume the lead and I will be the workgroup chair going forward. One additional question: I can't access the document to make any changes, not sure if this is by design or if I can be given access. Your help on figuring this out is needed, or should I be speaking to someone else? Thanks so much. Lucie

From: Jutras, Nathaniel
Sent: Wednesday, June 29, 2016 6:41 PM
To: Audette, Lucie <audette.lucie@epa.gov>
Cc: Scoville, Pat <Scoville.Pat@epa.gov>; Sutton, Tia <sutton.tia@epa.gov>; Farrar, Wanda <farrar.wanda@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>
Subject: RE: Splitting of SAN 5773 into 5773.1 for GHG Aircraft Engine Standards NPRM

Thanks, Lucie. I have created the split action in ADP Tracker (SAN 5773.1)

From: Audette, Lucie
Sent: Tuesday, June 28, 2016 5:01 PM
To: Jutras, Nathaniel <Jutras.Nathaniel@epa.gov>
Cc: Scoville, Pat <Scoville.Pat@epa.gov>; Sutton, Tia <sutton.tia@epa.gov>; Farrar, Wanda <farrar.wanda@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>
Subject: Splitting of SAN 5773 into 5773.1 for GHG Aircraft Engine Standards NPRM

Nate, Thanks for your help in splitting this action. As you requested following is the information you need to proceed:

Title: **Control of Air Pollution From Aircraft and Aircraft Engines: Proposed GHG Emissions Standards and Test Procedures**

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

To: Brunner, Christine[brunner.christine@epa.gov]
Cc: Yen, David[Yen.David@epa.gov]
From: Manning, Bryan
Sent: Thur 9/22/2016 5:36:20 PM
Subject: Draft SOW for Peer Review Facilitation - by Abt (PLEASE REVIEW) - updated ICF aircraft CO2 report
Abt SOW Peer Review of Aircraft CO2 Report 9-21-16.docx

Hello Chris,

Attached please find a draft SOW for the WA on peer review facilitation for the updated ICF aircraft CO2 report – via Abt. Let me know if you have any comments. Also, if you have an IGCE template for Abt, could you provide this to me?

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

EPA-HQ-2018-004348

To: Manning, Bryan[manning.bryan@epa.gov]
From: Manning, Bryan
Sent: Thur 9/15/2016 8:26:59 PM
Subject: CO2 SOW
SOW In-Prod Aircraft Cost Anal & Industry Charact CO2 Std_ICF 9-15-16.docx

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

To: Samulski, Michael[samulski.michael@epa.gov]; Audette, Lucie[audette.lucie@epa.gov]
From: Manning, Bryan
Sent: Thur 8/20/2015 3:11:10 PM
Subject: Draft Presentation for Air Division Directors' Briefing (Sept 1)
Aircraft GHG Emissions for Air Division Directors Briefing 8-19-15 .pptx

Hello,

Attached please find the draft presentation for the Air Division Directors' Briefing on Sept 1.

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process Let me know if you have any comments.

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

Aircraft GHG Emissions

NAACA Briefing

June 23, 2015

Introduction

- On June 10, 2015, EPA issued a proposal and Advance Notice of Proposed Rulemaking (ANPR) to take first steps to address GHG emissions from aircraft engines.
- The EPA is not at this time proposing aircraft engine GHG emission standards.
- Comments will be accepted for 60 days beginning when this proposal is published in the Federal Register.
- You can access the proposal and ANPR on EPA's website: www.epa.gov/otaq/aviation.htm
- This proposed action responds to a citizen petition the EPA received in December 2007 requesting the EPA issue an endangerment finding and standards under section 231(a) of the Act for the GHG emissions from aircraft.
- International aircraft CO2 standards are expected to be adopted in early 2016. The proposal and ANPR lay the foundation for the development and implementation of a domestic aircraft engine standard, in accordance with U.S. law and the international process.

Deliberative material - do not distribute, cite, or quote

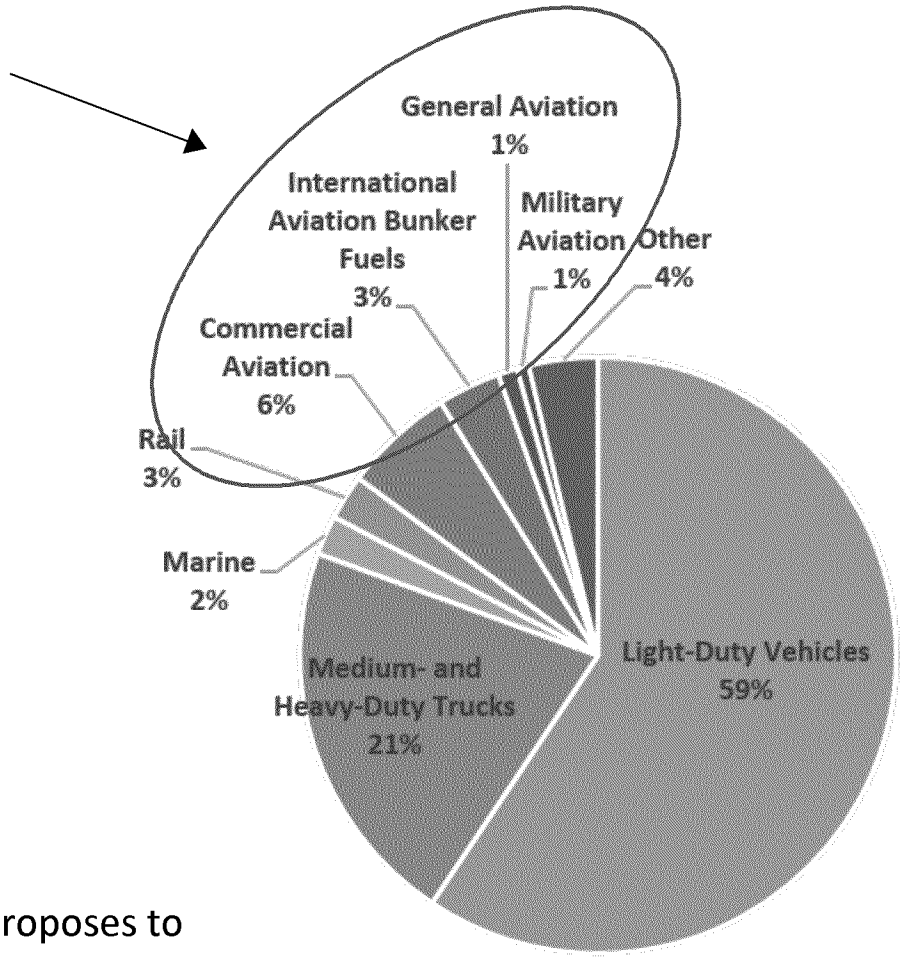
Aircraft GHG Endangerment

- The EPA Administrator is proposing to find that GHG emissions from certain classes of engines used primarily in commercial aircraft contribute to the air pollution that causes climate change and endangers public health and welfare. Specifically:
  - Proposing to find that GHG concentrations in the atmosphere endanger the public health and welfare of current and future generations within the meaning of section 231(a) of the Clean Air Act.
  - Finding made with respect to the same six well-mixed GHGs -- carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride -- that together were defined as the relevant air pollution in the 2009 Endangerment Finding under section 202(a) of the Clean Air Act.
  - Proposing to find that GHG pollutant emissions from certain classes of engines used in aircraft are contributing to this mix of GHGs in the atmosphere.
- Since 2009, the science on climate change has strengthened, lending further support to the Administrator's judgment that greenhouse gases in the atmosphere harm public health and welfare.
- In this proposed finding under section 231(a), the EPA relies upon and builds on the extensive scientific and technical evidence in the record supporting the 2009 Endangerment Finding, and supplements it with more recent major scientific climate change assessments.

Aircraft GHG Emissions Contribution

- Aircraft sector contributes ~11% of U.S. transportation GHGs
  - Largest remaining transportation category not yet regulated for GHGs.
  - 3% of total U.S. GHG emissions (not pictured). Total transportation is about a third.

- The aircraft categories covered by ICAO* comprise the vast majority of aviation sector GHG emissions (U.S. > 90%).



Source: Inventory of U.S. GHG Emissions and Sinks: 1990-2012

*International Civil Aviation Organization (ICAO) proposes to regulate subsonic jet aircraft with a maximum takeoff mass (MTOM) greater than 5,700 kg and subsonic propeller drive aircraft (e.g., turboprops) with a MTOM greater than 8,618 kg.

CO2 Standard Approach

- We are working within the International Civil Aviation Organization (ICAO) to establish global CO2 standards for aircraft
  - Developed NOx standards using this approach
  - Also working on PM standards for engines at ICAO
- ICAO is a specialized agency of the U.N., is a global organization that brings together States, manufacturers, NGOs, and industry organizations
  - Sets standards and regulations necessary for aviation safety, security, efficiency and regulatory, as well as for aviation environmental protection.
  - The environmental protection organization is the Committee on Aviation Environmental Protection (CAEP)
- The US Delegation to ICAO is led by the Federal Aviation Administration (FAA)
  - EPA acts as an advisor to FAA and contributes independent analysis to the working groups

CO_2 Standard Approach

- ICAO is expected to finalize CO_2 standards for aircraft in February 2016.
- ICAO standards are not self-implementing, but rather must be implemented through domestic regulation.
- EPA, in consultation with FAA, has responsibility for issuing air pollution standards for aircraft engines under CAA§231.

- FAA, under CAA§232, has responsibility to prescribe regulations to ensure compliance with the emissions standards.

CO2 Standard Status

- What has been done?
  - Metric system
  - Certification procedures

$$\frac{(1/SAR)_{AVG}}{RGF^{0.24}}$$

- What needs to be decided by 2016?
  - Applicability (new types vs. in-production)
  - Timing
  - Level of standards

Next Steps

- CAEP Steering Group Meeting in Montreal- July 20-25
- Public Hearing
  - August 11, Washington D.C. in the U.S. EPA Hearing Room
  - Hearing will be held if speakers request
- 60 day Comment Period from date of Publication in the Federal Register

Deliberative material - do not distribute, cite, or quote

To: Thrift, Mike[thrift.mike@epa.gov]; Jantarasami, Lesley[Jantarasami.Lesley@epa.gov]; Williams, Melina[Williams.Melina@epa.gov]
Cc: Birnbaum, Rona[Birnbaum.Rona@epa.gov]
From: Manning, Bryan
Sent: Mon 11/16/2015 9:33:58 PM
Subject: RE: Draft US working paper - aircraft CO2 standard
CAEP.10.IP.Agenda Item.05.en_GLOBAL-20151109.docx
CAEP.10.IP.Agenda Item.05.en_US-20151109.docx

Mike,

Ex. 5 - Attorney Client

I hope this explanation helps some.

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Thrift, Mike
Sent: Monday, November 16, 2015 3:57 PM
To: Jantarasami, Lesley <Jantarasami.Lesley@epa.gov>; Williams, Melina <Williams.Melina@epa.gov>
Cc: Manning, Bryan <manning.bryan@epa.gov>; Birnbaum, Rona <Birnbaum.Rona@epa.gov>
Subject: RE: Draft US working paper - aircraft CO2 standard

Ex. 5 - Attorney Client

Mike Thrift

United States Environmental Protection Agency

Office of General Counsel

San Diego Border Office

610 West Ash Street

San Diego, CA 92101

Thrift.mike@epa.gov

619-321-1960

From: Jantarasami, Lesley
Sent: Monday, November 16, 2015 11:37 AM
To: Williams, Melina <Williams.Melina@epa.gov>; Thrift, Mike <thrift.mike@epa.gov>
Cc: Manning, Bryan <manning.bryan@epa.gov>; Birnbaum, Rona <Birnbaum.Rona@epa.gov>
Subject: RE: Draft US working paper - aircraft CO2 standard

Hi Melina and Mike,

Ex. 5 - Attorney Client

Thanks,

Lesley

From: Manning, Bryan

Sent: Friday, November 06, 2015 10:35 AM
To: Jantarasami, Lesley <Jantarasami.Lesley@epa.gov>
Cc: Williams, Melina <Williams.Melina@epa.gov>
Subject: Draft US working paper - aircraft CO2 standard

Hi Lesley,

Ex. 5 - Deliberative Process

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Audette, Lucie[audette.lucie@epa.gov]
From: Manning, Bryan
Sent: Thur 6/2/2016 7:18:07 PM
Subject: ICAO Q&A- CO2 Standard
ICAO CO2 Standard Q and A_2-8-16 110 pm-ASD+OGC.docx
ICAO CO2 Standard Q and A_2-8-16 110 pm-ASD+OGC+BM.docx

Hello Lucie,

Attached (2nd attachment) is the latest Q&A for the WH CO2 Fact Sheet that I found (my comments added to OGC's comments). Unfortunately, it does not appear to be the final Q&A that went to the WH – since it is still RLSO.

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Audette, Lucie
Sent: Monday, February 08, 2016 2:53 PM
To: Birgfeld, Erin <Birgfeld.Erin@epa.gov>
Cc: Samulski, Michael <samulski.michael@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>; Charmley, William <charmley.william@epa.gov>

Subject: RE: ICAO QA- from EPA

Erin, Here are the revisions we discussed as well as Mike Thrift's (OGC) comment—all in track changes. I'm at my desk to discuss if needed. Thanks!

From: Birgfeld, Erin
Sent: Monday, February 08, 2016 2:30 PM
To: Audette, Lucie <audette.lucie@epa.gov>
Subject: FW: ICAO QA- from EPA

Here is my suggested edit to the first Q.. edit as necessary.

Thanks!

Ex. 5 - Deliberative Process

From: Millett, John
Sent: Friday, February 05, 2016 10:35 AM
To: Birgfeld, Erin <Birgfeld.Erin@epa.gov>
Cc: StClair, Christie <StClair.Christie@epa.gov>; Hengst, Benjamin <Hengst.Benjamin@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>; Bryan, David <Bryan.David@epa.gov>
Subject: RE: ICAO QA- from EPA

RLSO reflecting Janet McCabe's review and comments –

From: Birgfeld, Erin
Sent: Thursday, February 04, 2016 2:15 PM
To: Millett, John <Millett.John@epa.gov>
Cc: StClair, Christie <StClair.Christie@epa.gov>; Hengst, Benjamin <Hengst.Benjamin@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>; Bryan, David <Bryan.David@epa.gov>
Subject: FW: ICAO QA- from EPA

HI all,

This is the doc that Laura sent to the WH last night. She is having a call with them tonight at 5 and will get details on their roll out plans.

Stay tuned and thanks for everyone's help on this.

Best,

Erin

From: Allen, Laura
Sent: Thursday, February 04, 2016 11:03 AM
To: Birgfeld, Erin <Birgfeld.Erin@epa.gov>
Subject: FW: ICAO QA- from EPA

From: Allen, Laura
Sent: Wednesday, February 03, 2016 5:49 PM
To: 'Benenati, Frank' <Frank_J_Benenati@who.eop.gov>
Subject: ICAO QA- from EPA

Hey- here's the ICAO QA that I mentioned a few days ago. **Ex. 5 - Deliberative Process**

Ex. 5 - Deliberative Process

Thanks,

Laura Allen

Deputy Press Secretary
Office of the Administrator
U.S. Environmental Protection Agency

Email: Allen.Laura@epa.gov

Office: 202-564-1175

Mobile: 202-731-3005

Please consider the environment before printing this email.

To: Audette, Lucie[audette.lucie@epa.gov]
From: Manning, Bryan
Sent: Tue 9/13/2016 4:10:06 PM
Subject: Draft Briefing for WG Kickoff
Workgroup Kickoff Mtg_Aircraft GHG Standards NPRM_9-13-16.pptx

Hello Lucie,

Attached is my draft attempt at the WG Kickoff briefing. Ex. 5 - Deliberative Process
Ex. 5 - Deliberative Process Let me know if you have any comments. Of course, feel free to add slides, etc.

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Mueller, John[mueller.john@epa.gov]
From: Manning, Bryan
Sent: Wed 12/16/2015 4:14:26 PM
Subject: Example Matrix from CAEP SG15
CAEP10_SG3_DraftPaperReview_2015-07-15_CLEAN_nc.docx

Hello John,

As we discussed, attached is an example matrix from SG15. I hope this helps some. Thanks.

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

EPA-HQ-2018-004348

To: Maeroff, Bruce[Maeroff.Bruce@epa.gov]
From: Manning, Bryan
Sent: Thur 5/5/2016 3:28:53 PM
Subject: PPT & spreadsheet
Presentation of Calculations_ Cause or Contribute 5-5-16.pptx
Calcs Inventory Sect of Preamble for Bruce 5-5-16.xlsx

Thanks!

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

To: Yen, David[Yen.David@epa.gov]; Mueller, John[mueller.john@epa.gov]
From: Manning, Bryan
Sent: Tue 12/15/2015 1:28:28 PM
Subject: FW: updated briefing for Chris Grundler
Chris Briefing Next Steps Possible CAEP Outcomes 12-14-15.docx

See below/attached for updated briefing. Thank you. Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Samulski, Michael
Sent: Tuesday, December 15, 2015 7:57 AM
To: Manning, Bryan <manning.bryan@epa.gov>; Leggett, Cullen <Leggett.Cullen@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>
Subject: updated briefing

Ex. 5 - Deliberative Process I will bring 4 copies of the briefing.

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

To: Manning, Bryan[manning.bryan@epa.gov]
From: Manning, Bryan
Sent: Fri 6/19/2015 8:47:47 PM
Subject: EOP PPT
EOP Briefing_ICAO Aircraft CO2 Standard 6-19-15.pptx

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

EPA-HQ-2018-004348

To: Manning, Bryan[manning.bryan@epa.gov]
From: Manning, Bryan
Sent: Wed 5/4/2016 9:14:51 PM
Subject: latest spreadsheet
Calcs Inventory Sect of Preamble for Bruce 5-4-16.xlsx

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

From: Manning, Bryan
Location: AA-Room-Office-N62-ASDCDConfRoom/AA-OTAQ-OFFICE
Importance: Normal
Subject: FAA/MIT cost-benefit analysis: Call for staff (call Ex. 6 - Personal Privacy)
Start Date/Time: Wed 11/18/2015 6:00:00 PM
End Date/Time: Wed 11/18/2015 7:00:00 PM
2015 11 17 Technical comments on FAA CO2 informational CBA.DOCX

Hello,

Call Ex. 6 - Personal Privacy Ex. 5 - Deliberative Process Ex. 5 - Deliberative Process Ex. 5 - Deliberative Process Look forward to talking to you tomorrow at 1:00 pm eastern.

Thanks,

Bryan

EPA-HQ-2018-004348

To: Manning, Bryan[manning.bryan@epa.gov]
From: Manning, Bryan
Sent: Fri 9/9/2016 9:05:14 PM
Subject: workgroup kickoff ppt
Workgroup Kickoff Mtg_Aircraft GHG Standards NPRM_9-9-16.pptx

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

To: Samulski, Michael[samulski.michael@epa.gov]; Audette, Lucie[audette.lucie@epa.gov]
From: Manning, Bryan
Sent: Thur 11/12/2015 2:58:08 PM
Subject: FW: Request to help prep Janet for her 11/18 CAAAC speech (with Mike & Melina's comments)
V1_LJ-mt.docx

Hello Mike and Lucie,

Attached please find Mike Thrift and Melina Williams' comments. Thanks. Bryan

From: Williams, Melina
Sent: Tuesday, November 10, 2015 5:40 PM
To: Jantarasami, Lesley <Jantarasami.Lesley@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>; Thrift, Mike <thrift.mike@epa.gov>
Subject: RE: Request to help prep Janet for her 11/18 CAAAC speech

Hi Lesley,

Attached are my comments on top of Mike's (though Mike hasn't seen my edits yet). Thanks for sharing these with us.

Melina

Melina Williams | US EPA | Office of General Counsel | Air and Radiation Law Office | Mail Code 2344A | phone: (202) 564-3406 | fax: (202) 564-5603

The contents of this e-mail and any attachments to it may contain deliberative-process, attorney-client, attorney work product, or otherwise privileged material. Do not distribute outside of EPA or DOJ.

From: Jantarasami, Lesley
Sent: Tuesday, November 10, 2015 4:44 PM
To: Manning, Bryan; Thrift, Mike; Williams, Melina

Subject: FW: Request to help prep Janet for her 11/18 CAAAC speech

Hello Bryan, Mike, and Melina-

Could you please take a quick look at the 3 bullets in the attached? Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process I made comments in a few places already.

Thanks so much,

Lesley

From: Lemon, Mollie
Sent: Tuesday, November 10, 2015 4:01 PM
To: Jantarasami, Lesley <Jantarasami.Lesley@epa.gov>; DeLuca, Isabel <DeLuca.Isabel@epa.gov>; Newberg, Cindy <Newberg.Cindy@epa.gov>; Maranion, Bella <Maranion.Bella@epa.gov>; Horwitz, Paul <Horwitz.Paul@epa.gov>; Wilson, Erika <Wilson.Erika@epa.gov>
Cc: Birnbaum, Rona <Birnbaum.Rona@epa.gov>; Haeuber, Richard <Haeuber.Richard@epa.gov>
Subject: FW: Request to help prep Janet for her 11/18 CAAAC speech

Hi all – just a reminder on this for Thursday morning. Thanks!

From: Dennis, Allison
Sent: Thursday, November 05, 2015 11:35 AM
To: Mills, Kathy <Mills.Kathy@epa.gov>; Bremer, Kristen <Bremer.Kristen@epa.gov>; Birgfeld, Erin <Birgfeld.Erin@epa.gov>; Cherepy, Andrea <Cherepy.Andrea@epa.gov>; Lemon, Mollie <Lemon.Mollie@epa.gov>; Walters, Margaret <Walters.Margaret@epa.gov>
Cc: Ketcham-Colwill, Jim <Ketcham-Colwill.Jim@epa.gov>
Subject: Request to help prep Janet for her 11/18 CAAAC speech

Hi all!

On Wednesday, Nov. 18th, Janet will give her bi-annual air program update that the CAAAC meeting. She will have a 50-minute timeslot, where she will use 30 minutes for remarks, followed by Q&A. This session is open to the press. I put together a draft speech for your review. Ex. 5 - Deliberative Process **I will need all edits by next Thursday (12th) COB.** Her last speech to this group was in April so if you have any major accomplishments made since then that are not mentioned in these talkers, please feel free to add them.

Ex. 5 - Deliberative Process

Thank you!

Allison

To: Herzog, Erik[Herzog.Erik@epa.gov]
Cc: Yen, David[Yen.David@epa.gov]
From: Manning, Bryan
Sent: Fri 9/9/2016 7:01:51 PM
Subject: RE: grams CO2/kg-fuel: jet fuel from EPA GHG and Sinks

Okay, Erik. Thank you for letting me know how things worked out. Glad to hear that the numbers match.

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Herzog, Erik
Sent: Friday, September 09, 2016 2:58 PM
To: Manning, Bryan <manning.bryan@epa.gov>
Cc: Yen, David <Yen.David@epa.gov>
Subject: RE: grams CO2/kg-fuel: jet fuel from EPA GHG and Sinks

Ex. 5 - Deliberative Process

From: Manning, Bryan
Sent: Friday, September 09, 2016 11:54 AM
To: Herzog, Erik <Herzog.Erik@epa.gov>
Cc: Yen, David <Yen.David@epa.gov>
Subject: RE: grams CO2/kg-fuel: jet fuel from EPA GHG and Sinks

Ex. 5 - Deliberative Process

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Herzog, Erik
Sent: Friday, September 09, 2016 11:50 AM
To: Manning, Bryan <manning.bryan@epa.gov>
Cc: Yen, David <Yen.David@epa.gov>
Subject: RE: grams CO2/kg-fuel: jet fuel from EPA GHG and Sinks

Ex. 5 - Deliberative Process

From: Manning, Bryan
Sent: Friday, September 09, 2016 10:55 AM
To: Herzog, Erik <Herzog.Erik@epa.gov>
Cc: Yen, David <Yen.David@epa.gov>
Subject: grams CO2/kg-fuel: jet fuel from EPA GHG and Sinks

Hello Erik,

Ex. 5 - Deliberative Process

I hope this helps some.

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

EPA-HQ-2018-004348

To: Manning, Bryan[manning.bryan@epa.gov]
From: Manning, Bryan
Sent: Tue 5/3/2016 9:28:28 PM
Subject: latest response to FAA on their comments
2016-03-01_DRAFT aircraft GHG cause or contribution finding FRM preamble_FAAcomments 2016-03-10+EPA.docx

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

To: Samulski, Michael[samulski.michael@epa.gov]
From: Manning, Bryan
Sent: Tue 11/10/2015 9:54:29 PM
Subject: FW: Request to help prep Janet for her 11/18 CAAAC speech
V1_LJ.docx

FYI, see the below email and attached document Lesley is running by OGC. Janet McCabe's staff asked Lesley to review Janet's draft speech for the bi-annual air program update for the CAAAC meeting. **Ex. 5 - Deliberative Process** **Ex. 5 - Deliberative Process** Thanks.

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Jantarasami, Lesley
Sent: Tuesday, November 10, 2015 4:44 PM
To: Manning, Bryan <manning.bryan@epa.gov>; Thrift, Mike <thrift.mike@epa.gov>; Williams, Melina <Williams.Melina@epa.gov>
Subject: FW: Request to help prep Janet for her 11/18 CAAAC speech

Hello Bryan, Mike, and Melina-

Could you please take a quick look at the 3 bullets in the attached? Janet is giving a public

presentation where press might be in attendance, and so I want to be sure we are stating things accurately. I made comments in a few places already.

Thanks so much,

Lesley

From: Lemon, Mollie
Sent: Tuesday, November 10, 2015 4:01 PM
To: Jantarasami, Lesley <Jantarasami.Lesley@epa.gov>; DeLuca, Isabel <DeLuca.Isabel@epa.gov>; Newberg, Cindy <Newberg.Cindy@epa.gov>; Maranion, Bella <Maranion.Bella@epa.gov>; Horwitz, Paul <Horwitz.Paul@epa.gov>; Wilson, Erika <Wilson.Erika@epa.gov>
Cc: Birnbaum, Rona <Birnbaum.Rona@epa.gov>; Haeuber, Richard <Haeuber.Richard@epa.gov>
Subject: FW: Request to help prep Janet for her 11/18 CAAAC speech

Hi all – just a reminder on this for Thursday morning. Thanks!

From: Dennis, Allison
Sent: Thursday, November 05, 2015 11:35 AM
To: Mills, Kathy <Mills.Kathy@epa.gov>; Bremer, Kristen <Bremer.Kristen@epa.gov>; Birgfeld, Erin <Birgfeld.Erin@epa.gov>; Cherepy, Andrea <Cherepy.Andrea@epa.gov>; Lemon, Mollie <Lemon.Mollie@epa.gov>; Walters, Margaret <Walters.Margaret@epa.gov>
Cc: Ketcham-Colwill, Jim <Ketcham-Colwill.Jim@epa.gov>
Subject: Request to help prep Janet for her 11/18 CAAAC speech

Hi all!

On Wednesday, Nov. 18th, Janet will give her bi-annual air program update that the CAAAC meeting. She will have a 50-minute timeslot, where she will use 30 minutes for remarks, followed by Q&A. This session is open to the press. I put together a draft speech for your

review. Please feel free to add/remove topics as you see fit. **I will need all edits by next Thursday (12th) COB.** Her last speech to this group was in April so if you have any major accomplishments made since then that are not mentioned in these talkers, please feel free to add them.

Additionally, if you have Q&As/backgrounders for topics that may not rise to her talkers but Janet may get asked about, please send those materials to me as well (ex. VW, MERL, etc.)

Thank you!

Allison

To: Maeroff, Bruce[Maeroff.Bruce@epa.gov]
From: Manning, Bryan
Sent: Fri 9/9/2016 7:01:07 PM
Subject: FW: grams CO2/kg-fuel: jet fuel from EPA GHG and Sinks

Bruce,

See below. See if you can duplicate this effort. Thanks. Bryan

From: Herzog, Erik
Sent: Friday, September 09, 2016 2:58 PM
To: Manning, Bryan <manning.bryan@epa.gov>
Cc: Yen, David <Yen.David@epa.gov>
Subject: RE: grams CO2/kg-fuel: jet fuel from EPA GHG and Sinks

Ex. 5 - Deliberative Process

From: Manning, Bryan
Sent: Friday, September 09, 2016 11:54 AM
To: Herzog, Erik <Herzog.Erik@epa.gov>
Cc: Yen, David <Yen.David@epa.gov>
Subject: RE: grams CO2/kg-fuel: jet fuel from EPA GHG and Sinks

Ex. 5 - Deliberative Process

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Herzog, Erik
Sent: Friday, September 09, 2016 11:50 AM
To: Manning, Bryan <manning.bryan@epa.gov>
Cc: Yen, David <Yen.David@epa.gov>
Subject: RE: grams CO2/kg-fuel: jet fuel from EPA GHG and Sinks

Ex. 5 - Deliberative Process

From: Manning, Bryan
Sent: Friday, September 09, 2016 10:55 AM
To: Herzog, Erik <Herzog.Erik@epa.gov>
Cc: Yen, David <Yen.David@epa.gov>
Subject: grams CO2/kg-fuel: jet fuel from EPA GHG and Sinks

Hello Erik,

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

I hope this helps some.

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

EPA-HQ-2018-004348

To: Maeroff, Bruce[Maeroff.Bruce@epa.gov]
From: Manning, Bryan
Sent: Mon 5/2/2016 8:53:20 PM
Subject: Revised Spreadsheet for sending to FAA
Calcs Inventory Sect of Preamble for Bruce 5-2-16.xlsx

Hello Bruce,

Attached is a revised spreadsheet for sending to FAA. You were kind enough to help develop some PPT slides to explain the calculations based on an earlier version of this spreadsheet. Could you update these PPT slides based on this revised spreadsheet? Sorry about this, but I had to change the numbers based on the recent release of the Final EPA GHG & Sinks report.

Thank you for your help,

Bryan

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

To: Williams, Melina[Williams.Melina@epa.gov]; Thrift, Mike[thrift.mike@epa.gov]
Cc: Samulski, Michael[samulski.michael@epa.gov]; Jantarasami, Lesley[Jantarasami.Lesley@epa.gov]; Audette, Lucie[audette.lucie@epa.gov]
From: Manning, Bryan
Sent: Thur 12/10/2015 9:44:03 PM
Subject: Final aircraft GHG endangerment (ANPR text) - Clarification

Mike and Melina,

Sorry to bother you again.

Ex. 5 - Attorney Client

Ex. 5 - Attorney Client

Ex. 5 - Attorney Client

I hope this helps focus the basis of my questions. Any thoughts?

****

Ex. 5 - Attorney Client

****

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Manning, Bryan
Sent: Thursday, December 10, 2015 4:18 PM
To: Thrift, Mike <thrift.mike@epa.gov>; Williams, Melina <Williams.Melina@epa.gov>
Cc: Samulski, Michael <samulski.michael@epa.gov>; Jantarasami, Lesley <Jantarasami.Lesley@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>
Subject: Final aircraft GHG endangerment (ANPR text)

Hello Mike and Melina,

Ex. 5 - Attorney Client

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

EPA-HQ-2018-004348

To: Manning, Bryan[manning.bryan@epa.gov]
From: Manning, Bryan
Sent: Thur 4/28/2016 8:26:41 PM
Subject: latest spreadsheets
Calcs Inventory Sect of Preamble_4-28-16.xlsx
Calcs Inventory Sect of Preamble_4-27-16c.xlsx
WRI_CAIT World GHG 1990 to 2012_% Increase 4-27-16.xlsx

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

To: Thrift, Mike[thrift.mike@epa.gov]; Williams, Melina[Williams.Melina@epa.gov]
Cc: Samulski, Michael[samulski.michael@epa.gov]; Jantarasami, Lesley[Jantarasami.Lesley@epa.gov]; Audette, Lucie[audette.lucie@epa.gov]
From: Manning, Bryan
Sent: Thur 12/10/2015 9:18:12 PM
Subject: Final aircraft GHG endangerment (ANPR text)

Hello Mike and Melina,

Ex. 5 - Attorney Client

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

EPA-HQ-2018-004348

To: Manning, Bryan[manning.bryan@epa.gov]
From: Manning, Bryan
Sent: Wed 4/27/2016 2:30:20 PM
Subject: latest spreadsheets
WRI_CAIT World GHG 1990 to 2012_% Increase 4-27-16.xlsx
Calcs Inventory Sect of Preamble_4-27-16.xlsx

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

To: Audette, Lucie[audette.lucie@epa.gov]
From: Manning, Bryan
Sent: Wed 4/27/2016 12:20:00 PM
Subject: THANKS: Request: TPs for EU bilat by COB Weds.

Many thanks, Lucie!

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Audette, Lucie
Sent: Wednesday, April 27, 2016 8:19 AM
To: Manning, Bryan <manning.bryan@epa.gov>
Subject: RE: Request: TPs for EU bilat by COB Weds.

Will work on this!

From: Manning, Bryan
Sent: Tuesday, April 26, 2016 5:51 PM
To: Audette, Lucie <audette.lucie@epa.gov>
Cc: Samulski, Michael <samulski.michael@epa.gov>
Subject: FW: Request: TPs for EU bilat by COB Weds.

Hello Lucie,

I am having trouble finding recent talking points. I found some for Canada, and I revised them below. However, I think we need to beef them up some. Any thoughts? Note, I am working feverishly to get OGC revisions to the aircraft GHG preamble by ~11:00 am eastern tomorrow. If possible, would you mind working with Jessica on this? I will not have time until 11:00ish. Thanks.

Ex. 5 - Deliberative Process

Bryan

From: Gordon, Jessica M
Sent: Tuesday, April 26, 2016 5:11 PM
To: Manning, Bryan <manning.bryan@epa.gov>
Cc: Samulski, Michael <samulski.michael@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>
Subject: RE: Request: TPs for EU bilat by COB Weds.

Bryan,

I apologize if I've missed them, but I don't believe I have TPs on aircraft (beyond text we've approved for international statements). Could you please remind me of the context or pass them back to me?

Thanks very much, and sorry again,

Jessica

Jessica M. Gordon
International Climate Advisor

Office of Air and Radiation/Immediate Office

(202) 343-9444
gordon.jessica@epa.gov

From: Manning, Bryan
Sent: Monday, April 25, 2016 8:38 AM
To: Gordon, Jessica M <Gordon.Jessica@epa.gov>
Cc: Samulski, Michael <samulski.michael@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>
Subject: RE: Request: TPs for EU bilat by COB Weds.

Thanks for the message, Jessica. Please use the previously provided TPs for Janet on aircraft.

Thanks again,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Gordon, Jessica M
Sent: Friday, April 22, 2016 3:53 PM
To: Niebling, William <Niebling.William@epa.gov>; Franklin, Pamela <Franklin.Pamela@epa.gov>; Gunning, Paul <Gunning.Paul@epa.gov>; Harnett, Bill <Harnett.Bill@epa.gov>; Irving, Bill <Irving.Bill@epa.gov>; Krieger, Jackie <Krieger.Jackie@epa.gov>; Friedman, Kristina <Friedman.Kristina@epa.gov>; Blubaugh, Jim <Blubaugh.Jim@epa.gov>; Lupinacci, Jean <Lupinacci.Jean@epa.gov>; Newberg, Cindy <Newberg.Cindy@epa.gov>; Akerman, Nancy <Akerman.Nancy@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>
Subject: Request: TPs for EU bilat by COB Weds.

The Administrator will meet with EC VP Maros Sefcovic, who is in charge of the Energy Union, on May 3. EC has requested the following topics:

- air quality

- aviation emissions

- HFCs

- methane

- black carbon

We are also free to include other topics.

Please send me any EC-related TPs you have on these topics, or let me know if you have none. Some of you have provided TPs for Janet's and the Administrator's recent meetings with other EC officials; please tell me if you'd just like me to use those.

OITA is requesting TPs by noon on Thursday 4/28; please send me materials by COB Wednesday 4/27.

Thanks,

Jessica

To: Jantarasami, Lesley[Jantarasami.Lesley@epa.gov]
Cc: Williams, Melina[Williams.Melina@epa.gov]
From: Manning, Bryan
Sent: Fri 11/6/2015 3:34:38 PM
Subject: Draft US working paper - aircraft CO2 standard
CAEP 10 WP XX US CO2 Stringency_EPA-FAA- final 2 November 2015.docx

Hi Lesley,

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process Let me know if you have any concerns related to science issues.

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Audette, Lucie[audette.lucie@epa.gov]
Cc: Samulski, Michael[samulski.michael@epa.gov]
From: Manning, Bryan
Sent: Tue 4/26/2016 9:51:10 PM
Subject: FW: Request: TPs for EU bilat by COB Weds.

Hello Lucie,

I am having trouble finding recent talking points. I found some for Canada, and I revised them below. However, I think we need to beef them up some. Any thoughts? Note, I am working feverishly to get OGC revisions to the aircraft GHG preamble by ~11:00 am eastern tomorrow. If possible, would you mind working with Jessica on this? I will not have time until 11:00ish. Thanks.

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Bryan

From: Gordon, Jessica M
Sent: Tuesday, April 26, 2016 5:11 PM
To: Manning, Bryan <manning.bryan@epa.gov>
Cc: Samulski, Michael <samulski.michael@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>
Subject: RE: Request: TPs for EU bilat by COB Weds.

Bryan,

I apologize if I've missed them, but I don't believe I have TPs on aircraft (beyond text we've approved for international statements). Could you please remind me of the context or pass them back to me?

Thanks very much, and sorry again,

Jessica

Jessica M. Gordon
International Climate Advisor

Office of Air and Radiation/Immediate Office

(202) 343-9444
gordon.jessica@epa.gov

From: Manning, Bryan
Sent: Monday, April 25, 2016 8:38 AM

To: Gordon, Jessica M <Gordon.Jessica@epa.gov>
Cc: Samulski, Michael <samulski.michael@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>
Subject: RE: Request: TPs for EU bilat by COB Weds.

Thanks for the message, Jessica. Please use the previously provided TPs for Janet on aircraft.

Thanks again,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Gordon, Jessica M
Sent: Friday, April 22, 2016 3:53 PM
To: Niebling, William <Niebling.William@epa.gov>; Franklin, Pamela <Franklin.Pamela@epa.gov>; Gunning, Paul <Gunning.Paul@epa.gov>; Harnett, Bill <Harnett.Bill@epa.gov>; Irving, Bill <Irving.Bill@epa.gov>; Krieger, Jackie <Krieger.Jackie@epa.gov>; Friedman, Kristina <Friedman.Kristina@epa.gov>; Blubaugh, Jim <Blubaugh.Jim@epa.gov>; Lupinacci, Jean <Lupinacci.Jean@epa.gov>; Newberg, Cindy <Newberg.Cindy@epa.gov>; Akerman, Nancy <Akerman.Nancy@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>
Subject: Request: TPs for EU bilat by COB Weds.

The Administrator will meet with EC VP Maros Sefcovic, who is in charge of the Energy Union, on May 3. EC has requested the following topics:

- air quality

- aviation emissions

- HFCs

- methane

- black carbon

We are also free to include other topics.

Please send me any EC-related TPs you have on these topics, or let me know if you have none. Some of you have provided TPs for Janet's and the Administrator's recent meetings with other EC officials; please tell me if you'd just like me to use those.

OITA is requesting TPs by noon on Thursday 4/28; please send me materials by COB Wednesday 4/27.

Thanks,

Jessica

To: Maeroff, Bruce[Maeroff.Bruce@epa.gov]
From: Manning, Bryan
Sent: Tue 11/3/2015 3:55:59 PM
Subject: FW: Summary of issues with FAA cost-benefit analysis (ICAO aircraft CO2 standard)

SUMMARY of ISSUES with FAA COST-BENEFIT ANALYSIS

ANALYTICAL CONSISTENCY ISSUES:

Ex. 5 - Deliberative Process

To: Samulski, Michael[samulski.michael@epa.gov]
From: Manning, Bryan
Sent: Mon 11/2/2015 2:59:02 PM
Subject: Revised US CO2 WP - Due to Janet's comments
CAEP 10 WP XX US CO2 Stringency_23 October EPA2 + FAA.docx

Hello Mike,

Attached please find a revised US CO2 WP based on Janet's comments. I took a crack here at incorporating her comments, but let me know if you have any suggestions.

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Thrift, Mike[thrift.mike@epa.gov]
From: Manning, Bryan
Sent: Thur 10/29/2015 8:23:00 PM
Subject: THANKS: Boeing mtg on Oct 23 in Ann Arbor: Docket Materials??

Okay, Mike. Many thanks.

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Thrift, Mike
Sent: Thursday, October 29, 2015 4:03 PM
To: Manning, Bryan <manning.bryan@epa.gov>
Subject: RE: Boeing mtg on Oct 23 in Ann Arbor: Docket Materials??

Ex. 5 - Attorney Client

Mike Thrift

United States Environmental Protection Agency

Office of General Counsel

San Diego Border Office

610 West Ash Street

San Diego, CA 92101

Thrift.mike@epa.gov

619-321-1960

From: Manning, Bryan
Sent: Thursday, October 29, 2015 12:28 PM
To: Thrift, Mike <thrift.mike@epa.gov>
Subject: Boeing mtg on Oct 23 in Ann Arbor: Docket Materials??

Thank you for the reply, Mike. Since I am a bit rusty, I have another question for you.

Ex. 5 - Attorney Client

Ex. 5 - Attorney Client

Thanks again,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Thrift, Mike
Sent: Tuesday, October 27, 2015 5:39 PM
To: Manning, Bryan <manning.bryan@epa.gov>
Cc: Williams, Melina <Williams.Melina@epa.gov>; Jantarasami, Lesley <Jantarasami.Lesley@epa.gov>; Maeroff, Bruce <Maeroff.Bruce@epa.gov>
Subject: RE: Boeing mtg on Oct 23 in Ann Arbor: Docket Materials??

Ex. 5 - Attorney Client

Mike Thrift

United States Environmental Protection Agency

Office of General Counsel

San Diego Border Office

610 West Ash Street

San Diego, CA 92101

Thrift.mike@epa.gov

619-321-1960

From: Manning, Bryan
Sent: Tuesday, October 27, 2015 2:06 PM
To: Thrift, Mike <thrift.mike@epa.gov>
Cc: Williams, Melina <Williams.Melina@epa.gov>; Jantarasami, Lesley <Jantarasami.Lesley@epa.gov>; Maeroff, Bruce <Maeroff.Bruce@epa.gov>
Subject: Boeing mtg on Oct 23 in Ann Arbor: Docket Materials??

Hello Mike,

Attached please find materials from Boeing's visit to meet with us here in Ann Arbor last Friday.

Ex. 5 - Attorney Client

Ex. 5 - Attorney Client

Thank you,

Bryan

P.S. For this meeting, Boeing requested to meet with Bill Charmley et al.

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Thrift, Mike[thrift.mike@epa.gov]
From: Manning, Bryan
Sent: Thur 10/29/2015 7:27:45 PM
Subject: Boeing mtg on Oct 23 in Ann Arbor: Docket Materials??

Thank you for the reply, Mike. Since I am a bit rusty, I have another question for you.

Ex. 5 - Attorney Client

Ex. 5 - Attorney Client

Thanks again,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Thrift, Mike
Sent: Tuesday, October 27, 2015 5:39 PM
To: Manning, Bryan <manning.bryan@epa.gov>
Cc: Williams, Melina <Williams.Melina@epa.gov>; Jantarasami, Lesley <Jantarasami.Lesley@epa.gov>; Maeroff, Bruce <Maeroff.Bruce@epa.gov>
Subject: RE: Boeing mtg on Oct 23 in Ann Arbor: Docket Materials??

Ex. 5 - Attorney Client

Ex. 5 - Attorney Client

Mike Thrift

United States Environmental Protection Agency

Office of General Counsel

San Diego Border Office

610 West Ash Street

San Diego, CA 92101

Thrift.mike@epa.gov

619-321-1960

From: Manning, Bryan
Sent: Tuesday, October 27, 2015 2:06 PM
To: Thrift, Mike <thrift.mike@epa.gov>
Cc: Williams, Melina <Williams.Melina@epa.gov>; Jantarasami, Lesley <Jantarasami.Lesley@epa.gov>; Maeroff, Bruce <Maeroff.Bruce@epa.gov>
Subject: Boeing mtg on Oct 23 in Ann Arbor: Docket Materials??

Hello Mike,

Attached please find materials from Boeing's visit to meet with us here in Ann Arbor last Friday.

Ex. 5 - Attorney Client

Ex. 5 - Attorney Client

Ex. 5 - Attorney Client

Thank you,

Bryan

P.S. For this meeting, Boeing requested to meet with Bill Charmley et al.

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

EPA-HQ-2018-004348

To: Manning, Bryan[manning.bryan@epa.gov]
From: Manning, Bryan
Sent: Thur 4/21/2016 9:34:03 PM
Subject: latest spreadsheet
Calcs Inventory Sect of Preamble_4-21-16.xlsx

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

To: Richard Billings[Richard.Billings@erg.com]
Cc: James Chesnut[James.Chesnut@erg.com]; Jennifer Sellers[Jennifer.Sellers@erg.com]; Jody Tisano[Jody.Tisano@erg.com]; Maeroff, Bruce[Maeroff.Bruce@epa.gov]
From: Manning, Bryan
Sent: Thur 5/7/2015 2:30:11 PM
Subject: RE: Updated small jet report (very close to being done)
GHG Small Jet Inventory 5-5-2015+BM.docx

Nice job on the revisions (particularly Table 2-1 and the new Appendix A), Richard. We are very close to being done. See my attached minor comments (or revisions). Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Let me know if you have any questions.

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Richard Billings [mailto:Richard.Billings@erg.com]
Sent: Tuesday, May 05, 2015 2:52 PM
To: Manning, Bryan
Cc: James Chesnut; Jennifer Sellers; Jody Tisano
Subject: Updated small jet report

found all of the GHG & Sink references (more than I thought) and made them "final". Also updated table 2-1 by resorting the rows and changing the title plus we added an appendix, that should help. Let me know what you think.

Thanks.

Richard Billings

Eastern Research Group

1600 Perimeter Park Drive

Morrisville, NC 27312

(919) 468-7812

To: Thrift, Mike[thrift.mike@epa.gov]
Cc: Audette, Lucie[audette.lucie@epa.gov]; Jantarasami, Lesley[Jantarasami.Lesley@epa.gov]
From: Manning, Bryan
Sent: Mon 4/18/2016 9:24:05 PM
Subject: FW: public comment question
7.29.09 IPI Petition to EPA_Fuel Petition.pdf
Letter Withdrawing 211 Intent to Sue Notice.pdf

Hello Mike,

Ex. 5 - Attorney Client

Also, do you have 15 minutes to talk about this (including how to respond to their comments) by phone in the next few days?

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Jantarasami, Lesley
Sent: Monday, April 18, 2016 12:21 PM
To: Manning, Bryan <manning.bryan@epa.gov>
Subject: public comment question

Hi Bryan,

Ex. 5 - Attorney Client

Thanks,

Lesley

To: Williams, Melina[Williams.Melina@epa.gov]; Jantarasami, Lesley[Jantarasami.Lesley@epa.gov]; Thrift, Mike[thrift.mike@epa.gov]
From: Manning, Bryan
Sent: Wed 4/13/2016 2:22:38 PM
Subject: RE: Melina Comment on page 149 & potential response (PLEASE REVIEW)
aircraft GHG finding FRM preamble_FARdraft.docx

Melina,

Attached is a copy of the document. Thanks.

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Williams, Melina
Sent: Wednesday, April 13, 2016 9:13 AM
To: Manning, Bryan <manning.bryan@epa.gov>; Jantarasami, Lesley <Jantarasami.Lesley@epa.gov>; Thrift, Mike <thrift.mike@epa.gov>
Subject: RE: Melina Comment on page 149 & potential response (PLEASE REVIEW)

Hi Bryan,

Ex. 5 - Attorney Client

Thanks,

Melina

Melina Williams | US EPA | Office of General Counsel | Air and Radiation Law Office | Mail Code 2344A | phone: (202) 564-3406 | fax: (202) 564-5603

The contents of this e-mail and any attachments to it may contain deliberative-process, attorney-client, attorney work product, or otherwise privileged material. Do not distribute outside of EPA or DOJ.

From: Manning, Bryan
Sent: Wednesday, April 13, 2016 8:56 AM
To: Williams, Melina <Williams.Melina@epa.gov>; Jantarasami, Lesley <Jantarasami.Lesley@epa.gov>; Thrift, Mike <thrift.mike@epa.gov>
Subject: Melina Comment on page 149 & potential response (PLEASE REVIEW)

Hello Melina, Mike, and Lesley,

Ex. 5 - Attorney Client

Ex. 5 - Attorney Client

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Jantarasami, Lesley[Jantarasami.Lesley@epa.gov]
From: Manning, Bryan
Sent: Mon 4/11/2016 7:58:54 PM
Subject: FW: Intersection between aircraft CO2 standards and the ICAO MBM process: recent Administrator McCarthy comments

Lesley,

See below email from Bill to Paul et al. Thanks.

Bryan

From: Charmley, William
Sent: Monday, April 11, 2016 2:37 PM
To: Audette, Lucie <audette.lucie@epa.gov>; Samulski, Michael <samulski.michael@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>
Subject: FW: Intersection between aircraft CO2 standards and the ICAO MBM process: recent Administrator McCarthy comments

Dear all -

Below is the email I sent to Chris and Sarah Dunham. I included both the inside EPA article and the draft language from the Final Endangerment Finding on the ICAO process.

Lucie – thanks for helping me with this earlier today.

Bill

From: Gunning, Paul
Sent: Monday, April 11, 2016 12:27 PM
To: Charmley, William <charmley.william@epa.gov>; Grundler, Christopher <grundler.christopher@epa.gov>; Dunham, Sarah <Dunham.Sarah@epa.gov>
Cc: Hengst, Benjamin <Hengst.Benjamin@epa.gov>; Samulski, Michael <samulski.michael@epa.gov>; Birnbaum, Rona <Birnbaum.Rona@epa.gov>
Subject: RE: Intersection between aircraft CO2 standards and the ICAO MBM process: recent Administrator McCarthy comments

Bill, thanks for flagging this as we were not aware of the remarks. Looping in Rona too as we are beginning internal review of the preamble language.

Paul

From: Charmley, William
Sent: Monday, April 11, 2016 11:02 AM
To: Grundler, Christopher <grundler.christopher@epa.gov>; Dunham, Sarah <Dunham.Sarah@epa.gov>; Gunning, Paul <Gunning.Paul@epa.gov>
Cc: Hengst, Benjamin <Hengst.Benjamin@epa.gov>; Gunning, Paul <Gunning.Paul@epa.gov>; Samulski, Michael <samulski.michael@epa.gov>
Subject: Intersection between aircraft CO2 standards and the ICAO MBM process: recent Administrator McCarthy comments

Dear Chris, Sarah, and Paul

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

The article has the title "**McCarthy Warns EPA Could Issue Stronger Aircraft GHG Rule If Global Talks Slip**"

This article includes the following:

After the ICAO council endorses the CO2 standard in June and the full assembly approves the m
member countries must codify it into their domestic law.

EPA began that process last summer, issuing a proposed endangerment finding -- a legal prereq
GHG regulation -- as well as an advanced notice of proposed rulemaking that took comment on s
debated in the ICAO negotiations. The agency intends to finalize its endangerment finding this su

That endangerment finding, McCarthy said during an April 7 event in Ottawa, Canada, can be us
translate the ICAO standard into domestic law. But, "[i]f the ICAO process is not sufficient, it is an
independently move forward," the administrator added.

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

I do not expect either of you to read it, but attached is the current 17 pages of discussion in the draft Final Endangerment Finding which discusses the overall topic of EPA aircraft standards and ICAO, including the IACO CO2 standards and EPA CO2 standards NPRM. I have included the very limited discussion of the NPRM at the bottom of this email.

Ex. 5 - Deliberative Process However, I do want to make sure you are both aware of how we talk about this topic.

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

I expect that both FAA and others will have detailed comments on this text during interagency review. We are also considering sending these 16 pages to FAA in the next day or two, prior to the formal interagency review, as a courtesy.

Please let me know if you have any comments or questions on this topic.

Thanks

Bill

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

EPA-HQ-2018-004348

To: Manning, Bryan[manning.bryan@epa.gov]
From: Manning, Bryan
Sent: Thur 3/31/2016 10:15:17 PM
Subject: latest spreadsheet
Calcs Inventory Sect of Preamble with 2012 WRI-CAIT data 3-31-16.xlsx

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

To: Yen, David[Yen.David@epa.gov]
From: Manning, Bryan
Sent: Mon 6/29/2015 8:32:43 PM
Subject: FW: Materials for Monday (11:45) meeting with Janet on Aircraft
Janet McCabe Briefing ICAO CO2 Standard SG15 Mtg 6-29-15 v2.pptx

David,

Attached is the updated version. Thanks. Bryan

From: Manning, Bryan
Sent: Monday, June 29, 2015 11:02 AM
To: Sutton, Tia
Subject: FW: Materials for Monday (11:45) meeting with Janet on Aircraft

Hello Tia,

If we can replace the Janet briefing for 11:45, attached is the updated version. Slide #19 has been updated (this is the only revision).

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Leggett, Cullen
Sent: Monday, June 29, 2015 10:24 AM
To: Manning, Bryan; Audette, Lucie
Subject: RE: Materials for Monday (11:45) meeting with Janet on Aircraft

Updated slide deck w/ side 19 corrected.

From: Manning, Bryan
Sent: Friday, June 26, 2015 1:19 PM
To: Sutton, Tia; Hengst, Benjamin
Cc: Iffland, JoNell; Leggett, Cullen; Yen, David; Mueller, John; OTAQ Materials; Charmley, William; Samulski, Michael; Audette, Lucie; Maeroff, Bruce
Subject: Materials for Monday (11:45) meeting with Janet on Aircraft

Hello,

Attached are the materials for our Monday, June 29 (at 11:45) briefing with Janet on Aircraft (ICAO CO2 Standard). These materials are ready to go to OAR. Let us know if you have any questions.

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Sutton, Tia[sutton.tia@epa.gov]
From: Manning, Bryan
Sent: Mon 6/29/2015 3:02:16 PM
Subject: FW: Materials for Monday (11:45) meeting with Janet on Aircraft
Janet McCabe Briefing ICAO CO2 Standard SG15 Mtg 6-29-15 v2.pptx

Hello Tia,

If we can replace the Janet briefing for 11:45, attached is the updated version. Slide #19 has been updated (this is the only revision).

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Leggett, Cullen
Sent: Monday, June 29, 2015 10:24 AM
To: Manning, Bryan; Audette, Lucie
Subject: RE: Materials for Monday (11:45) meeting with Janet on Aircraft

Updated slide deck w/ side 19 corrected.

From: Manning, Bryan
Sent: Friday, June 26, 2015 1:19 PM
To: Sutton, Tia; Hengst, Benjamin
Cc: Iffland, JoNell; Leggett, Cullen; Yen, David; Mueller, John; OTAQ Materials; Charmley, William; Samulski, Michael; Audette, Lucie; Maeroff, Bruce
Subject: Materials for Monday (11:45) meeting with Janet on Aircraft

Hello,

Attached are the materials for our Monday, June 29 (at 11:45) briefing with Janet on Aircraft (ICAO CO2 Standard). These materials are ready to go to OAR. Let us know if you have any questions.

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Orlin, David[Orlin.David@epa.gov]
Cc: Samulski, Michael[samulski.michael@epa.gov]; Audette, Lucie[audette.lucie@epa.gov]; Thrift, Mike[thrift.mike@epa.gov]
From: Manning, Bryan
Sent: Fri 10/21/2016 6:25:16 PM
Subject: FW: Early Guidance Briefing Materials- Aircraft GHG Standards
Early Guidance Briefing_Aircraft GHG Std_October 25 2016.pptx

Hi David,

Per your request, attached please find the slides for this Early Guidance Briefing. Sorry to hear that you will not be able to make the meeting on Oct 25.

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Audette, Lucie
Sent: Wednesday, October 19, 2016 4:05 PM
To: Schillo, Bruce <Schillo.Bruce@epa.gov>; Griffiths, Charles <Griffiths.Charles@epa.gov>; Benner, Tim <Benner.Tim@epa.gov>; Dutton, Steven <Dutton.Steven@epa.gov>; McDow, Stephen <McDow.Stephen@epa.gov>; Belser, Evan <Belser.Evan@epa.gov>; Thrift, Mike

<thrift.mike@epa.gov>; Birkett, Daniel <Birkett.Daniel@epa.gov>; Castro, Marina <Castro.Marina@epa.gov>; Aspy, Dale <Aspy.Dale@epa.gov>; Powell, Alan <Powell.Alan@epa.gov>; Aumann, Ethan <Aumann.Ethan@epa.gov>; Russ, Timothy <Russ.Tim@epa.gov>
Cc: Manning, Bryan <manning.bryan@epa.gov>
Subject: Early Guidance Briefing Materials- Aircraft GHG Standards

Dear workgroup members,

Attached is the Early Guidance Briefing for the Proposed Aircraft GHG Emissions Standards and Test Procedures which is schedule with Janet McCabe for this coming Tuesday, October 25 from 3-4 pm. Your respective AAs and you should each have received a meeting invite along with room number/call-in number.

Please let me know if you have any questions or comments with regard to the attached materials.

Thanks so much. Lucie

To: Thrift, Mike[thrift.mike@epa.gov]
Cc: Audette, Lucie[audette.lucie@epa.gov]; Samulski, Michael[samulski.michael@epa.gov]
From: Manning, Bryan
Sent: Thur 3/31/2016 7:06:06 PM
Subject: Bill Charmley comment: sect II of aircraft GHG endang FRM (PLEASE REVIEW)

Hello Mike,

We just received comments from Bill Charley on section II of the aircraft GHG endangerment FRM.

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Since you had reviewed this section II recently, I wanted to make sure you were okay with this suggested edits above and on page 24 of the preamble (SharePoint). Let us know if you are okay with this.

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Thrift, Mike[thrift.mike@epa.gov]
Cc: Williams, Melina[Williams.Melina@epa.gov]; Jantarasami, Lesley[Jantarasami.Lesley@epa.gov]; Maeroff, Bruce[Maeroff.Bruce@epa.gov]
From: Manning, Bryan
Sent: Tue 10/27/2015 9:05:54 PM
Subject: Boeing mtg on Oct 23 in Ann Arbor: Docket Materials??
Boeing_Draft_Agenda.pdf
Boeing_AviationCO2EmissionsReductionStrategy.pdf
Boeing_ICAO CO2 Std_Perspective_Overview.pdf

Hello Mike,

Attached please find materials from Boeing's visit to meet with us here in Ann Arbor last Friday.

Ex. 5 - Attorney Client

Ex. 5 - Attorney Client

Thank you,

Bryan

P.S. For this meeting, Boeing requested to meet with Bill Charmley et al.

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Audette, Lucie[audette.lucie@epa.gov]
From: Manning, Bryan
Sent: Fri 6/26/2015 5:50:31 PM
Subject: FYI: Materials for Monday, 6/29 (11:45) meeting with Janet on Aircraft
Janet McCabe Briefing ICAO CO2 Standard SG15 Mtg 6-29-15.pptx

FYI, Lucie. Tia sent this to Janet's office. Thanks. Bryan

From: Sutton, Tia
Sent: Friday, June 26, 2015 1:49 PM
To: OAR Briefings
Cc: Manning, Bryan; Charmley, William; Hengst, Benjamin; Samulski, Michael
Subject: Materials for Monday, 6/29 (11:45) meeting with Janet on Aircraft

Hi all,
Attached are materials for Janet's 11:45am briefing on Monday, June 29th on Aircraft (ICAO CO_2 Standard).

Thank you,
Tia

To: Thrift, Mike[thrift.mike@epa.gov]
Cc: Samulski, Michael[samulski.michael@epa.gov]
From: Manning, Bryan
Sent: Mon 10/26/2015 2:34:05 PM
Subject: Gina Briefing - aircraft CO2 (PLEASE REVIEW)
ICAO Aircraft CO2 Std_Gina briefing 10-23-15.pptx

Hello Mike,

As you may know, we are scheduled to brief Gina McCarthy on Oct 30 at 11:30 eastern – on the aircraft CO2 standard in CAEP. We already had a pre-brief with Janet McCabe on Oct 13, and

Ex. 5 - Attorney Client **Ex. 5 - Attorney Client**

We believe we have done so on slide #7 of the attachment. Let us know if you have any comments on this slide. Of course, feel free to review the rest of the briefing as well.

Note, this briefing is still being reviewed internally within my office by others, and we wanted to make sure we received your review at the same time.

Thank you,

Bryan

P.S. We are scheduled to pre-brief Janet again on Oct 29 at noon eastern.

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Samulski, Michael[samulski.michael@epa.gov]
From: Manning, Bryan
Sent: Fri 10/23/2015 8:17:35 PM
Subject: Updated Gina Briefing - aircraft CO2 (PLEASE REVIEW)
ICAO Aircraft CO2 Std_Gina briefing 10-23-15.pptx

Hello Mike,

Attached please find an updated Gina briefing for the US position on the aircraft CO2 standard. Ex. 5 - Deliberative Process Ex. 5 - Deliberative Process Let me know what you think - or if you have any other comments.

Ex. 5 - Deliberative Process

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Samulski, Michael[samulski.michael@epa.gov]; Audette, Lucie[audette.lucie@epa.gov]
From: Manning, Bryan
Sent: Wed 10/19/2016 4:26:57 PM
Subject: Revised Early Guidance Briefing: (PLEASE REVIEW)
Early Guidance Briefing_Aircraft GHG Std_Oct 19 2016.pptx

Hi Mike and Lucie,

Attached please find the revised Early Guidance briefing. Let me know if you have any comments.

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

EPA-HQ-2018-004348

To: Manning, Bryan[manning.bryan@epa.gov]
From: Manning, Bryan
Sent: Wed 10/21/2015 9:44:05 PM
Subject: us paper
CAEP 10 WP XX US CO2 Stringency_v2 20 October+EPA.docx

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

To: Samulski, Michael[samulski.michael@epa.gov]; Audette, Lucie[audette.lucie@epa.gov]
From: Manning, Bryan
Sent: Mon 12/15/2014 5:52:48 PM
Subject: RE: draft revised talking points for Janet
Notes for Meeting with Rich Swayze 12 15 14+BM.docx

Thank you, Mike. Your revisions look fine. I have a two suggested additions on pages 1-2.

Thanks again,

Bryan

From: Samulski, Michael
Sent: Monday, December 15, 2014 12:32 PM
To: Audette, Lucie; Manning, Bryan
Subject: draft revised talking points for Janet

Here is an updated briefing document. Please have a look at the first 3 pages and let me know if I missed anything.

Thanks,

Mike

****
Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov
****

To: Audette, Lucie[audette.lucie@epa.gov]; Jantarasami, Lesley[Jantarasami.Lesley@epa.gov]
From: Manning, Bryan
Sent: Wed 11/12/2014 10:44:22 PM
Subject: FW: Aircraft CO2 reporting requirement - earlier exchange with Mike Thrift
Aircraft engines and Mandatory Reporting Rule of 2009-mt110113.docx
Guidance letter from CISD.pdf
CD-14-01 guidance letter.pdf

Hello,

Attached (1st attachment) and below is feedback from Mike Thrift (red font) on a reporting requirement Q&A that Lucie drafted a while back. Also, attached (2nd and 3rd attachments) are draft guidance letters to manufacturers for reporting aircraft engine emissions. The 2nd attachment was tied to the GHG reporting rule, and the 3rd attachment was tied to our 2012 aircraft engine rule. Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process I hope this helps some.

Thank you,

Bryan

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

From: Manning, Bryan
Sent: Tuesday, October 22, 2013 10:27 AM
To: Audette, Lucie
Subject: Aircraft CO2 reporting requirement - earlier exchange with Mike Thrift

Hello Lucie,

I stopped by this morning to confirm the changes (upfront) that need to be made to the aircraft GHG briefing for Janet McCabe, but you were away from your desk. When would be a good time to stop by today? I am available except 1:00-2:30 today.

FYI, see below for the earlier email exchanges we had with OGC's Mike Thrift about an aircraft CO2 reporting requirement.

Ex. 5 - Deliberative Process Ex. 5 - Deliberative Process

Thank you,

Bryan

From: thrift, mike
Sent: Friday, February 08, 2013 11:37 AM
To: Manning, Bryan
Subject: Re: Aircraft CO2 cert requirement question (quick question) - PLEASE READ

Ex. 5 - Attorney Client

Mike Thrift
U.S. Environmental Protection Agency
Office of General Counsel (2344-A)
1200 Pennsylvania Ave., NW
Washington, D.C. 20460

From: Bryan Manning/AA/USEPA/US
To: Mike Thrift/DC/USEPA/US@EPA
Date: 02/08/2013 11:19 AM
Subject: Aircraft CO2 cert requirement question (quick question) - PLEASE READ

Hello Mike

Ex. 5 - Attorney Client

Thank you,

Bryan

----- Forwarded by Bryan Manning/AA/USEPA/US on 02/08/2013 11:07 AM -----

From: Bryan Manning/AA/USEPA/US
To: Mike Thrift/DC/USEPA/US@EPA
Cc: John Mueller/AA/USEPA/US@EPA, Michael Samulski/AA/USEPA/US@EPA
Date: 11/15/2012 02:06 PM
Subject: Re: Aircraft CO2 cert requirement question

Ex. 5 - Attorney Client

Let me know if you have further questions.

Thanks again,

Bryan
[attachment "CAEP9_WP-XXX.2_CO2TG Report_Appendix E_Annex_16 Volume_III CO2 Standard (121012.pdf" deleted by Mike Thrift/DC/USEPA/US]

From: Mike Thrift/DC/USEPA/US
To: Bryan Manning/AA/USEPA/US@EPA
Cc: John Mueller/AA/USEPA/US@EPA, Michael Samulski/AA/USEPA/US@EPA
Date: 11/15/2012 01:37 PM
Subject: Re: Aircraft CO2 cert requirement question

Ex. 5 - Attorney Client

Mike Thrift
U.S. Environmental Protection Agency
Office of General Counsel (2344-A)
1200 Pennsylvania Ave., NW
Washington, D.C. 20460

-----Bryan Manning/AA/USEPA/US wrote: -----
To: Mike Thrift/DC/USEPA/US@EPA
From: Bryan Manning/AA/USEPA/US
Date: 11/15/2012 01:28PM
Cc: John Mueller/AA/USEPA/US@EPA, Michael Samulski/AA/USEPA/US@EPA
Subject: Re: Aircraft CO2 cert requirement question

Thank you for the reply, Mike. It is helpful.

Ex. 5 - Attorney Client

Ex. 5 - Attorney Client

hope this helps some.

Thanks again,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality
Assessment and Standards Division
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

Mike Thrift---11/15/2012 12:56:39 PM---Ex. 5 - Attorney Client

Ex. 5 - Attorney Client

From: Mike Thrift/DC/USEPA/US
To: Bryan Manning/AA/USEPA/US@EPA
Cc: John Mueller/AA/USEPA/US@EPA, Michael Samulski/AA/USEPA/US@EPA
Date: 11/15/2012 12:56 PM
Subject: Re: Aircraft CO2 cert requirement question

Ex. 5 - Attorney Client

Mike Thrift
U.S. Environmental Protection Agency
Office of General Counsel (2344-A)
1200 Pennsylvania Ave., NW
Washington, D.C. 20460

-----Bryan Manning/AA/USEPA/US wrote: -----
To: Mike Thrift/DC/USEPA/US@EPA
From: Bryan Manning/AA/USEPA/US
Date: 11/15/2012 11:06AM
Cc: John Mueller/AA/USEPA/US@EPA, Michael Samulski/AA/USEPA/US@EPA
Subject: Aircraft CO2 cert requirement question

Hello Mike,

Any thoughts on the below message(s) from last week?

Thanks,

Bryan
----- Forwarded by Bryan Manning/AA/USEPA/US on 11/15/2012 11:04 AM -----

From: Bryan Manning/AA/USEPA/US
To: Mike Thrift/DC/USEPA/US@EPA
Cc: John Mueller/AA/USEPA/US@EPA, Michael Samulski/AA/USEPA/US@EPA
Date: 11/08/2012 05:38 PM
Subject: Fw: Aircraft CO2 cert requirement question

Hello Mike,

Ex. 5 - Attorney Client

Ex. 5 - Attorney Client Then, when you have a moment, let me know if you have any thoughts on my related questions (asked above).

Thank you,

Bryan

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Assessment and Standards Division
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov
----- Forwarded by Bryan Manning/AA/USEPA/US on 11/08/2012 05:31 PM -----

From: Bryan Manning/AA/USEPA/US
To: John Mueller/AA/USEPA/US@EPA
Date: 11/08/2012 02:51 PM
Subject: Re: Fw: Aircraft CO2 cert requirement question

Sorry for the delay on a response, John. I talked this over with Mike Samulski, and we agreed on the response in bold font below.

Thanks,

Bryan

John Mueller---11/07/2012 10:36:40 AM---Bryan - here is the email exchange in the CO2 cert requirement. Any isight would be appreciated.

From: John Mueller/AA/USEPA/US
To: Bryan Manning/AA/USEPA/US@EPA
Date: 11/07/2012 10:36 AM
Subject: Fw: Aircraft CO2 cert requirement question

Ex. 5 - Deliberative Process Any isight would be appreciated.

John

-----Forwarded by John Mueller/AA/USEPA/US on 11/07/2012 10:35AM -----
To: John Mueller/AA/USEPA/US@EPA
From: Mike Thrift/DC/USEPA/US
Date: 10/25/2012 03:32PM
Subject: Aircraft CO2 cert requirement question

Ex. 5 - Attorney Client

Mike Thrift
U.S. Environmental Protection Agency
Office of General Counsel (2344-A)
1200 Pennsylvania Ave., NW
Washington, D.C. 20460

-----John Mueller/AA/USEPA/US wrote: -----
To: Mike Thrift/DC/USEPA/US@EPA
From: John Mueller/AA/USEPA/US
Date: 10/25/2012 02:50PM
Subject: Aircraft CO2 cert requirement question

Hey Mike,

Ex. 5 - Attorney Client

Thanks,
John

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL VEHICLE AND FUEL EMISSIONS LABORATORY
2565 PLYMOUTH ROAD
ANN ARBOR, MICHIGAN 48105-2498

OFFICE OF
AIR AND RADIATION

January 21, 2014

CD-14-01 (Aircraft)

SUBJECT: Submission of Required Compliance Reports by Aircraft Engine Manufacturers

Dear Manufacturer:

This letter is to inform you of your obligation to submit various required reports to EPA under our regulations covering your industry and of EPA's future plans to ensure industry compliance with these requirements. These requirements arose out of the Mandatory Green House Gas Reporting Rule, promulgated in October 2009, which can be found in 40 CFR Part 87.64 and the Tier 6 and Tier 8 NOx requirements, promulgated in June 2012, which can be found in 40 CFR Part 87.42.

Under these EPA regulations covering aircraft turbine engines, manufacturers holding U.S. FAA type certificates are required to submit exhaust emission data (NO_x,HC, CO, Smoke and CO_2) to EPA to comply with the terms of the reporting requirements.

To promote full manufacturer compliance in this area, we have created a template for manufacturers to use that has been posted at http://www.epa.gov/otaq/certdat2.htm. All completed templates should be emailed annually to aircraft_engine_reporting@epa.gov by February 28 each year.

Additionally, EPA will be actively monitoring the compliance status for all reports you are required to file. Failure to file a required report is a prohibited act under our regulations and can result in referral of your violation of our regulations to the EPA Office of Enforcement and Compliance Assurance for possible administrative civil penalties (monetary fines) against you. If you are not the correct person in your organization to be receiving this request, we request that you both forward this request to the proper person and inform us via the email address listed below.

Any questions you may have regarding reporting requirements for your industry should be directed to aircraft_engine_reporting@epa.gov.

Sincerely,

Byron Bunker, Director
Compliance Division
Office of Transportation and Air Quality

To: Samulski, Michael[samulski.michael@epa.gov]
From: Manning, Bryan
Sent: Thur 10/1/2015 9:08:08 PM
Subject: Draft Gina briefing: aircraft CO2 Standard (PLEASE REVIEW)
ICAO Aircraft CO2 Standard for Gina McCarthy_10-1-15.pptx

Hello Mike,

Attached please find a rough draft Gina briefing on the aircraft CO2 standard. Note, I put a lot in the appendix for now. At this point, I am just trying to get a read if I am going in the right direction with this briefing.

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Samulski, Michael[samulski.michael@epa.gov]
From: Manning, Bryan
Sent: Tue 6/23/2015 5:20:44 PM
Subject: RE: Revised Janet Briefing (ready to send to Bill)
Janet McCabe Briefing ICAO SG15 Mtg 6-22-15.pptx

Hello Mike,

As we discussed, attached please find the latest version of the Janet Briefing to send to Bill. Thanks.

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Samulski, Michael
Sent: Tuesday, June 23, 2015 12:38 PM
To: Manning, Bryan
Subject: Revised Janet Briefing

Bryan,

I made some revisions to the briefing, mostly in terms of trying to get the information level right for Janet.

See what you think.

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

EPA-HQ-2018-004348

To: Manning, Bryan[manning.bryan@epa.gov]
From: Manning, Bryan
Sent: Wed 9/30/2015 9:26:04 PM
Subject: CO2 Gina brfg
ICAO Aircraft CO2 Standard for Gina McCarthy_9-30-15.pptx

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

To: Jantarasami, Lesley[Jantarasami.Lesley@epa.gov]
Cc: Audette, Lucie[audette.lucie@epa.gov]
From: Manning, Bryan
Sent: Mon 3/23/2015 5:43:56 PM
Subject: Revised ERG report - GA GHG jet fuel breakout
GHG Small Jet Inventory-3-20-15 master-tracked.docx
GHG Small Jet Inventory-3-20-15 master-tracked.pdf
Documentation Small Jet Review Process.docx
Documentation Small Jet Review Process.pdf
GHG Small Jet Inventory 3-20-15 master-clean.docx

Hello Lesley,

Ex. 5 - Deliberative Process

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Richard Billings [mailto:Richard.Billings@erg.com]
Sent: Monday, March 23, 2015 12:05 PM
To: Manning, Bryan; Maeroff, Bruce; Yen, David
Cc: Jody Tisano; James Chesnut; Jennifer Sellers
Subject: FW: Files attached...

Bryan,

Attached is the QA/Peer review summary.

Ex. 5 - Deliberative Process

Let me know if you have any questions…

Richard

Richard Billings
Eastern Research Group
1600 Perimeter Park Drive, Morrisville, NC 27560
(919) 468-7812

To: Samulski, Michael[samulski.michael@epa.gov]
From: Manning, Bryan
Sent: Tue 3/17/2015 6:59:53 PM
Subject: RE: EPA Aircraft GHG/EF - supplemental document

Sorry, Mike. Disregard my earlier message. Our emails crossed in real time.

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Samulski, Michael
Sent: Tuesday, March 17, 2015 2:56 PM
To: Hengst, Benjamin; Manning, Bryan
Subject: RE: EPA Aircraft GHG/EF - supplemental document

No. We shared a copy of this report with FAA when we shared the ANPR for review.

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Hengst, Benjamin
Sent: Tuesday, March 17, 2015 2:44 PM
To: Manning, Bryan
Cc: Samulski, Michael
Subject: Re: EPA Aircraft GHG/EF - supplemental document

FAA won't be surprised, right?

On Mar 17, 2015, at 1:21 PM, Manning, Bryan <manning.bryan@epa.gov> wrote:

> Hello Ben,
>
> As you may recall, last Friday you asked for this attached ICF report (according to OMB's request) -- "ICF, *CO2 Analysis of CO2-Reducing Technologies for Aircraft*, Final Report, EPA Contract Number EP-C-12-011." This report was referenced in footnote 237 of the draft aircraft GHG endangerment/ANPR. ICF completed the revisions to the report today (as described below). It is ready to go to OMB. Sorry for the delay. Let me know if you have any questions.
>
> Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Hengst, Benjamin
Sent: Friday, March 13, 2015 4:35 PM
To: Manning, Bryan; Samulski, Michael; Audette, Lucie; Leggett, Cullen
Cc: Sutton, Tia; Orlin, David
Subject: RE: EPA Aircraft GHG/EF - supplemental document

Yes—we can wait until you are ready

From: Manning, Bryan
Sent: Friday, March 13, 2015 4:29 PM
To: Hengst, Benjamin; Samulski, Michael; Audette, Lucie; Leggett, Cullen
Cc: Sutton, Tia; Orlin, David
Subject: RE: EPA Aircraft GHG/EF - supplemental document

Thank you for the message, Ben. As you may know, footnote 237 states the following: "ICF, *CO2 Analysis of CO2-Reducing Technologies for Aircraft*, Final Report, EPA Contract Number EP-C-12-011, page 32 [INSERT FINAL DATE]." We shared this draft

report with FAA. Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Thanks again,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Hengst, Benjamin
Sent: Friday, March 13, 2015 4:11 PM
To: Samulski, Michael; Manning, Bryan; Audette, Lucie; Leggett, Cullen
Cc: Sutton, Tia; Orlin, David
Subject: FW: EPA Aircraft GHG/EF - supplemental document

Can you guys send this to me and Tia so we can forward to OMB?

From: Whiteman, Chad Ex. 6 - EOP
Sent: Friday, March 13, 2015 3:53 PM
To: Sutton, Tia; Hengst, Benjamin
Subject: RE: EPA Aircraft GHG/EF - supplemental document

Would you folks please provide the ICR study referenced in footnote 237? Thanks, Chad

<ICF_CO2 Analysis of CO2-Reducing Technologies for Aircraft_March 17 2015.docx>

To: --- Ex. 6 - Personal Privacy
Cc: OTAQ[OTAQ@epa.gov]
Bcc: Simon, Joseph[Simon.Joseph@epa.gov]; Maeroff, Bruce[Maeroff.Bruce@epa.gov]
From: Manning, Bryan
Sent: Tue 3/10/2015 4:19:03 PM
Subject: RE: Your EPA Inquiry - It's time to act on aircraft emissions

Dear Mickael Belot:

Thank you for your email of February 1, 2015, in which you express support for the Environmental Protection Agency's rulemaking now underway, and in consultation with Federal Aviation Administration (FAA), which begins the regulatory process for addressing greenhouse gas (GHG) emissions from aircraft engines. Our Administrator has asked us to answer on her behalf.

This rulemaking will determine whether GHG emissions from aircraft engines cause or contribute to the endangerment of public health or welfare and thus should be regulated under the Clean Air Act. These findings, if made, are a necessary first step to adopting any aircraft engine GHG emission standards.

Concurrent with the proposed findings that we expect to issue in May 2015, the EPA plans to release an Advance Notice of Proposed Rulemaking (ANPR) to provide an overview of the International Civil Aviation Organization's (ICAO) efforts to establish an international, technology-based CO2 aircraft emissions standard. The ANPR will include progress to date on the ICAO efforts, and the potential use of section 231 of the Clean Air Act to promulgate under domestic law standards that are of at least equal stringency to the international CO2 standards, ensuring transparency and the opportunity for public comment.

We note your concerns regarding the ICAO deliberations. Both the FAA and the EPA have worked through ICAO to set international aircraft engine emissions standards and related requirements, which we then work to adopt domestically using our authority under sections 231 and 232 of the Clean Air Act. Both of our agencies have been engaged since 2010 at ICAO to develop international CO2 emissions aircraft standards that achieve meaningful reductions. We will continue working diligently toward such standards, which are scheduled to be agreed to in February 2016.

We look forward to receiving your comments on the proposed findings and ANPR when they are released this spring. Should you have any questions, please feel free to contact me.

Sincerely,

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

Ex. 6 - Personal Privacy

To: OTAQ@EPA
Date: 02/01/2015 11:33 AM
Subject: Your EPA Inquiry - (001113324) Ex. 6 - Personal Privacy - It's time to act on aircraft emissions - OTAQ Web

---

UserWord
human
Word
human
comments
Dear Administrator McCarthy,

I'm writing to express strong support for the important rulemaking process now underway at the Environmental Protection Agency, in consultation with the Federal Aviation Administration, to set emission standards to curb greenhouse gas pollution from the nation's aircraft fleet.

I urge the EPA to analyze all measures available to reduce greenhouse gas emissions from new and existing aircraft under Section 231 of the Clean Air Act in the forthcoming advanced notice of proposed rulemaking (ANPR), with the goal of proposing final standards no later than the end of 2015.

Greenhouse gas emissions from aircraft are currently responsible for more than 3 percent of total U.S. emissions and are one of the fastest-growing carbon pollution sources, on track to triple globally by 2050 under business-as-usual scenarios. Yet, if we are to avoid the worst effects of climate change by holding the average global temperature increase to or below 2Â°C above preindustrial levels, greenhouse gas emissions from all sources must be substantially reduced over that same time period and must reach near-zero levels well before the end of the century.

The EPA has an acknowledged duty under the Clean Air Act to set domestic emission standards regardless of whether the International Civil Aviation Organization proceeds. I urge EPA to go beyond a discussion of International Civil Aviation Organization's standard-setting efforts and to analyze all means available to EPA and FAA to reduce aircraft carbon emissions.

Sincerely,

Mickael Belot
email
Ex. 6 - Personal Privacy
name
Mickael
org

referrer
http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CCkQFjAB&url=http%3A%2
cmt.htm&ei=81TOVMbnEMvTaPH gAg&usg=AFQjCNFMOPEkK5F9cyfpe8Z1jcYPUAK-
cw&bvm=bv.85076809,d.d2s
ssubject
It's time to act on aircraft emissions

WARNING NOTICE
This electronic mail originated from a federal government
computer system of the United States Environmental
Protection Agency (EPA). Unauthorized access or use
of this EPA system may subject violators to criminal,
civil and/or administrative action. For official
purposes, law enforcement and other authorized personnel
may monitor, record, read, copy and disclose all
information which an EPA system processes. Any person's
access or use, authorized and unauthorized, of this EPA
system to send electronic mail constitutes consent to these
terms.

This information is for tracking purposes only.
Submitting script: /cgi-bin/mail.cgi
Submitting host: /cgi-bin/mail.cgi (86.220.251.41)
Browser: Mozilla/5.0 (Windows NT 6.1; WOW64; Trident/7.0; rv:11.0) like Gecko
Referred: http://www.epa.gov/otaq/oms-cmt.htm
TSSMS: orcdizux
Mail to File: omsmail.txt

To: Audette, Lucie[audette.lucie@epa.gov]
From: Manning, Bryan
Sent: Fri 5/15/2015 3:33:25 AM
Subject: Revised Stakeholder Call List and attached email distribution list
Roll Out -Aviation Endagerment-NPRM 5-1+BM2.docx
Contact list 5-14-15.xls

Hello Lucie,

Ex. 5 - Deliberative Process

FYI, I was not able to upload the latest versions of the two attachments on the h:drive (from home).

Thank you,

Bryan

P.S. Of course, we will want to discuss the stakeholder call list with Mike Samulski on Monday.

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Ghanta, Venu[Ghanta.Venu@epa.gov]
Cc: Maeroff, Bruce[Maeroff.Bruce@epa.gov]
From: Manning, Bryan
Sent: Thur 5/8/2014 10:30:41 PM
Subject: Data for latest EPA GHG Report
Mobile Sources - U.S. Inventory of GHG Emissions and Sinks 1900-2011 .xlsx

Hello Venu,

I hope you are well. If you do not mind me asking, do you have a similar file to the attached Excel file (for the 2013 report) for the latest EPA GHG and Sinks Report (2014 report)? You were kind enough to provide me the attachment last year, and thus, I thought you may have it this year (2014) as well.

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Samulski, Michael[samulski.michael@epa.gov]; Audette, Lucie[audette.lucie@epa.gov]; Jantarasami, Lesley[Jantarasami.Lesley@epa.gov]; Sutton, Tia[sutton.tia@epa.gov]
From: Manning, Bryan
Sent: Mon 8/31/2015 3:22:37 PM
Subject: Presentation for Air Division Directors' Briefing (Sept 1)
Aircraft GHG Emissions for Air Division Directors Briefing 8-31-15.pptx

Hello,

Based on a comment from Lesley (2nd bullet, slide #8), attached please find the updated presentation for the Air Division Directors' Briefing on Sept 1. Tia, this presentation is ready to be sent to the Air Division Directors (after you have a look through it) for tomorrow's 2:00 call

Thanks,

Bryan

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

To: Jantarasami, Lesley[Jantarasami.Lesley@epa.gov]
Cc: Audette, Lucie[audette.lucie@epa.gov]
From: Manning, Bryan
Sent: Mon 8/31/2015 2:07:13 PM
Subject: FW: Draft Presentation for Air Division Directors' Briefing (Sept 1)
Aircraft GHG Emissions for Air Division Directors Briefing 8-19-15_.pptx

Hello Lesley,

I just returned from vacation today. See the attached updated presentation for the Air Division Directors' briefing, which Mike Samulski has okay'd. As you suggested, we will plan on you covering slide #3 (endangerment slide), and we will plan to cover the rest. Let me know if you have any comments on the updated presentation.

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Manning, Bryan
Sent: Thursday, August 20, 2015 11:11 AM
To: Samulski, Michael; Audette, Lucie
Subject: Draft Presentation for Air Division Directors' Briefing (Sept 1)

Hello,

Attached please find the draft presentation for the Air Division Directors' Briefing on Sept 1.

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process Let me know if you have any comments.

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Audette, Lucie[audette.lucie@epa.gov]
Cc: Samulski, Michael[samulski.michael@epa.gov]
From: Manning, Bryan
Sent: Wed 9/3/2014 3:24:59 PM
Subject: Revised Roll Out Strategy/Q&A on h: drive
ICAO Aviation GHG Announcement - Roll out - v3 (2)lca comment+BM.docx

Lucie,

Attached please find a revised roll out strategy/Q&A with the item on the why we are submitting the info paper to CAEP (see page 6). Let me know if you have any questions.

Thank you,

Bryan

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

From: Manning, Bryan
Location: AA-Room-Office-N125-ConfRoom/AA-OTAQ-OFFICE
Importance: Normal
Subject: Discuss Comment Bubbles in Preamble/RIA Outlines: aircraft CO2 NPRM
Start Time: Tue 11/21/2017 2:00:00 PM
End Time: Tue 11/21/2017 3:30:00 PM
Required Attendees: Yen, David; Leggett, Cullen; Mueller, John; Samulski, Michael; Audette, Lucie; Maeroff, Bruce

Outline_Assignments_Preamble_Aircraft CO2 Stds NPRM 11-7-17.docx

Outline_Assignments_RIA_Aircraft CO2 Stds NPRM_11-15-17.docx

We may not need the full 1.5 hours for the meeting, but I reserved this amount of time just in case we run long.

Thanks,

Bryan

To: Samulski, Michael[samulski.michael@epa.gov]; Thrift, Mike[thrift.mike@epa.gov]; Audette, Lucie[audette.lucie@epa.gov]
From: Manning, Bryan
Sent: Tue 10/24/2017 2:46:05 PM
Subject: Revised Mandy Briefing: Aircraft CO2 rule (TIME SENSITIVE)
Briefing_Aircraft CO2 Rule 10-23-17v2.pptx

Hi Mike Samulski, Mike Thrift, and Lucie,

Attached please find a revised briefing for Mandy (aircraft CO2 rule) that incorporates the feedback from the pre-brief for Sarah yesterday. See red and strikeout font for the revisions.

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process Let me know if you have any comments.

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Simon, Joseph[Simon.Joseph@epa.gov]
From: Manning, Bryan
Sent: Wed 11/15/2017 8:55:47 PM
Subject: Updated Outlines for aircraft CO2 standard NPRM: preamble and RIA
Outline_Assignments_Preamble_Aircraft CO2 Stds NPRM 11-7-17.docx
Outline_Assignments_RIA_Aircraft CO2 Stds NPRM_11-15-17.docx

Hi Joe,

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process Let me know if you have any questions.

Thank you for your help,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Maeroff, Bruce[Maeroff.Bruce@epa.gov]
From: Manning, Bryan
Sent: Tue 9/2/2014 1:08:35 PM
Subject: FW: ICAO whw blurb.docx

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Audette, Lucie
Sent: Thursday, August 28, 2014 2:46 PM
To: Birgfeld, Erin; Samulski, Michael; Birnbaum, Rona; Manning, Bryan
Cc: Mylan, Christopher
Subject: RE: ICAO whw blurb.docx

Erin, The page link below is where we have placed aircraft related rulemakings/issues. We have not posted either the aircraft petitions or our 2012 response at this point. Information on ICAO is found within each write-up for a given rule.

Bryan Manning, the team lead for aircraft, will be back from AL on Tuesday, Mike is hoping that we can wait until then to discuss what type of blurb we should craft. Does that sound ok? If you are comfortable with that approach, I'll send an appointment to you, Chris, Brian, and I to discuss on Tuesday so that we can get materials ready to post asap. Lucie

From: Birgfeld, Erin
Sent: Thursday, August 28, 2014 2:25 PM
To: Audette, Lucie; Samulski, Michael; Birnbaum, Rona
Cc: Mylan, Christopher
Subject: RE: ICAO whw blurb.docx

Thanks Lucie,

I will incorporate those edits. It occurs to me that since the ICAO website is not open to the public so we should also plan to put something in on the main website. Is there a place on the OTAQ site where we have information on the suit and court decision on this? Would this page make sense?

http://www.epa.gov/otaq/aviation.htm

Thanks,

Erin

Erin Birgfeld

Director of Communications

Office of Transportation and Air Quality

Tel: 202.564.6741

Cell: 202.255.4434

From: Audette, Lucie
Sent: Thursday, August 28, 2014 1:57 PM
To: Birgfeld, Erin; Samulski, Michael; Birnbaum, Rona
Cc: Hengst, Benjamin
Subject: RE: ICAO whw blurb.docx

With apologies for another change, there are 2 places in the current text where the paper we are submitting is referred to as a "working" paper that should be changed to and "information" paper. Thanks so much. Lucie

From: Birgfeld, Erin

Sent: Thursday, August 28, 2014 1:53 PM
To: Audette, Lucie; Samulski, Michael; Birnbaum, Rona
Cc: Hengst, Benjamin
Subject: RE: ICAO whw blurb.docx

Thanks Lucie!

Rona, I'll send along at 2:30 and incorporate any comments from you as necessary.

-Erin

Erin Birgfeld

Director of Communications

Office of Transportation and Air Quality

Tel: 202.564.6741

Cell: 202.255.4434

From: Audette, Lucie
Sent: Thursday, August 28, 2014 1:49 PM
To: Birgfeld, Erin; Samulski, Michael; Birnbaum, Rona
Cc: Hengst, Benjamin
Subject: RE: ICAO whw blurb.docx

Erin, Attached are my comments.

From: Birgfeld, Erin
Sent: Thursday, August 28, 2014 1:34 PM
To: Samulski, Michael; Audette, Lucie; Birnbaum, Rona
Cc: Hengst, Benjamin
Subject: FW: ICAO whw blurb.docx
Importance: High

Mike, Lucie, and Rona,

We got the go ahead and need to provide a blurb to the press office today by 2:30 so they can connect with WH comms. Can you take a look and see if you have any edits?

-Erin

Erin Birgfeld

Director of Communications

Office of Transportation and Air Quality

Tel: 202.564.6741

Cell: 202.255.4434

From: Millett, John
Sent: Thursday, August 28, 2014 1:29 PM
To: Knapp, Kristien; Birgfeld, Erin; McMichael, Nate; Mylan, Christopher
Cc: Hengst, Benjamin
Subject: ICAO whw blurb.docx

Ex. 5 - Deliberative Process

Thanks -- John

Ex. 5 - Deliberative Process

To: Yen, David[Yen.David@epa.gov]; Lindsey, Leah[lindsey.leah@epa.gov]
From: Manning, Bryan
Sent: Tue 11/14/2017 6:43:13 PM
Subject: FYI: Peer review work assignment (WA 1-15): Documents
Aircrft Cost-Technology Rpt_Charge Questions_11-14-17.docx
ICF - EPA 2017 Aircraft CO2 Cost Assessment_11-3-2017.docx
Tech Response Spreadsheet_11-6-7v2.xlsx
ICF - EPA Aerospace Industry Characterization_11-3-2017.docx

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process Thanks. Bryan

From: Manning, Bryan
Sent: Tuesday, November 14, 2017 10:35 AM
To: 'Viator, Catherine' <viator@rti.org>
Cc: Amy Doll <adoll@endyna.com>; siddhanti@endyna.com; Mueller, John <mueller.john@epa.gov>
Subject: New peer review work assignment (WA 1-15): Documents

Hi Catherine et al,

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Let me know if you have any questions.

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Viator, Catherine [mailto:viator@rti.org]
Sent: Monday, November 13, 2017 10:56 AM
To: Manning, Bryan <manning.bryan@epa.gov>
Subject: new peer review work assignment

Hi Bryan,

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process Do you have time for a quick call this morning before noon EST? Ex. 5 - Deliberative Process

Thanks!

Catherine

Catherine Viator

Food, Nutrition, & Obesity Policy Research

RTI International

3040 Cornwallis Road

Research Triangle Park, NC 27709

TEL: 919.597.5127

EMAIL: viator@rti.org

To: Manning, Bryan[manning.bryan@epa.gov]
From: Manning, Bryan
Sent: Fri 10/20/2017 8:27:50 PM
Subject: Schedule Spreadsht & Outlines/Names
Aircraft CO2 Standards NPRM Timeline 10-20-17.xlsx
Outline_Assignments_RIA_Aircraft GHG Standards NPRM 10-20-17.docx
Outline_Assignments_Preamble_Aircraft GHG Standards NPRM 10-20-17.docx

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Viator, Catherine[viator@rti.org]
Cc: Amy Doll[adoll@endyna.com]; siddhanti@endyna.com[siddhanti@endyna.com]; Mueller, John[mueller.john@epa.gov]
From: Manning, Bryan
Sent: Tue 11/14/2017 3:36:00 PM
Subject: New peer review work assignment (WA 1-15): Documents
Aircrft Cost-Technology Rpt_Charge Questions_11-14-17.docx
ICF - EPA 2017 Aircraft CO2 Cost Assessment_11-3-2017.docx
Tech Response Spreadsheet_11-6-7v2.xlsx
ICF - EPA Aerospace Industry Characterization_11-3-2017.docx

Hi Catherine et al,

It was good to talk with you yesterday. In the 1st attachment, please find the draft charge questions for the first report (to be peer reviewed), *Aircraft CO2 Cost and Technology Refresh and Aerospace Industry Characterization*, in WA 1-15. Let me know if you have any comments on these charge questions.

Ex. 5 - Deliberative Process

Let me know if you have any questions.

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Viator, Catherine [mailto:viator@rti.org]
Sent: Monday, November 13, 2017 10:56 AM
To: Manning, Bryan <manning.bryan@epa.gov>
Subject: new peer review work assignment

Hi Bryan,

We received the new WA last week to continue the aircraft emissions peer review, and we look forward to completing this work! Do you have time for a quick call this morning before noon EST? We just want to ask if the first report is ready for peer review and discuss the schedule.

Thanks!

Catherine

Catherine Viator

Food, Nutrition, & Obesity Policy Research

RTI International

3040 Cornwallis Road

Research Triangle Park, NC 27709

TEL: 919.597.5127

EMAIL: viator@rti.org

To: Iffland, JoNell[Iffland.JoNell@epa.gov]
From: Manning, Bryan
Sent: Wed 10/22/2014 4:15:30 PM
Subject: Briefing for Janet that I put on Bill's chair (ICAO update)
McCabe Update on ICAO progress October 22c.docx

Hello JoNell,

As we discussed, attached is the briefing that I put on Bill's chair (ICAO update).

Thank you,

Bryan

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

To: Samulski, Michael[samulski.michael@epa.gov]; Audette, Lucie[audette.lucie@epa.gov]
From: Manning, Bryan
Sent: Tue 11/7/2017 10:14:48 PM
Subject: Updated RIA Outline: aircraft CO2 NPRM (PLEASE REVIEW)
Outline_Assignments_RIA_Aircraft CO2 Stds NPRM 11-7-17_redline.docx
Outline_Assignments_RIA_Aircraft CO2 Stds NPRM 11-7-17_clean.docx

Hi Mike and Lucie,

Based on our discussions yesterday, attached please find a revised RIA outline for the aircraft CO2 NPRM. For your convenience, I have provided redline and clean versions.

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process Let me know if you have any comments before I distribute this updated RIA outline to the rest of the team.

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Maeroff, Bruce[Maeroff.Bruce@epa.gov]
From: Manning, Bryan
Sent: Thur 10/19/2017 1:28:13 PM
Subject: ICF March 2015 report and Oct 2017 report - COMPARE
ICF_CO2 Analysis of CO2-Reducing Technologies for Aircraft_March 17 2015.pdf
ICF - EPA 2017 Aircraft CO2 Cost Assessment 10.18.2017 CLEAN VERSION.docx

Hi Bruce,

Attached is the ICF March 2015 report and the Oct 2017 report.

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Maeroff, Bruce[Maeroff.Bruce@epa.gov]
From: Manning, Bryan
Sent: Tue 10/21/2014 6:18:47 PM
Subject: FW: Revised Pre-Brief for Chris on ICAO Progress (Janet McCabe Briefing) - today at 4:00
McCabe Update on ICAO progress Grundler Prebrief October 21.docx

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Manning, Bryan
Sent: Tuesday, October 21, 2014 1:18 PM
To: OTAQ Materials
Cc: Hengst, Benjamin; Samulski, Michael; Charmley, William; Iffland, JoNell; Miller, Debra L.; Audette, Lucie; Leggett, Cullen
Subject: Revised Pre-Brief for Chris on ICAO Progress (Janet McCabe Briefing) - today at 4:00

Hello,

Attached please find revised materials for a pre-brief for Chris on ICAO Progress, which is scheduled today (Oct 21) at 4:00 -- prior to briefing Janet McCabe on Oct 23. The revision to the materials is the addition of a plot on page 4 of the briefing. If possible, please print this briefing out in color so that the plot can be read properly.

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Maeroff, Bruce[Maeroff.Bruce@epa.gov]
From: Manning, Bryan
Sent: Mon 10/20/2014 5:11:30 PM
Subject: RE: Global GHG data: Compare CAIT, IEA, and EIA
CO2HighlightsExceltables.xls

Ex. 5 - Deliberative Process

Thanks again,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Maeroff, Bruce
Sent: Monday, October 20, 2014 12:26 PM
To: Manning, Bryan
Subject: RE: Global GHG data: Compare CAIT, IEA, and EIA

Here is a part of the response.

Ex. 5 - Deliberative Process

Bruce Maeroff

Senior Service America, Inc.

Supporting the U.S. EPA through a Cooperative

Agreement under the SEE Program,

Assessment and Standards Division,

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105 U.S.A.

Cube N130

ph (734) 214-4304 fax (734) 214-4816

maeroff.bruce@epa.gov

From: Manning, Bryan
Sent: Sunday, October 19, 2014 9:26 PM
To: Maeroff, Bruce
Subject: Global GHG data: Compare CAIT, IEA, and EIA

Hello Bruce,

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Maeroff, Bruce[Maeroff.Bruce@epa.gov]
From: Manning, Bryan
Sent: Mon 10/20/2014 1:26:20 AM
Subject: Global GHG data: Compare CAIT, IEA, and EIA

Hello Bruce,

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Maeroff, Bruce[Maeroff.Bruce@epa.gov]
From: Manning, Bryan
Sent: Thur 10/16/2014 7:37:42 PM
Subject: RE: THANKS

MANY THANKS, Bruce!

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Maeroff, Bruce
Sent: Thursday, October 16, 2014 3:34 PM
To: Manning, Bryan
Subject:

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Bruce Maeroff

Senior Service America, Inc.

Supporting the U.S. EPA through a Cooperative

Agreement under the SEE Program,

Assessment and Standards Division,

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105 U.S.A.

Cube N130

ph (734) 214-4304 fax (734) 214-4816

maeroff.bruce@epa.gov

To: Audette, Lucie[audette.lucie@epa.gov]; Samulski, Michael[samulski.michael@epa.gov]
From: Manning, Bryan
Sent: Thur 10/16/2014 5:04:03 PM
Subject: RE: draft briefing for Janet: Update on Recent ICAO meetings + ANPR status
McCabe Update on ICAO progress touch base on status of Aircraft_Proposal_ANPRM development+BM.docx

Many thanks for your efforts, Lucie. Attached please find my comments. Let me know if you have any questions.

Thanks again,

Bryan

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

From: Audette, Lucie
Sent: Wednesday, October 15, 2014 3:55 PM
To: Samulski, Michael; Manning, Bryan
Subject: draft briefing for Janet: Update on Recent ICAO meetings + ANPR status

Mike and Bryan, This draft briefing was pulled together from the 2 existing briefings we've done previously on these topics.

We are scheduled to Prebrief Chris on Tuesday, Oct 21 at 4pm and then Janet on Thursday, Oct 23, 11 am. Currently we do not have a time on Bill's calendar prior to Chris. I'm working with JoNell to get this scheduled.

I've provided comments/questions in comment bubbles. Please revise using track changes. Thanks so much. Lucie

To: Samulski, Michael[samulski.michael@epa.gov]
Cc: Thrift, Mike[thrift.mike@epa.gov]; Audette, Lucie[audette.lucie@epa.gov]
From: Manning, Bryan
Sent: Wed 10/18/2017 2:29:46 PM
Subject: Revised Mandy Briefing: aircraft CO2 rule (TIME SENSITIVE)
Briefing_Aircraft CO2 Std_for Mandy Gunasekara_10-18-17.pptx

Hi Mike Samulski,

Ex. 5 - Attorney Client

Ex. 5 - Attorney Client Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process Of course, let us know if you have any comments before we send this briefing to Bill.

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Jantarasami, Lesley[Jantarasami.Lesley@epa.gov]
Cc: Audette, Lucie[audette.lucie@epa.gov]
From: Manning, Bryan
Sent: Thur 10/2/2014 7:01:10 PM
Subject: FW: OP comments on Aircraft GHG Endangerment Finding draft notice outline

Hello Lesley,

Ex. 5 - Deliberative Process

Thank you,

Bryan

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

From: Schillo, Bruce
Sent: Wednesday, October 01, 2014 5:15 PM
To: Jantarasami, Lesley; Audette, Lucie
Cc: Birnbaum, Rona; Samulski, Michael; Manning, Bryan; DeAngelo, Ben; Thrift, Mike; Benner, Tim; Dutton, Steven; McDow, Stephen; Sarofim, Marcus; Leggett, Cullen; Wolverton, Ann; Yen, David; Maeroff, Bruce; Gordon, Jessica M; Hockstad, Leif; Williams, Melina
Subject: OP comments on Aircraft GHG Endangerment Finding draft notice outline

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

I tried to do a redline/strikeout of the Word document, but got very strange results, Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

To: Samulski, Michael[samulski.michael@epa.gov]; Thrift, Mike[thrift.mike@epa.gov]; Audette, Lucie[audette.lucie@epa.gov]
From: Manning, Bryan
Sent: Tue 10/17/2017 8:37:59 PM
Subject: Draft Briefing for Mandy on aircraft CO2 rule (TIME SENSITIVE)
Briefing_Aircraft CO2 Std_for Mandy Gunasekara_10-17-17.pptx

Hi Lucie, Mike Samulski, and Mike Thrift,

Attached please find the draft briefing for Mandy on the aircraft CO2 rule. I am sending this document to you all at the same time due to time constraints. Mike Thrift, as we discussed, I particularly need your help on slides #10 and 11 , but feel free to comment on any other slide. However, as noted earlier, Mike Samulski and Lucie Audette are reviewing the document simultaneously. Let me know if you have any comments.

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Thrift, Mike[thrift.mike@epa.gov]
Cc: Orlin, David[Orlin.David@epa.gov]
From: Manning, Bryan
Sent: Thur 10/12/2017 5:32:45 PM
Subject: FW: Pre-Brief: Aircraft CO2 Rulemaking (Oct 16 at 11:00) - Do you plan on calling in?
Status Briefing_Aircraft GHG Std_for Sarah Dunham v.4_10-12-17.pptx

Hi Mike,

We are working to get a call-in number for this pre-brief for Chris. Do you plan on calling in for it? It would be good to know whether or not we should expect you on the call-in line.

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Manning, Bryan
Sent: Thursday, October 12, 2017 1:10 PM
To: OTAQ Materials <OTAQMaterials@epa.gov>
Cc: Samulski, Michael <samulski.michael@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>; Sargeant, Kathryn <sargeant.kathryn@epa.gov>; Thrift, Mike <thrift.mike@epa.gov>; Orlin, David <Orlin.David@epa.gov>; Leggett, Cullen <Leggett.Cullen@epa.gov>; Yen, David

<Yen.David@epa.gov>; Mueller, John <mueller.john@epa.gov>; Charmley, William <charmley.william@epa.gov>; Iffland, JoNell <Iffland.JoNell@epa.gov>; Cook, Leila <cook.leila@epa.gov>; Hengst, Benjamin <Hengst.Benjamin@epa.gov>; Burch, Julia <Burch.Julia@epa.gov>; Gonzalez, Gail <Gonzalez.Gail@epa.gov>; Maeroff, Bruce <Maeroff.Bruce@epa.gov>; Lindsey, Leah <lindsey.leah@epa.gov>
Subject: Pre-Brief: Aircraft CO2 Rulemaking (Oct 16 at 11:00)

Hi,

Attached please find the pre-brief for Chris on Oct 16 at 11:00 – aircraft CO2 rulemaking. Let us know if you have any questions.

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Samulski, Michael
Sent: Thursday, October 12, 2017 10:42 AM
To: Manning, Bryan <manning.bryan@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>
Subject: RE: Revised Aircraft CO2 rule briefing for Sarah (Pre-Briefing for Chris): PLEASE

REVIEW

A couple of minor comments:

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Thanks,

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Manning, Bryan
Sent: Tuesday, October 10, 2017 5:31 PM

To: Samulski, Michael <samulski.michael@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>
Subject: Revised Aircraft CO2 rule briefing for Sarah (Pre-Briefing for Chris): PLEASE REVIEW

Hi Mike and Lucie,

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process Let me know if you have any comments.

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Iffland, JoNell[Iffland.JoNell@epa.gov]; Gonzalez, Gail[Gonzalez.Gail@epa.gov]
From: Manning, Bryan
Sent: Thur 10/12/2017 5:29:49 PM
Subject: FW: Pre-Brief: Aircraft CO2 Rulemaking (Oct 16 at 11:00) - Need call-in number for Mike Thrift of OGC
Status Briefing_Aircraft GHG Std_for Sarah Dunham v.4_10-12-17.pptx

Hi JoNell or Gail,

For this Oct 16 (at 11:00) pre-brief for Chris, we need a call-in number for Mike Thrift of OGC. Could you arrange for a call-in number?

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Manning, Bryan
Sent: Thursday, October 12, 2017 1:10 PM
To: OTAQ Materials <OTAQMaterials@epa.gov>
Cc: Samulski, Michael <samulski.michael@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>; Sargeant, Kathryn <sargeant.kathryn@epa.gov>; Thrift, Mike <thrift.mike@epa.gov>; Orlin, David <Orlin.David@epa.gov>; Leggett, Cullen <Leggett.Cullen@epa.gov>; Yen, David

<Yen.David@epa.gov>; Mueller, John <mueller.john@epa.gov>; Charmley, William <charmley.william@epa.gov>; Iffland, JoNell <Iffland.JoNell@epa.gov>; Cook, Leila <cook.leila@epa.gov>; Hengst, Benjamin <Hengst.Benjamin@epa.gov>; Burch, Julia <Burch.Julia@epa.gov>; Gonzalez, Gail <Gonzalez.Gail@epa.gov>; Maeroff, Bruce <Maeroff.Bruce@epa.gov>; Lindsey, Leah <lindsey.leah@epa.gov>
Subject: Pre-Brief: Aircraft CO2 Rulemaking (Oct 16 at 11:00)

Hi,

Attached please find the pre-brief for Chris on Oct 16 at 11:00 – aircraft CO2 rulemaking. Let us know if you have any questions.

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Samulski, Michael
Sent: Thursday, October 12, 2017 10:42 AM
To: Manning, Bryan <manning.bryan@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>
Subject: RE: Revised Aircraft CO2 rule briefing for Sarah (Pre-Briefing for Chris): PLEASE

REVIEW

A couple of minor comments:

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Thanks,

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Manning, Bryan
Sent: Tuesday, October 10, 2017 5:31 PM

To: Samulski, Michael <samulski.michael@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>
Subject: Revised Aircraft CO2 rule briefing for Sarah (Pre-Briefing for Chris): PLEASE REVIEW

Hi Mike and Lucie,

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process Let me know if you have any comments.

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Samulski, Michael[samulski.michael@epa.gov]; Charmley, William[charmley.william@epa.gov]; Manning, Bryan[manning.bryan@epa.gov]; Leggett, Cullen[Leggett.Cullen@epa.gov]; Mueller, John[mueller.john@epa.gov]
From: Burch, Julia
Sent: Tue 1/23/2018 10:52:00 PM
Subject: FW: Boeing & GE meeting materials
image2018-01-23-175826.pdf

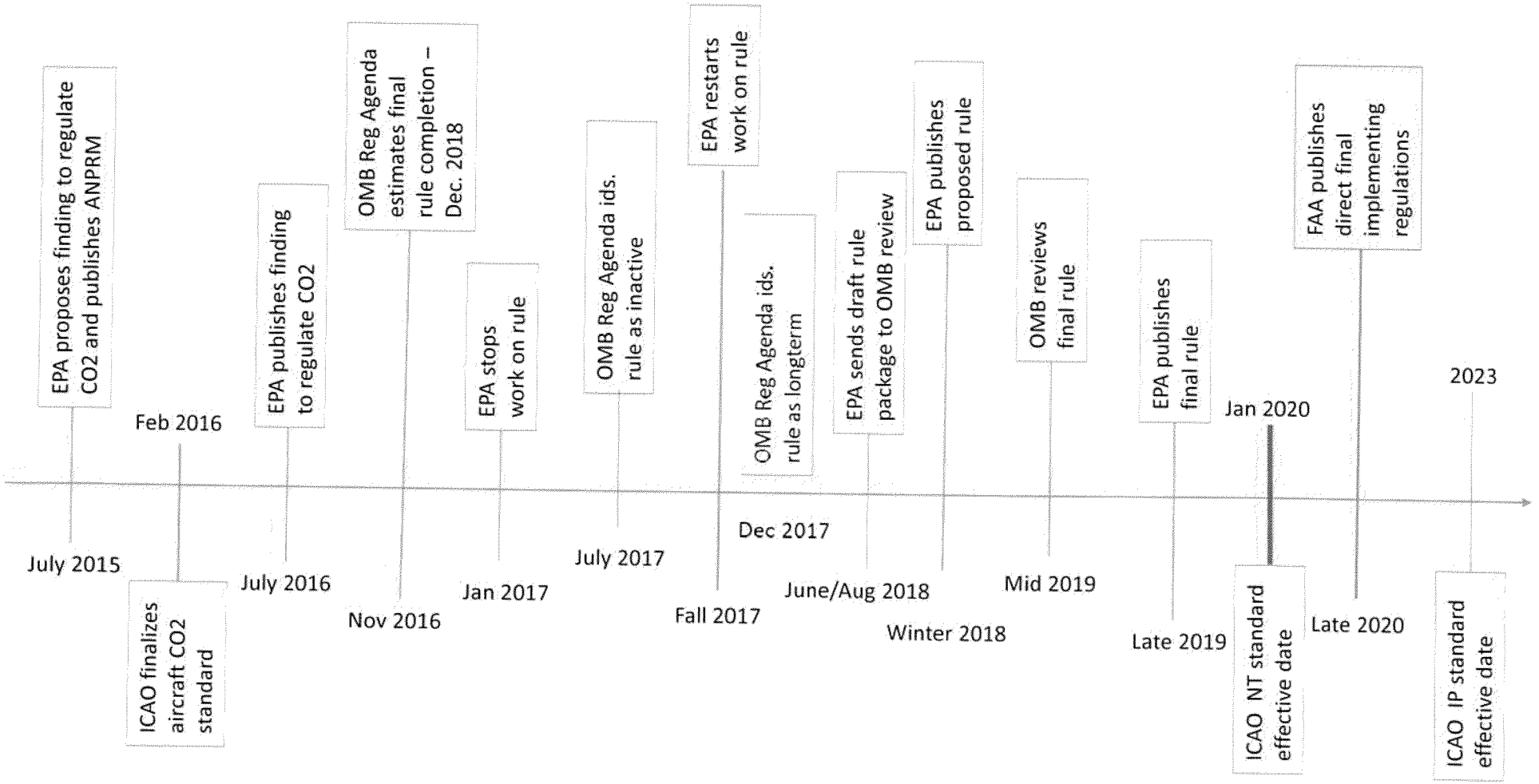
Attached is the handout that Ben previously sent and the sign in sheet from the meeting with Boeing and GE today. Let me know if you need anything else.

Regards,

Julia Burch
Office of Transportation and Air Quality
U.S. Environmental Protection Agency
202-564-0961

From: DC-WJCN-6510N-M@epa.gov [mailto:DC-WJCN-6510N-M@epa.gov]
Sent: Tuesday, January 23, 2018 5:58 PM
To: Burch, Julia <Burch.Julia@epa.gov>
Subject: boeing & ge meeting materials

Estimated Aircraft CO_2 Rule Development Milestones



Date: Tuesday, January 23, 2018 at 3:30pm

Meeting: Boeing + GE

Rule(s) Discussed:

Written Materials? Yes/No:

Name	Organization	Phone Number
Pete Pinguino	Boeing	703-414-6486
John Moloney	Boeing	703 465-3264
Neal Kemker	GE	202 637 4084
Michael Fitzpatrick	GE	202-412-6624
Ben Hengst	EPA	
Chris Grundler		
Julia Burch		
Collen Leggett		
Bryan Manning		
Bill Charmley		
John Mueller		
Bill Wehrum		

To: ricardo.Dupont@anac.gov.br[ricardo.Dupont@anac.gov.br]
Cc: Manning, Bryan[manning.bryan@epa.gov]
From: Ralph Rissmiller
Sent: Tue 9/8/2015 1:56:12 PM
Subject: ETM Comments
ETM Vol III draft v1 2+BD+DS+GS+RR.docx

Ricardo & Bryan,

I'm not sure if you got this email or not. I had some strange delivery failure notifications.

Ralph Rissmiller
RR Aviation Services, LLC
19685 S 1475 Rd
Stockton, MO 65785-7430
Email: rrissmil@aol.com
Tel: 316-253-6182 (cell), 417-276-8316 (home)
Fax: 417-276-1314

To: Manning, Bryan[manning.bryan@epa.gov]
From: Pagano, Peter A
Sent: Mon 11/7/2016 6:16:56 PM
Subject: Boeing presentation materials from Nov 2 meeting - attachment 2
Sustainable Aviation Biofuel Boeing - EPA Nov 2016.pptx

Here's the second attachment. Thanks again.

All the best,

Peter A. Pagano
Director, Environment
The Boeing Company
703-414-6486
Email: peter.a.pagano@boeing.com

To: 'Ricardo Antonio Binotto Dupont'[ricardo.Dupont@anac.gov.br]
Cc: Manning, Bryan[manning.bryan@epa.gov]
From: Ralph Rissmiller
Sent: Tue 9/8/2015 1:45:30 PM
Subject: ETM Comments
ETM Vol III draft v1 2+BD+DS+GS+RR.docx

Bryan,

I'm not sure if you got this email or not. I had some strange delivery failure notifications.

Ralph Rissmiller
RR Aviation Services, LLC
19685 S 1475 Rd
Stockton, MO 65785-7430
Email: rrissmil@aol.com
Tel: 316-253-6182 (cell), 417-276-8316 (home)
Fax: 417-276-1314

To: Manning, Bryan[manning.bryan@epa.gov]
Cc: Peter.Zimm@icfi.com[Peter.Zimm@icfi.com]
From: Ralph Rissmiller
Sent: Tue 1/20/2015 3:17:48 PM
Subject: Comments on Potential CO2 InPA Applicability Option Working Paper
150119_CAEP10_WG3_CO2-8_WPxx_Potential InP Applicability Option_Draft rr cmts.docx

Bryan,

Attached are some comments relating to the NAA Potential CO2 InPA Applicability Option Working Paper. They are incorporated as comments in the document. Please forward to Steve, Laszlo and others as necessary. Thanks.

Ralph Rissmiller

RR Aviation Services, LLC

19685 S 1475 Rd

Stockton, MO 65785-7430

Email: rrissmil@aol.com

Tel: 316-253-6182 (cell), 417-276-8316 (home)

Fax: 417-276-1314

To: Manning, Bryan[manning.bryan@epa.gov]
Cc: Zimm, Peter[Peter.Zimm@icfi.com]; McDonald, Glenn[GMcDonald@icfi.com]; Staniec, Kali[Kali.Staniec@icfi.com]
From: Menon, Chirag
Sent: Fri 9/25/2015 10:24:37 PM
Subject: ICF-Averaging & Banking Mechanisms for Aviation CO2 Emissions Regulation Paper
ICF - Averaging & Banking Mechanisms for Aviation CO2 Emissions Regulation- September 25th.docx

Hi Bryan,

Please find attached the first draft of the report.

Please let us know if you have any questions and we look forward to hearing from you next week.

Best,

Chirag

Chirag Menon | Research Assistant | 734.929.6180 (office) | chirag.menon@icfi.com | icfi.com/aviation |

ICF International | 101 N. Main Suite 400, Ann Arbor, MI 48104 | 734.604.4050 (m)

Please consider the environment before printing this e-mail.

NOTICE: This message is for the designated recipient only and may contain privileged or confidential information. If you have received it in error, please notify the sender immediately and delete the original. Any other use of this e-mail is prohibited.

To: Anastasia Kharina[karin@theicct.org]
Cc: Yen, David[Yen.David@epa.gov]; Mazyar Zeinali[mazyar@theicct.org]; Manning, Bryan[manning.bryan@epa.gov]
From: Kraft, Isobel
Sent: Fri 2/21/2014 11:41:08 PM
Subject: RE: Help with Ascend Fleet
deliveriesmade12312010.xls
deliveriesdue12312010.xls

I attached the data we agreed on. Hopefully this works with what you currently have.

I made two queries: One with the context "Deliveries Made" from 12/31/2010 to 12/31/2500 and one with the context "Deliveries Due" with the same dates. The Deliveries Made should give you what has already occurred and and Deliveries Due should give you scheduled, future deliveries.

The only thing I can think to do if this data doesn't work and re-archiving the entire set and isolating the delivery dates past 12/31/2010. Maybe David will be able to come up with a better solution on Monday, but I will try to check in next week from school.

Thanks,

Isobel

From: Anastasia Kharina <karin@theicct.org>
Sent: Friday, February 21, 2014 4:49 PM
To: Kraft, Isobel
Cc: Yen, David; Mazyar Zeinali; Manning, Bryan
Subject: Re: Help with Ascend Fleet

The fault is all mine, as I can't remember exactly how the queries work.
"As at" would give you all the data as at the specified date. Usually this is useful if we want to see whether an airplane is in storage or in service, etc. at that specific date.
I think we can go through a different route: Lets still choose "**Historical Fleet**" as the context, and extract all "**Delivery Date" after 12/31/2010**. This way we have enough overlap (3years) to make sure nothing is left behind. Please check if Ascend gives you entries with "Delivery Date" of year 2500. This might sound funny, but that is what we want (cause this is how Ascend handles unknown delivery date far in the future).

Again, if you prefer, please don't hesitate to call me at the number listed on my signature.

Thanks again!

Karin

Anastasia Kharina
karin@theicct.org | (415) 202-5738
The International Council on Clean Transportation
One Post Street, San Francisco CA 94104
www.theicct.org

On Feb 21, 2014, at 1:37 PM, "Kraft, Isobel" <Kraft.Isobel@epa.gov> wrote:

I chose "Historical Fleet" as the context "as at" 3/1/2013, but I believe that this shows me all of the data (including the data you extracted previously). However, another option is choosing "Deliveries Made" and then "Deliveries Due" from the dates you requested. This would total about 18,000 records. But, I am still not sure if that is correct.
Is this the type of query that you were expecting? Sorry for the confusion, I am just a bit unclear about what Historical Fleet means.

Isobel

From: Anastasia Kharina <karin@theicct.org>
Sent: Friday, February 21, 2014 4:22 PM
To: Kraft, Isobel
Cc: Yen, David; Mazyar Zeinali; Manning, Bryan
Subject: Re: Help with Ascend Fleet

Hi Isobel,
you can leave it as is, because I am going to merge it with the data that we already have.

Wow that seems like a lot of airplanes. As a reference, up to April 3, 2013 (when we archived the database), we have 80,655 aircraft already.
If we extract only aircraft added to the database within the last 13months, it should be less than 80,000.
Could you tell me what you extracted from the database exactly?

Thank you so much for the help!

Karin

Anastasia Kharina
karin@theicct.org | (415) 202-5738
The International Council on Clean Transportation

One Post Street, San Francisco CA 94104
www.theicct.org

On Feb 21, 2014, at 1:14 PM, "Kraft, Isobel" <Kraft.Isobel@epa.gov> wrote:

Hi Karin,

Is there any formatting you would like to see with the exported data? I can leave it as is, or I can organize it for you in pivot table based how you would like to view the data.

There are about 80,000 records and ascend limits the exports to 40,000 lines (based on the old excel limitation). I am trying to remember how I fixed this before, so I have half of the output (up to a delivery data in 2006) and I am working on the second half.

Thanks,

Isobel

From: Anastasia Kharina <karin@theicct.org>
Sent: Thursday, February 20, 2014 5:15 PM
To: Yen, David; Kraft, Isobel
Cc: Mazyar Zeinali; Manning, Bryan
Subject: Re: Help with Ascend Fleet

Thank you, David.
Isobel, thank you in advance for your help.
My memory on Ascend interface needs to be refreshed since we archived the database on April 3, 2013.
What we need is basically a refresher of the Historical Fleet database, with crucial data being delivery date (all the way to year 2500).
That includes all aircraft entered into the database from March 1, 2013 to today to make sure nothing falls through the cracks.

Please let me know if you need me to be more specific; and if it is easier for you please don't hesitate to give me a call at the number listed in my signature.

Thank you much
Best,
Karin

Anastasia Kharina
karin@theicct.org | (415) 202-5738
The International Council on Clean Transportation
One Post Street, San Francisco CA 94104
www.theicct.org

On Feb 20, 2014, at 11:45 AM, "Yen, David" <Yen.David@epa.gov> wrote:

> Sure, please send it to Isobel. She is very familiar with Ascend. I will be off tomorrow but I can follow this up next week if needed.
>
> Best,
> David
>
> From: Anastasia Kharina [mailto:karin@theicct.org]
> Sent: Thursday, February 20, 2014 2:35 PM
> To: Yen, David
> Cc: Mazyar Zeinali
> Subject: Help with Ascend Fleet
>
> Hello David,
>
> For the upcoming WG3 meeting in Seattle, a paper by ICSA on "The Importance of In-Production Applicability For a Meaningful ICAO CO2 Standard" (attached) will be discussed as an IP.
> This paper includes an analysis based on Ascend Fleet database, which we archived in April 2013.
> We think that it would be very beneficial if we could update this analysis with current data, which will include new deliveries and fixed orders.
> Would you think it possible for us the get some help from you on this, since EPA has full access to Ascend?
> If so, I will send you the Ascend Queries needed.
>
> Thank you in advance,
> best
> Karin

To: Manning, Bryan[manning.bryan@epa.gov]
Cc: McDonald, Glenn[GMcDonald@icfi.com]
From: Zimm, Peter
Sent: Thur 1/23/2014 3:46:21 PM
Subject: RE: Update (thoughts from Steve Arrowsmith)
2014-01-21 CO2TG Briefing v3.6.pptx

Bryan,

Please see attached proposed final deck for tomorrow's call. Note new slides added or changes to existing slides:

Ex. 5 - Deliberative Process

LMK if you want to get on the phone to discuss.

Peter

-----Original Message-----
From: Manning, Bryan [mailto:manning.bryan@epa.gov]
Sent: Thursday, January 23, 2014 9:47 AM
To: Zimm, Peter
Cc: McDonald, Glenn
Subject: RE: Update (thoughts from Steve Arrowsmith)

Okay, Peter. Many thanks for the update. Sounds fine.

Ex. 5 - Deliberative Process

Thanks again,

Bryan

Bryan Manning
U.S. EPA Office of Transportation and Air Quality Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

-----Original Message-----
From: Zimm, Peter [mailto:Peter.Zimm@icfi.com]
Sent: Thursday, January 23, 2014 8:45 AM
To: Manning, Bryan
Subject: Update

Bryan,

To update you, all the new slides are built. Glenn and I need to verify some content on two of the slides and we're done. We're going into meetings this am until 10:30 and will finalize and get over to you late this am.

Peter

To: McDonald, Glenn[GMcDonald@icfi.com]
Cc: Manning, Bryan[manning.bryan@epa.gov]; Maeroff, Bruce[Maeroff.Bruce@epa.gov]; Samulski, Michael[samulski.michael@epa.gov]; Yen, David[Yen.David@epa.gov]
From: Zimm, Peter
Sent: Fri 2/14/2014 5:43:31 PM
Subject: 2014-02-24 CAEP Seattle v4.5.pptx
2014-02-24 CAEP Seattle v4.5.pptx

Gents,

See attached slide deck – proposed showtime version. Please review and comment.

I will be unavailable for a short time – 20 minutes.

Peter

EPA-HQ-2018-004348

To: Manning, Bryan[manning.bryan@epa.gov]
Cc: McDonald, Glenn[GMcDonald@icfi.com]
From: Zimm, Peter
Sent: Thur 2/13/2014 9:00:00 PM
Subject: 2014-02-24 CAEP Seattle v4.2.pptx
2014-02-24 CAEP Seattle v4.2.pptx

Bryan,

See attached deck – it's just about showtime ready – a few questions for you noted in yellow boxes.

Sorry for late delivery – took a lot more to get engine techs into the picture. Looking forward to talking at 4:30 – LMK if you need to change to a different time.

Peter

EPA-HQ-2018-004348

To: Manning, Bryan[manning.bryan@epa.gov]
From: Zimm, Peter
Sent: Wed 2/12/2014 4:48:54 PM
Subject: Slides for 3pm discussion
2014-02-24 CAEP Seattle v3.7.pptx

Bryan,

See attached slides for today's discussion. Slides added: 12, 32, 45-51.

I'm inclined to remove references to Task 3 (slides 12, 46, 47) and want to pare down to fit the time allotted but wanted to get this into your hands ASAP for discussion.

Looking forward to talking later today.

PETER C. ZIMM | Principal | +1.347.843.9746 | peter.zimm@icfi.com
ICF SH&E | 101 North Main Street, Suite 400, Ann Arbor, MI 48104 USA | icfi.com/aviation

EPA-HQ-2018-004348

To: Manning, Bryan[manning.bryan@epa.gov]
Cc: McDonald, Glenn[GMcDonald@icfi.com]
From: Zimm, Peter
Sent: Thur 1/23/2014 5:27:43 PM
Subject: 2014-01-21 CO2TG Briefing v3.6.pptx
2014-01-21 CO2TG Briefing v3.6.pptx

With our changes.

To: Maeroff, Bruce[Maeroff.Bruce@epa.gov]
From: Manning, Bryan
Sent: Sat 2/22/2014 1:45:41 AM
Subject: FYI: Help with Ascend Fleet
deliveriesmade12312010.xls
deliveriesdue12312010.xls

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Kraft, Isobel
Sent: Friday, February 21, 2014 6:41 PM
To: Anastasia Kharina
Cc: Yen, David; Mazyar Zeinali; Manning, Bryan
Subject: RE: Help with Ascend Fleet

I attached the data we agreed on. Hopefully this works with what you currently have.

I made two queries: One with the context "Deliveries Made" from 12/31/2010 to 12/31/2500 and one with the context "Deliveries Due" with the same dates. The Deliveries Made should give you what has already occurred and and Deliveries Due should give you scheduled, future deliveries.

The only thing I can think to do if this data doesn't work and re-archiving the entire set and isolating the delivery dates past 12/31/2010. Maybe David will be able to come up with a better solution on Monday, but I will try to check in next week from school.

Thanks,

Isobel

From: Anastasia Kharina <karin@theicct.org>
Sent: Friday, February 21, 2014 4:49 PM
To: Kraft, Isobel
Cc: Yen, David; Mazyar Zeinali; Manning, Bryan
Subject: Re: Help with Ascend Fleet

The fault is all mine, as I can't remember exactly how the queries work.

"As at" would give you all the data as at the specified date. Usually this is useful if we want to see whether an airplane is in storage or in service, etc. at that specific date.

I think we can go through a different route: Lets still choose "**Historical Fleet**" as the context, and extract all "**Delivery Date" after 12/31/2010**. This way we have enough overlap (3years) to make sure nothing is left behind. Please check if Ascend gives you entries with "Delivery Date" of year 2500. This might sound funny, but that is what we want (cause this is how Ascend handles unknown delivery date far in the future).

Again, if you prefer, please don't hesitate to call me at the number listed on my signature.

Thanks again!

Karin

Anastasia Kharina

karin@theicct.org | (415) 202-5738

The International Council on Clean Transportation

One Post Street, San Francisco CA 94104

www.theicct.org

On Feb 21, 2014, at 1:37 PM, "Kraft, Isobel" <Kraft.Isobel@epa.gov> wrote:

I chose "Historical Fleet" as the context "as at" 3/1/2013, but I believe that this shows me all of the data (including the data you extracted previously). However, another option is choosing "Deliveries Made" and then "Deliveries Due" from the dates you requested. This would total about 18,000 records. But, I am still not sure if that is correct.

Is this the type of query that you were expecting? Sorry for the confusion, I am just a bit unclear about what Historical Fleet means.

Isobel

From: Anastasia Kharina <karin@theicct.org>
Sent: Friday, February 21, 2014 4:22 PM
To: Kraft, Isobel
Cc: Yen, David; Mazyar Zeinali; Manning, Bryan
Subject: Re: Help with Ascend Fleet

Hi Isobel,

you can leave it as is, because I am going to merge it with the data that we already have.

Wow that seems like a lot of airplanes. As a reference, up to April 3, 2013 (when we archived the database), we have 80,655 aircraft already.

If we extract only aircraft added to the database within the last 13months, it should be less than 80,000.

Could you tell me what you extracted from the database exactly?

Thank you so much for the help!

Karin

Anastasia Kharina

karin@theicct.org | (415) 202-5738

The International Council on Clean Transportation

One Post Street, San Francisco CA 94104

www.theicct.org

On Feb 21, 2014, at 1:14 PM, "Kraft, Isobel" <Kraft.Isobel@epa.gov> wrote:

Hi Karin,

Is there any formatting you would like to see with the exported data? I can leave it as is, or I can organize it for you in pivot table based how you would like to view the data.

There are about 80,000 records and ascend limits the exports to 40,000 lines (based on the old excel limitation). I am trying to remember how I fixed this before, so I have half of the output (up to a delivery data in 2006) and I am working on the second half.

Thanks,

Isobel

From: Anastasia Kharina <karin@theicct.org>
Sent: Thursday, February 20, 2014 5:15 PM
To: Yen, David; Kraft, Isobel
Cc: Mazyar Zeinali; Manning, Bryan
Subject: Re: Help with Ascend Fleet

Thank you, David.

Isobel, thank you in advance for your help.

My memory on Ascend interface needs to be refreshed since we archived the database on April 3, 2013.

What we need is basically a refresher of the **Historical Fleet** database, with crucial data being delivery date (all the way to year 2500).

That includes all aircraft entered into the database from March 1, 2013 to today to make sure nothing falls through the cracks.

Please let me know if you need me to be more specific; and if it is easier for you please don't hesitate to give me a call at the number listed in my signature.

Thank you much

Best,

Karin

Anastasia Kharina

karin@theicct.org | (415) 202-5738

The International Council on Clean Transportation

One Post Street, San Francisco CA 94104

www.theicct.org

On Feb 20, 2014, at 11:45 AM, "Yen, David" <Yen.David@epa.gov> wrote:

Sure, please send it to Isobel. She is very familiar with Ascend. I will be off tomorrow but I can follow this up next week if needed.

Best,

David

From: Anastasia Kharina [mailto:karin@theicct.org]
Sent: Thursday, February 20, 2014 2:35 PM
To: Yen, David
Cc: Mazyar Zeinali
Subject: Help with Ascend Fleet

Hello David,

For the upcoming WG3 meeting in Seattle, a paper by ICSA on "The Importance of In-

Production Applicability For a Meaningful ICAO CO2 Standard" (attached) will be discussed as an IP.

This paper includes an analysis based on Ascend Fleet database, which we archived in April 2013.

We think that it would be very beneficial if we could update this analysis with current data, which will include new deliveries and fixed orders.

Would you think it possible for us the get some help from you on this, since EPA has full access to Ascend?

If so, I will send you the Ascend Queries needed.

Thank you in advance,

best

Karin

From: Manning, Bryan
Location: AA-Room-Office-N62-ASDCDConfRoom/AA-OTAQ-OFFICE
Importance: Normal
Subject: Aircraft CO2 NPRM: Baseline Emissions Inventory - EPA GHG & Sinks Report or David Yen's Model
Start Date/Time: Wed 10/12/2016 6:00:00 PM
End Date/Time: Wed 10/12/2016 7:00:00 PM

Ex. 5 - Deliberative Process

Thanks,

Bryan

From: Audette, Lucie
Location: N. 125 Ann Arbor Call in number: Ex. 6 - Personal Privacy
Importance: Normal
Subject: Aircraft GHG Emissions Standards - WORKGROUP KICKOFF
Start Date/Time: Wed 9/14/2016 5:00:00 PM
End Date/Time: Wed 9/14/2016 6:00:00 PM
Agency Action.pdf
Final Aircraft GHG Findings of Endangerment and Contribution August 15 2016.pdf
Fact Sheet.pdf
Workgroup Kickoff Mtg_Aircraft GHG Standards NPRM_9-13-16final.pptx

In preparation for our workgroup kickoff meeting tomorrow, I have attached briefing materials we will walk through during the meeting. Lucie
Agency Action.pdf Hello everyone,

Welcome to the Aircraft GHG Emissions Standards Workgroup! Thank-you for agreeing to be part of this rulemaking workgroup which I will be chairing. Bryan Manning is the alternate workgroup chair. I've done a busy search of your calendars for September 14 and almost everyone is available for our kick-off meeting scheduled for September 14, 1-2 pm.

CALL-IN NUMBER: Ex. 6 - Personal Privacy

I've also attached a few documents including the tiering form, final Findings and fact sheet to provide you an overview of this proposed action which follows on our final endangerment and cause or contribute finding for aircraft GHG emissions which was published on August 15th in the Federal Register. Please feel free to me prior to our first meeting if you have any questions. I will be sending a separate agenda next week prior to our meeting.

Again, thank you for your participation and I look forward to our first meeting next week. Lucie

Fact Sheet.pdf

From: Samulski, Michael
Location: AA-Room-Office-N125-ConfRoom/AA-OTAQ-OFFICE
Importance: Normal
Subject: Aircraft CO2 Rulemaking Analyses
Start Date/Time: Tue 7/12/2016 7:00:00 PM
End Date/Time: Tue 7/12/2016 8:00:00 PM
Rulemaking Analyses for Aircraft CO2 Standard Rule - Draft 7 11 16.pptx
PROs and CONs of aircraft analysis options.docx

I put together a first cut at recommendations and PROs/CONs as a starting point for this meeting. See the attached Word document. Also I made some updates to the briefing based on some of the feedback we got from FAA today. It still needs more work…
Rulemaking Analyses for Aircraft CO2 Standard Rule - Draft 7 11 16.pptx
PROs and CONs of aircraft analysis options.docx

The purpose of this meeting is to develop PROs/CONs and staff recommendations for the open questions identified in the attached draft briefing.

This seems to be the best time for most of us.

Ken, if you can join us, we can use the following call in number: **Ex. 6 - Personal Privacy**

Ex. 6 - Personal Privacy

To: Shoaff, John[Shoaff.John@epa.gov]; Mazza, Carl[Mazza.Carl@epa.gov]; Hockstad, Leif[Hockstad.Leif@epa.gov]
Cc: Samulski, Michael[samulski.michael@epa.gov]
From: Sargeant, Kathryn
Sent: Mon 9/25/2017 8:20:51 PM
Subject: Update on aircraft GHG peer review
Peer Review Options for Aircraft Products v4b.docx
Example Peer Review Decision Documentation.pdf

The administration has decided to move forward with the aircraft GHG rule, and we briefed Chris today on our recommendations for peer review (see attached Word document).

Chris has approved this plan and we intend to move forward accordingly.

We will be getting on Sarah's calendar soon to talk about the rulemaking effort but will be unlikely to focus on peer review issues.

Please let me know if you have questions or concerns with our peer review plan and its rationale. I'd be happy to talk with you if you do.

Thanks for all your help on peer review issues generally, and this specific one, too.

From: Samulski, Michael
Sent: Thursday, September 21, 2017 3:35 PM
To: OTAQ Materials <OTAQMaterials@epa.gov>
Cc: Charmley, William <charmley.william@epa.gov>; Iffland, JoNell <Iffland.JoNell@epa.gov>; Gonzalez, Gail <Gonzalez.Gail@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>; Leggett, Cullen <Leggett.Cullen@epa.gov>; Yen, David <Yen.David@epa.gov>; Mueller, John <mueller.john@epa.gov>; Sargeant, Kathryn <sargeant.kathryn@epa.gov>
Subject: Materials for 2:00 Monday Briefing with Chris - Peer Review Options for Aircraft Studies

Attached are 1) a briefing on peer review options and 2) an example peer review decision form from the Peer Review Handbook.

We may send up further information tomorrow.

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

To: Sargeant, Kathryn[sargeant.kathryn@epa.gov]
Cc: Samulski, Michael[samulski.michael@epa.gov]
From: Audette, Lucie
Sent: Thur 2/9/2017 6:34:53 PM
Subject: FW: OP's comments on Draft Analytic Blueprint- Aircraft GHG Standards and Test Procedures (SAN 5773.1)
Schillo suggested Analytic Plan for Aircraft GHG Standard.docx

Hi Kathryn, I wanted to share with you the comments we just received from OP on the aircraft analytic plan, Ex. 5 - Deliberative Process Let me know your thoughts. Thanks!

From: Schillo, Bruce
Sent: Thursday, February 09, 2017 12:59 PM
To: Audette, Lucie <audette.lucie@epa.gov>
Cc: Griffiths, Charles <Griffiths.Charles@epa.gov>; Benner, Tim <Benner.Tim@epa.gov>; Dutton, Steven <Dutton.Steven@epa.gov>; McDow, Stephen <McDow.Stephen@epa.gov>; Belser, Evan <Belser.Evan@epa.gov>; Thrift, Mike <thrift.mike@epa.gov>; Birkett, Daniel <Birkett.Daniel@epa.gov>; Castro, Marina <Castro.Marina@epa.gov>; Aspy, Dale <Aspy.Dale@epa.gov>; Powell, Alan <Powell.Alan@epa.gov>; Aumann, Ethan <Aumann.Ethan@epa.gov>; Russ, Timothy <Russ.Tim@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>; Samulski, Michael <samulski.michael@epa.gov>
Subject: OP's comments on Draft Analytic Blueprint- Aircraft GHG Standards and Test Procedures (SAN 5773.1)

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Bruce Schillo | Policy & Regulatory Analysis Division | Office of Policy | EPA
1200 Pennsylvania Avenue, NW | Mail Code 1803, WJC-N 3512-a | Washington, DC 20460
202-564-6552 | 202-564-7322 (fax) | schillo.bruce@epa.gov

To: Samulski, Michael[samulski.michael@epa.gov]
From: Sargeant, Kathryn
Sent: Wed 6/21/2017 7:51:23 PM
Subject: FW: SAB prep call
Aviation GHG Pages from Fall 2016 WkGrp Memo Appendix.pdf
Agenda SAB-June 29 post.pdf
SAB - Aircraft GHG Emissons Standards.docx
Fall 2016 WkGrp Memo attAB.PDF

FYI

From: Hengst, Benjamin
Sent: Wednesday, June 21, 2017 3:50 PM
To: Grundler, Christopher <grundler.christopher@epa.gov>; Charmley, William <charmley.william@epa.gov>
Cc: Sargeant, Kathryn <sargeant.kathryn@epa.gov>
Subject: FW: SAB prep call

Bill, Chris:

I think we should raise this tomorrow with Sarah, after the CSL meeting.

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

From: Samulski, Michael
Sent: Wednesday, June 21, 2017 3:40 PM
To: Charmley, William <charmley.william@epa.gov>; Hengst, Benjamin <Hengst.Benjamin@epa.gov>
Cc: Sargeant, Kathryn <sargeant.kathryn@epa.gov>; Burch, Julia <Burch.Julia@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>; Schenk, Ruth <schenk.ruth@epa.gov>
Subject: SAB prep call

Bill and Ben,

We just had a call with John Shoaff and Carl Mazza at OAPPS (formerly OPAR) on preparing for the upcoming SAB teleconference next week. The OTAQ attendees are copied on this message.

Ex. 5 - Deliberative Process

Julia, is there anything you would like to add?

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Shoaff, John
Sent: Tuesday, June 20, 2017 2:57 PM
To: Shoaff, John; Sargeant, Kathryn; Samulski, Michael; Manning, Bryan; Audette, Lucie; Mazza, Carl
Cc: Charmley, William
Subject: SAB Prep Call
When: Wednesday, June 21, 2017 2:00 PM-3:00 PM (UTC-05:00) Eastern Time (US & Canada).
Where: teleconference Ex. 6 - Personal Privacy conf. code

Added supplementary info, scroll down under original note below, and attachments.

All,

In follow-up to Leif's note on Friday at 2:39 (see also for background re: SAB agenda and supporting docs), I wanted to schedule a quick call to check in on the typical process for these SAB discussions and strategize on how we might wish to prepare for the discussion as needed.

Carl is also reviewing the SAB's peer review suggestions vs. the PR Handbook to see how they might jive with time frames and in order to assist with potential clarifications or responses.

Thanks!

John

Supplementary info. for our conversation:

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Attachments

1. Key Pages from SAB WG Memo Appendix
2. SAB Agenda
3. Full SAB WG Memo & Appendices
4. GHG Aviation Template submitted in follow up to Fall 2016 Reg Agenda

-

-

To: Samulski, Michael[samulski.michael@epa.gov]
From: Simon, Joseph
Sent: Wed 2/25/2015 3:13:26 PM
Subject: RE: draft aircraft letters
AX-15-000-5135 draft Resp Ltr joint w FAA (Airlines for America).docx
AX-15-000-4615 draft Resp Ltr joint w FAA (CBD).docx

Hi Mike,

Here are your two letters.

I needed to expand "EPA" and "FAA" in some places and added GHG in others.

Any questions, please let me know.

Joe Simon

Senior Service America, Inc.

Supporting the USEPA through a Cooperative Agreement

under the Senior Environmental (SEE) Program

Assessment and Standards Division

Direct line 734-214-4835

Email: Simon.Joseph@epa.gov

From: Samulski, Michael
Sent: Wednesday, February 25, 2015 9:15 AM
To: Simon, Joseph
Subject: draft aircraft letters

Joe,

Here are the 2 draft letters. Please format them as we discussed, and I will send them back to

FAA for final review.

Thanks,

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

To: Birgfeld, Erin[Birgfeld.Erin@epa.gov]
Cc: Samulski, Michael[samulski.michael@epa.gov]
From: Audette, Lucie
Sent: Fri 11/6/2015 2:25:54 PM
Subject: RE: UM Lecture Nov 11
ICAO Aircraft CO2 Std_high level overview 11-6-2015.pptx

Hi Erin, Here are a few slides that provide that high level overview you were looking for. Let me know if you need anything further. Kind regards, Lucie

-----Original Message-----
From: Birgfeld, Erin
Sent: Friday, November 06, 2015 9:11 AM
To: Audette, Lucie <audette.lucie@epa.gov>; Samulski, Michael <samulski.michael@epa.gov>
Subject: FW: UM Lecture Nov 11

HI Lucie and Mike,

Do you have any high level messaging slides on aircraft and its contribution to GHG's / expected future growth/ reasons for taking action now? I have your TP for janet that I will also provide.

Anything with a graphic would be best. I'm trying to get something to chris by noon today.

Thanks!

-Erin

-----Original Message-----
From: Birgfeld, Erin
Sent: Tuesday, November 03, 2015 3:55 PM
To: Moran, Robin <moran.robin@epa.gov>; Simon, Karl <Simon.Karl@epa.gov>; Bunker, Byron <bunker.byron@epa.gov>; Alson, Jeff <alson.jeff@epa.gov>
Cc: Moltzen, Michael <Moltzen.Michael@epa.gov>; Snapp, Lisa <snapp.lisa@epa.gov>; Hengst, Benjamin <Hengst.Benjamin@epa.gov>; Argyropoulos, Paul <Argyropoulos.Paul@epa.gov>; Samulski, Michael <samulski.michael@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>; Bynum, Cheryl <bynum.cheryl@epa.gov>; Yanca, Catherine <yanca.catherine@epa.gov>
Subject: FW: UM Lecture Nov 11

Hi all,

Chris is giving an hour lecture at U of M next week titled "Transportation: Current and Future State". Can you send me by COB tomorrow (if possible) any high level and interesting slides that would be useful for the topic titled: "Transportation: Current and Future State"

Should encompass

Should encompass:
environmental context-- what the world looks like today-- where it is headed with current policy ---what more needs to be done and Emerging trends (Karl, Lisa, Jeff) passenger vehicles (Robin, Jeff, Lisa) HD (Cay, Cheryl B.) Aircraft (Lucie, Mike) Fuels (Karl, Paul A.)

Robin, I already have the SAE slides, and the Asilomar slides. I do not have the Traverse City slides. Can you send those along?

Thank you!

-Erin

See specific thoughts from Chris below.

"Transportation: Current and Future State"

Should encompass environmental context-- what the world looks like today-- where it is headed with current policy---what more needs to be done

Should encompass passenger vehicles , HD, Aircraft, and fuels)

Assemble TC, Asilomar, and SAE Chicago slides (Robin)

See if Jeff and Lisa and Karl have some interesting new stuff on emerging trends.

Thank you!

-Erin

-----Original Message-----
From: Grundler, Christopher
Sent: Tuesday, November 03, 2015 8:28 AM
To: Birgfeld, Erin <Birgfeld.Erin@epa.gov>
Cc: Simon, Karl <Simon.Karl@epa.gov>; Hengst, Benjamin <Hengst.Benjamin@epa.gov>
Subject: UM Lecture Nov 11

Erin
Pls put a call out for cool slides that fit the topic of

"Transportation: Current and Future State"

Should encompass environmental context-- what the world looks like today-- where it is headed with current policy---what more needs to be done

Should encompass passenger vehicles, HD, Aircraft, and fuels

Assemble TC, Asilomar, and SAE Chicago slides (Robin)

See if Jeff and Lisa and Karl have some interesting new stuff on emerging trends

No dense, text dominant stuff.

45-60 minutes

Christopher Grundler, Director
Office of Transportation and Air Quality U.S. Environmental Protection Agency
202.564.1682 (Washington)
734.214.4207 (Ann Arbor)
www.epa.gov/otaq

To: Nancy Kruger[nkruger@4cleanair.org]
Cc: Jantarasami, Lesley[Jantarasami.Lesley@epa.gov]; Samulski, Michael[samulski.michael@epa.gov]
From: Audette, Lucie
Sent: Mon 6/22/2015 5:44:59 PM
Subject: RE: Agenda (revised) for 6/23 NACAA call
Aircraft GHG Emissions for NAACA Meeting 6-22-15_.pptx

Nancy, attached are the slides that we will use tomorrow. While I will be on the phone call tomorrow, Mike Samulski and Lesley Jantarasami will be doing the briefing itself.

Mike Samulski is the Center Director for Large Marine and Aviation Center within the Assessment and Standards Division for OTAQ

Lesley Jantarasami is a climate science and policy analyst for the Climate Change Division in EPA's Office of Atmospheric Programs

Lucie Audette is Senior Policy Advisor within the Assessment and Standards Division for OTAQ

From: Nancy Kruger [mailto:nkruger@4cleanair.org]
Sent: Monday, June 22, 2015 1:00 PM
To: Audette, Lucie; Yanca, Catherine
Subject: Agenda (revised) for 6/23 NACAA call

Lucie and Cay,

The agenda (revised to include Phase 2) for tomorrow's NACAA call is attached. We look forward to talking with all of you.

We'll post your slides when we receive them.

Thanks so much!

-Nancy

Nancy Kruger

Deputy Director

National Association of Clean Air Agencies

444 North Capitol Street, NW

Suite 307

Washington, DC 20001

tel: (202) 624-7864

fax: (202) 624-7863

nkruger@4cleanair.org

www.4cleanair.org

To: Samulski, Michael[samulski.michael@epa.gov]
From: Audette, Lucie
Sent: Thur 7/7/2016 8:32:41 PM
Subject: RE: Aircraft CO2 Rulemaking Analyses
Rulemaking Analyses for Aircraft CO2 Standard Rule - Draft 7 7 16 +LCA.pptx

Mike, I had a few suggested changes + 1 comment on slide 8. Suggested changes are on slides 2,3,7,8. Overall Looks good. Lucie

From: Samulski, Michael
Sent: Thursday, July 07, 2016 3:07 PM
To: Manning, Bryan <manning.bryan@epa.gov>; Leggett, Cullen <Leggett.Cullen@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>; Yen, David <Yen.David@epa.gov>; Davidson, Ken <Davidson.Ken@epa.gov>
Cc: Mueller, John <mueller.john@epa.gov>; Zawacki, Margaret <zawacki.margaret@epa.gov>; Hoyer, Marion <hoyer.marion@epa.gov>; Sargeant, Kathryn <sargeant.kathryn@epa.gov>
Subject: Aircraft CO2 Rulemaking Analyses

A number of you have gotten an invitation to brief Bill on our plans for the aircraft CO2 rulemaking analyses (Thursday 7/14 at 1:00). If you were not on the invitation list and would like to be, please let me know and I will ask Gail to add you.

I am sending the draft briefing to you for your feedback. You will see that there are a number of open questions, some marked in red. Cullen is already following up on the questions noted for FAA.

I think we need to do a little more work before we brief Bill. For each of the open questions, I would like us to pull together PROS and CONS, and also a staff recommendations. For this reason, I will be setting up a meeting for next Tuesday, which is the only day Bryan, Cullen, and Lucie are all in the office in the next week.

Thanks,

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

EPA-HQ-2018-004348

To: Samulski, Michael[samulski.michael@epa.gov]
From: Audette, Lucie
Sent: Fri 2/20/2015 4:43:15 PM
Subject: Draft response to 2 controls
AX-15-000-4615 CBD et al.docx
AX-15-000-5135_Airlines for America_Nancy Young et al.docx

I'll drop the folders off so you can see the letters we received.

ExxonMobil

May 4 - 7, 2015

EPA ANPRM Process

Advance Notice of *Proposed* Rule Making

Energy lives here™

Keith Camp
ExxonMobil Research and Engineering

Overall Process

- **Legislation.**
- **Advance Notice of Proposed Rulemaking (optional).**
- **Proposed Rule.**
- **Public comment.**
- **Final Rule.**
- **Judicial review (optional).**
- **Effective date.**

Legislative Process

- **Congress writes a Bill**
- **The Bill is approved by Congress (the House and Senate)**
- **The Bill is signed by the President**
- **The Bill becomes a Law (Act or Statute) e.g. Clean Air Act**
- **The text of the Law is codified in the U.S. Code**

- **Laws are general and often require specific regulations to understand how to comply**
- **The government creates agencies to interpret the law and write regulations e.g. the EPA**

Regulatory Process

- **Regulatory agency determines if a regulation is necessary**

- **Step 1: EPA Proposes a Regulation**
  - The Agency researches the issues and, if necessary, proposes a regulation, also known as a Notice of Proposed Rulemaking (NPRM). The proposal is listed in the *Federal Register (FR)* so that members of the public can consider it and send their comments to us. The proposed rule and supporting documents are also filed in EPA's official docket on Regulations.gov.
- **Step 2: EPA Considers Your Comments and Issues a Final Rule**
  - Generally, once we consider the comments received when the proposed regulation was issued, we revise the regulation accordingly and issue a final rule. This final rule is also published in the FR and in EPA's official docket on Regulations.gov.
- **Step 3: The Regulation is Codified in the *Code of Federal Regulations***
  - Once a regulation is completed and has been printed in the FR as a final rule, it is codified when it is added to the *Code of Federal Regulations* (CFR). The CFR is the official record of all regulations created by the federal government. It is divided into 50 volumes, called titles, each of which focuses on a particular area. Almost all environmental regulations appear in Title 40. The CFR is revised yearly, with one fourth of the volumes updated every three months. Title 40 is revised every July 1.

http://www2.epa.gov/laws-regulations/basics-regulatory-process

Advance Notice of Proposed Rule Making

- **Advance Notice of Proposed Rulemaking**.
  - Optional step
    - Publishing the agency's initial analysis of the subject matter.
    - Opportunity for early public input on key issues.
  - Any data or communications regarding the upcoming rule are made available to the public for review.

U.S. Aircraft GHG Rulemaking Process

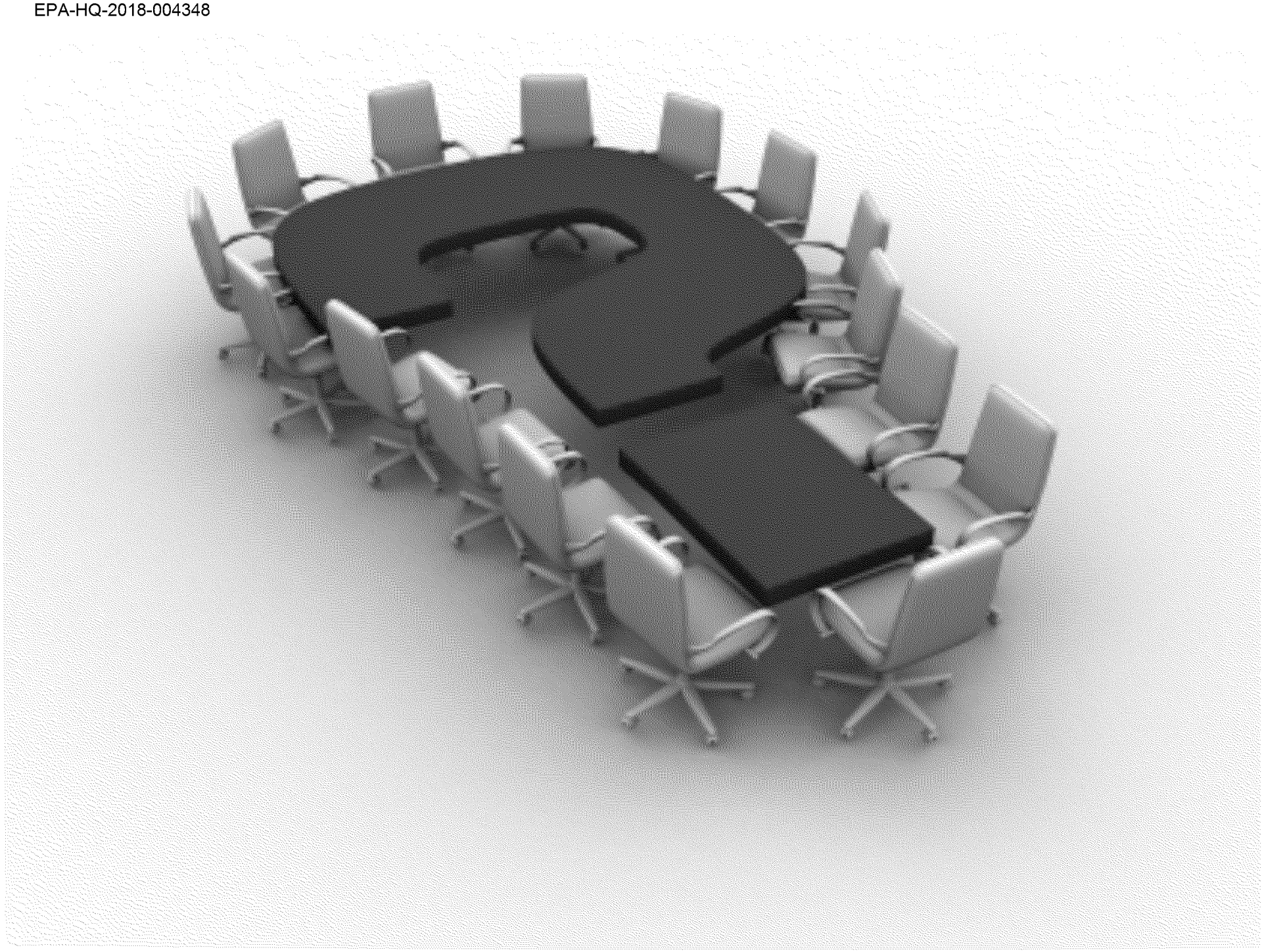
- U.S./EPA is now moving forward with a rulemaking process to propose endangerment and cause or contribute findings regarding aircraft GHG emissions.
  - U.S./EPA will issue an ANPRM to provide an overview of ICAO/CAEP efforts to set aircraft CO2 standards its endangerment cause/contribute findings.
    - Basis for ANPRM findings
      - U.S./EPA's 2009 §202 CAA endangerment and cause or contribute findings for on-road vehicles
      - Previous peer-reviewed science from the major climate change science assessments
        - U.S. Global Change Research Program (USGCRP)
        - National Research Council (NRC)
        - Intergovernmental Panel on Climate Change (IPCC)
        - Updated reports from the same major climate change assessments.

U.S. Aircraft GHG Rulemaking Process

- Currently, the U.S. expects approval signature for the domestic release of the proposal/ANPRM in late April 2015. (EPA has indicated this will now be in May 2015)

- Where:
  - Site
    - http://www.epa.gov/otaq/aviation.htm
  - Complete Process
    - http://www.epa.gov/otaq/aviation.htm#ghg
  - Text

Aircraft GHG
Rulemaking Process



Message

From: Manning, Bryan [manning.bryan@epa.gov]
Sent: 11/12/2015 6:33:13 PM
To: Ex. 6 - Personal Privacy yahoo.com
Subject: RE: CO2/aviation update...?

Hello Mr. Ewing,

The below email was forwarded to me. Thank you for your message and interest in the environment.

It would take until about the Spring of 2016 to finalize the proposed aircraft greenhouse gas endangerment and cause or contribute findings. In this final action, we would plan to respond to comments on the proposed findings. Any future EPA actions toward aircraft standards would also be open to public comment and review before they could take effect.

Sincerely,

Bryan

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

From: Ewing Tom [mailto: Ex. 6 - Personal Privacy @yahoo.com]
Sent: Thursday, November 12, 2015 10:03 AM
To: Iffland, JoNell
Subject: Fw: CO2/aviation update...?

Ms. Iffland - any updates on CO2/aircraft developments? Thanks!

TE

----- Forwarded Message -----
From: Ewing Tom <Ex. 6 - Personal Privacy yahoo.com>
To: JoNell Iffland <iffland.jonell@epa.gov>
Sent: Tuesday, October 6, 2015 3:56 PM
Subject: CO2/aviation update...?

Ms. Iffland - is there any update available regarding EPA's next steps and timeline since the close of the comment period regarding the 07/01/15 Federal Register "proposed finding" referencing greenhouse gases and aviation? Is the Agency planning a response to comments? Thank you.

Tom Ewing
"reply" or
Ex. 6 - Personal Privacy

To: Samulski, Michael[samulski.michael@epa.gov]
From: Audette, Lucie
Sent: Mon 10/19/2015 5:55:17 PM
Subject: For Review: draft TPs
Talking Points updated 10-19-2015.docx

Mike found these in the materials that we had prepared and had gone through review for the June release. I've tweaked them a bit. See what you think. Lucie

From: Samulski, Michael
Location: AA-Room-Office-N66-ConfRoom/AA-OTAQ-OFFICE
Importance: Normal
Subject: CO2 drafting schedule
Start Time: Tue 3/27/2018 6:30:00 PM
End Time: Tue 3/27/2018 7:00:00 PM
Required Attendees: Cullen Leggett (leggett.cullen@epa.gov); Mueller, John; yen.david@epa.gov; maeroff.bruce@epa.gov
Optional Attendees: Manning, Bryan
Outline_Assignments_Preamble_Aircraft CO2 Stds NPRM.docx
Outline_Assignments_RIA_Aircraft CO2 Stds NPRM.docx

I have a conflict, so am rescheduling for tomorrow just before the team meeting.

Mike

****

Time is getting short to get the preamble and RIA drafted. I would like to pin down dates that first drafts done of the different sections will be ready for my review.

Thanks,

Mike

From: Samulski, Michael
Location: AA-Room-Office-N66-ConfRoom/AA-OTAQ-OFFICE
Importance: Normal
Subject: FW: CO2 drafting schedule
Start Time: Tue 3/27/2018 6:30:00 PM
End Time: Tue 3/27/2018 7:00:00 PM
Required Attendees: maeroff.bruce@epa.gov
Outline_Assignments_Preamble_Aircraft CO2 Stds NPRM.docx
Outline_Assignments_RIA_Aircraft CO2 Stds NPRM.docx

I set this up to discuss rule drafting schedule. We can go into the CO2 part of the team meeting with any remaining time, then follow with PM after 3:00. I will only be available until 3:30 tomorrow.

Mike

-----Original Appointment-----
From: Samulski, Michael
Sent: Friday, March 23, 2018 8:55 AM
To: Samulski, Michael; Cullen Leggett (leggett.cullen@epa.gov); Mueller, John; yen.david@epa.gov
Cc: Manning, Bryan
Subject: CO2 drafting schedule
When: Tuesday, March 27, 2018 2:30 PM-3:00 PM (UTC-05:00) Eastern Time (US & Canada).
Where: AA-Room-Office-N66-ConfRoom/AA-OTAQ-OFFICE

I have a conflict, so am rescheduling for tomorrow just before the team meeting.

Mike

****

Time is getting short to get the preamble and RIA drafted. I would like to pin down dates that first drafts done of the different sections will be ready for my review.

Thanks,

Mike

From: Samulski, Michael
Location: AA-Room-Office-N66-ConfRoom/AA-OTAQ-OFFICE
Importance: Normal
Subject: CO2 drafting schedule
Start Time: Tue 3/27/2018 6:30:00 PM
End Time: Tue 3/27/2018 7:00:00 PM
Required Attendees: Cullen Leggett (leggett.cullen@epa.gov); Mueller, John; yen.david@epa.gov
Optional Attendees: Manning, Bryan
Outline_Assignments_Preamble_Aircraft CO2 Stds NPRM.docx
Outline_Assignments_RIA_Aircraft CO2 Stds NPRM.docx

I have a conflict, so am rescheduling for tomorrow just before the team meeting.

Mike

****

Time is getting short to get the preamble and RIA drafted. I would like to pin down dates that first drafts done of the different sections will be ready for my review.

Thanks,

Mike

From: Samulski, Michael
Location: AA-Room-Office-N66-ConfRoom/AA-OTAQ-OFFICE
Importance: High
Subject: Canceled: CO2 drafting schedule
Start Time: Tue 3/27/2018 6:30:00 PM
End Time: Tue 3/27/2018 7:00:00 PM
Outline_Assignments_Preamble_Aircraft CO2 Stds NPRM.docx
Outline_Assignments_RIA_Aircraft CO2 Stds NPRM.docx

I have a conflict, so am rescheduling for tomorrow just before the team meeting.

Mike

****

Time is getting short to get the preamble and RIA drafted. I would like to pin down dates that first drafts done of the different sections will be ready for my review.

Thanks,

Mike

From: Samulski, Michael
Location: AA-Room-Office-N125-ConfRoom/AA-OTAQ-OFFICE
Importance: Normal
Subject: CO2 drafting schedule
Start Time: Mon 3/26/2018 7:30:00 PM
End Time: Mon 3/26/2018 8:00:00 PM
Required Attendees: Cullen Leggett (leggett.cullen@epa.gov); Mueller, John; yen.david@epa.gov
Optional Attendees: Manning, Bryan

Outline_Assignments_Preamble_Aircraft CO2 Stds NPRM.docx

Outline_Assignments_RIA_Aircraft CO2 Stds NPRM.docx

Time is getting short to get the preamble and RIA drafted. I would like to pin down dates that first drafts done of the different sections will be ready for my review.

Thanks,

Mike

To: charmley.william@epa.gov[charmley.william@epa.gov]
Cc: Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]; Manning, Bryan[manning.bryan@epa.gov]
From: Samulski, Michael
Sent: Thur 9/21/2017 4:57:03 PM
Subject: Early Guidance Briefing
Early Guidance Briefing_Aircraft GHG Std_October 25 2016.pptx

Bill,

You had mentioned giving us your thoughts on revisions to the early guidance briefing, with a view to us having something to discuss with Chris at Monday's peer review briefing.

Do you anticipate having a chance to do that, or would you like us to take a crack at updating the briefing?

I will be out of the office tomorrow, but Bryan and Lucie will be here to make any revisions.

For your convenience, last year's Early Guidance Briefing is attached. This should be the same document that Bryan handed you a paper copy of.

Thanks,

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

To: OTAQ Materials[OTAQMaterials@epa.gov]
Cc: charmley.william@epa.gov[charmley.william@epa.gov]; Manning, Bryan[manning.bryan@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]; Mueller, John[mueller.john@epa.gov]; yen.david@epa.gov[yen.david@epa.gov]; Orlin, David[Orlin.David@epa.gov]; Thrift, Mike[thrift.mike@epa.gov]; JoNell Iffland (iffland.jonell@epa.gov)[iffland.jonell@epa.gov]; Gonzalez, Gail[Gonzalez.Gail@epa.gov]; Lindsey, Leah[lindsey.leah@epa.gov]; Gerring, Holly[gerring.holly@epa.gov]
From: Samulski, Michael
Sent: Fri 1/5/2018 7:49:57 PM
Subject: RE: Materials for Monday's 3:00 briefing with Chris on Aircraft CO2 standards
Briefing_Aircraft CO2 Rule DRAFT 1 5 18.pptx

Use this one instead. We just received a graphic from industry on timing which I added to the briefing.

Mike

****
Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov
****

From: Samulski, Michael
Sent: Friday, January 05, 2018 2:37 PM
To: OTAQ Materials <OTAQMaterials@epa.gov>
Cc: charmley.william@epa.gov; Manning, Bryan <manning.bryan@epa.gov>; Cullen Leggett (leggett.cullen@epa.gov) <leggett.cullen@epa.gov>; Mueller, John <mueller.john@epa.gov>; yen.david@epa.gov; Orlin, David <Orlin.David@epa.gov>; Thrift, Mike <thrift.mike@epa.gov>; JoNell Iffland (iffland.jonell@epa.gov) <iffland.jonell@epa.gov>; Gonzalez, Gail <Gonzalez.Gail@epa.gov>; Lindsey, Leah <lindsey.leah@epa.gov>; Gerring, Holly <gerring.holly@epa.gov>
Subject: Materials for Monday's 3:00 briefing with Chris on Aircraft CO2 standards

Monday's meeting is a pre-brief for our January 17th meeting with Bill Wehrum. The attached file is a draft briefing that we would use with Bill W.

Mike

****
Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov
****

To: OTAQ Materials[OTAQMaterials@epa.gov]
Cc: charmley.william@epa.gov[charmley.william@epa.gov]; Manning, Bryan[manning.bryan@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]; Mueller, John[mueller.john@epa.gov]; yen.david@epa.gov[yen.david@epa.gov]; Orlin, David[Orlin.David@epa.gov]; Thrift, Mike[thrift.mike@epa.gov]; JoNell Iffland (iffland.jonell@epa.gov)[iffland.jonell@epa.gov]; Gonzalez, Gail[Gonzalez.Gail@epa.gov]; Lindsey, Leah[lindsey.leah@epa.gov]; Gerring, Holly[gerring.holly@epa.gov]
From: Samulski, Michael
Sent: Fri 1/5/2018 7:37:13 PM
Subject: Materials for Monday's 3:00 briefing with Chris on Aircraft CO2 standards
Briefing_Aircraft CO2 Rule DRAFT 1 5 18.pptx

Monday's meeting is a pre-brief for our January 17th meeting with Bill Wehrum. The attached file is a draft briefing that we would use with Bill W.

Mike

****
Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov
****

EPA-HQ-2018-004348

To: Manning, Bryan[manning.bryan@epa.gov]; yen.david@epa.gov[yen.david@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]; Mueller, John[mueller.john@epa.gov]; maeroff.bruce@epa.gov[maeroff.bruce@epa.gov]; Lindsey, Leah[lindsey.leah@epa.gov]; Gerring, Holly[gerring.holly@epa.gov]
From: Samulski, Michael
Sent: Tue 1/2/2018 2:53:32 PM
Subject: Draft Materials for Aircraft Pre-Brief with Bill
Briefing_Aircraft CO2 Rule DRAFT 1 3 18.pptx

Here is the draft briefing we will discuss with Bill at 1:00 tomorrow. It is largely the same as the Sarah Dunham briefing, with some updates to reflect our discussions with Boeing/GE.

Mike

****
Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov
****

From: Samulski, Michael
Location: AA-Room-Office-N125-ConfRoom/AA-OTAQ-OFFICE
Importance: Normal
Subject: Aircraft CO2 Rulemaking Analyses
Start Date/Time: Tue 7/12/2016 7:00:00 PM
End Date/Time: Tue 7/12/2016 8:00:00 PM
Rulemaking Analyses for Aircraft CO2 Standard Rule - Draft 7 11 16.pptx
PROs and CONs of aircraft analysis options.docx

I put together a first cut at recommendations and PROs/CONs as a starting point for this meeting. See the attached Word document. Also I made some updates to the briefing based on some of the feedback we got from FAA today. It still needs more work…

The purpose of this meeting is to develop PROs/CONs and staff recommendations for the open questions identified in the attached draft briefing.

This seems to be the best time for most of us.

Ken, if you can join us, we can use the following call in number **Ex. 6 - Personal Privacy**

Ex. 6 - Personal Privacy

To: charmley.william@epa.gov[charmley.william@epa.gov]
Cc: Manning, Bryan[manning.bryan@epa.gov]
From: Samulski, Michael
Sent: Tue 2/28/2017 12:36:55 PM
Subject: FW: icymi-- greenwire article on aircraft GHG stds

The below article speaks on industry and NGO support for aircraft CO2 standards and CORSIA.

From: Orlin, David
Sent: Monday, February 27, 2017 5:11 PM
To: Thrift, Mike <thrift.mike@epa.gov>; Williams, Melina <Williams.Melina@epa.gov>; Samulski, Michael <samulski.michael@epa.gov>
Subject: icymi-- greenwire article on aircraft GHG stds

To Woo Trump, Backers Pitch 'Business Case' For Global Aircraft GHG Deals
February 27, 2017

Environmentalists and industry groups are urging EPA and the Department of Transportation (DOT) to craft rules to implement two international agreements reached last year curbing aircraft greenhouse gases (GHGs), pitching a "business case" for the deals and arguing that they are less controversial than carbon controls directed at other industries, such as the power sector.

However, it is largely undetermined how the new administration will proceed, particularly since participation in the agreements would require EPA to promulgate GHG standards for aircraft engines -- at a time when the Trump team is looking to roll back many Obama-era climate rules and potentially target the agency's authority to regulate in that space.

In addition, aircraft industry representatives have said legislation will be needed implement one of the deals, though there is debate with some environmentalists over whether this is necessary. If Congress does need to act, it may be difficult to find enough Republican support for any legislation given many GOP lawmakers' opposition to GHG controls.

The two agreements were adopted by the United States and nearly 190 countries under the International Civil Aviation Organization (ICAO) last year. The first, a certification standard -- known as the carbon dioxide standard -- covering new and in-production aircraft, was adopted in February.

The second, adopted in October, is a global market-based measure (MBM) limiting emissions from existing aircraft. That measure functions as an offset system, under which airlines would cap their GHG emissions at 2020 levels and purchase offsets to cover any emissions from international flights beyond that level they are unable to reduce through other measures like fuel efficiency, technology improvements and sustainable alternative jet fuels.

The U.S. aircraft industry broadly views the two global policies as part of a larger strategy to address GHG emissions from the sector and to meet an overall industry-wide goal of carbon-neutral growth after 2020. The sector was heavily involved in the ICAO negotiations crafting both the CO2 standard and the MBM, and it strongly supports both outcomes.

And industry groups and other observers warn that if the United States declines to participate in the agreements -- particularly the CO2 standard -- it could carry risks, potentially limiting manufacturers' ability to sell their aircraft to other countries and restricting airlines' ability to fly internationally.

The Obama EPA initiated the process of adopting the CO2 standard into law, finalizing a finding that aircraft GHGs endanger public health and welfare -- which serves as a legal prerequisite to any regulation of the sector's emissions. In the finding, the agency said it would craft GHG limits that are "at least as stringent" as the global CO2 standard.

It remains an open question whether the Trump EPA, under the control of Scott Pruitt, will move forward with the standards, or whether the administration in general will adhere to the MBM deal. The Trump team has already pledged to roll back or weaken several of the Obama administration's GHG controls, including those for existing power plants and for light-duty vehicles.

'Differently Situated'

But supporters of the aircraft deals, including industry and environmentalists, are attempting to paint the aviation standards as

noncontroversial, particularly given the strong support from industry and the global dynamic, thus decoupling the issue from the heated debate to come over whether and how EPA should regulate GHGs.

The decision in front of EPA to regulate GHGs from aircraft engines, by adopting into domestic law ICAO's CO2 standard, "is not a political statement. It is more of a business case" involving "industry certainty," said Suzanne Murray, a former EPA Region 6 counsel who now works as an attorney for Haynes and Boone.

Speaking at a Feb. 22 conference hosted by the International Air Transport Association, Murray said she believes the aviation industry is "very differently situated" than other industries like the power sector in part because "you have recognition of the ICAO efforts in the U.S. Regulation."

She also noted the involvement of the DOT's Federal Aviation Administration (FAA), which is charged with implementing the CO2 certification standard EPA would set. Thus, if the Trump EPA declines to adopt ICAO's CO2 standard into domestic law, it could place the FAA, which has to have "some certainty and . . . clarity about what they're certifying to," in a "precarious position," Murray said.

DOT and FAA's involvement in implementing the standards could ultimately help them get across the regulatory finish line, should the Trump administration decide the issue falls in the realm of transportation policy and not environmental policy, Annie Petsonk of the Environmental Defense Fund (EDF) suggested.

"If the Department of Transportation has the lead" on these issues "as a policy matter within the administration, and if industry is saying, . . . 'This is our chance to get a set of regulations for ourselves that we think address the problem and we can live with economically,' then I think it has a chance to survive," Petsonk said.

Although the Trump administration has not yet publicly addressed aircraft GHG policy or the ICAO agreements, advisers have suggested the Trump EPA could attempt to target the agency's 2009 GHG endangerment finding, which underpins EPA's climate regulations including the aircraft risk finding and any potential standards for that sector.

But Murray said she finds it "unlikely" that the Trump administration will ultimately target the underlying endangerment finding. Instead, she suggested the Trump EPA is more likely "going to do an analysis of the endangerment finding and regulation of carbon industry-by-industry."

Such a scenario, she suggested, could benefit the aviation industry. Analysis of carbon regulation for a sector like the power industry, for example, "could be very different from the analysis you would do on regulation of carbon from the aviation industry where you have . . . already made some decisions about cost effectiveness, about technology, about how you want to participate in the global market," Murray said. She added: "I think that may weigh differently in the analysis of how this regulation may move forward."

'Love Sonnet'

Aircraft industry groups are also perfecting their pitch to the new administration in support of the ICAO deals.

Nancy Young of Airlines for America said if she were writing a "love sonnet" to the Trump administration to persuade it to pursue the ICAO deals, her message would "come back to technology, operations and infrastructure."

She described the MBM in particular as a "critical gap filler for our ability to do business internationally under a common set of goals," noting that message should speak to the administration's "business" and "America first" interests.

However, she cautioned that industry's "love sonnet" to the Trump administration "is a different story" if other countries do not adhere to the notion that the MBM is the sole international deal to limit existing aircraft GHGs -- which was a crucial request of industry during the negotiations.

Young criticized efforts like a proposed international aviation tax being floated in Sweden and the European Union's Emissions Trading System -- should it continue to cover intra-Europe flights after 2021 when the MBM takes hold -- noting industry's message to the Trump team is about the whole "package and the ability to do this right for business."

Young, as well as Murray, warned of a "worst-case scenario" if the Trump administration were to not move forward with GHG standards for aircraft engines.

Young noted that if the United States did not adopt the ICAO CO2 standard into law so that American manufacturers such as Boeing can ensure their aircraft are properly certified, "other countries could use the technique of, 'We won't let those aircraft into our air space because it's an air worthiness standard that it doesn't meet.'" That refers to a seldom-used provision under the Chicago Convention, the 1944 treaty establishing ICAO, that gives countries the ability to not allow another country's aircraft to enter their air space if that country is not complying with ICAO standards.

Such enforcement of the MBM, covering existing aircraft, is more complicated, however, because that measure applies to airlines and to countries, and functions as an offsetting program rather than a technology-based certification standard, making it more difficult to respond when parties are not "living up to the real deal" of the MBM.

Young said instead that enforcement of the MBM will "rely on the will of the states and the bilateral process for consultation to make sure that that happens right," adding that industry groups will also play a "persuasive role."

EDF's Petsonk also noted the importance of self-regulation by industry, arguing "that kind of culture will be crucial" to the MBM's implementation. She suggested another important aspect to enforcement of the aircraft GHG limits could be an "increasing consciousness among the flying public that this is an issue that must be dealt with." Petsonk noted "that is true not only for the customers flying in travel terms, but also in freight terms." The latter dynamic could also come into play as countries and localities committed to GHG reductions seek to import products with a low carbon impact.

California and several other national and subnational markets "want to know the carbon footprint of the products they are buying," Petsonk said, "and if [the products] are flown in, they want to know how the airline is dealing" with its GHG emissions. -- *Abby Smith* (asmith@iwpnews.com)

Related News | Mid Day E-mail | Transition 2016-2017 | Air | Climate Policy Watch |

To: Audette, Lucie[audette.lucie@epa.gov]
Cc: Manning, Bryan[manning.bryan@epa.gov]; Leggett, Cullen[Leggett.Cullen@epa.gov]; charmley.william@epa.gov[charmley.william@epa.gov]
From: Samulski, Michael
Sent: Wed 10/14/2015 11:41:35 AM
Subject: RE: Draft Talking Points for Janet
Aircraft CO2 talking points 10 14 15.docx

Lucie,

Can you have a look at the attached this morning? These are the talking points that we told Janet we would prepare in advance of tomorrow's meeting.

Thanks,

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Charmley, William
Sent: Wednesday, October 14, 2015 6:53 AM
To: Samulski, Michael
Cc: Manning, Bryan; Leggett, Cullen; Audette, Lucie

Subject: RE: Draft Talking Points for Janet

Mike

Ex. 5 - Deliberative Process

That it. I would like Lucie to review as well, and of course Ben and Chris. I won't be able to spend any meaningful time on this between now and Thursday, but I will be trying to look at emails when I can.

Good luck on Thursday.

From: Samulski, Michael
Sent: Tuesday, October 13, 2015 3:00 PM
To: Charmley, William
Cc: Manning, Bryan; Leggett, Cullen

Subject: Draft Talking Points for Janet

Bill,

Here are the draft talking points for Gina. I'm copying them below as well, in the hope that you can read them that way on your phone. We will plan on sending this to Ben in the morning.

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

Key Messages

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

From: Samulski, Michael
Location: AA-Room-Office-N125-ConfRoom/AA-OTAQ-OFFICE
Importance: Normal
Subject: Aircraft CO2 Rulemaking Analyses
Start Date/Time: Tue 7/12/2016 7:00:00 PM
End Date/Time: Tue 7/12/2016 8:00:00 PM
Rulemaking Analyses for Aircraft CO2 Standard Rule - Draft 7 7 16.pptx

The purpose of this meeting is to develop PROs/CONs and staff recommendations for the open questions identified in the attached draft briefing.

This seems to be the best time for most of us.

Ken, if you can join us, we can use the following call in number: 1-866-299-3188, passcode 734 214 4532

To: charmley.william@epa.gov[charmley.william@epa.gov]
Cc: Bryan Manning (manning.bryan@epa.gov)[manning.bryan@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]
From: Samulski, Michael
Sent: Tue 10/13/2015 7:00:27 PM
Subject: Draft Talking Points for Janet
Aircraft CO2 talking points.docx

Bill,

Here are the draft talking points for Gina. I'm copying them below as well, in the hope that you can read them that way on your phone. We will plan on sending this to Ben in the morning.

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

Key Messages

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

To: charmley.william@epa.gov[charmley.william@epa.gov]
Cc: Bryan Manning (manning.bryan@epa.gov)[manning.bryan@epa.gov]; Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]
From: Samulski, Michael
Sent: Fri 12/11/2015 1:49:47 PM
Subject: Draft materials for 12/15 Briefing with Chris on Aircraft CO2
Chris Briefing Next Steps Possible CAEP Outcomes Draft 12-11-15.docx

Bill,

Attached are draft materials, for your review, to use for next Tuesday's briefing with Chris on aircraft CO2.

Ex. 5 - Deliberative Process

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

To: Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]
Cc: Manning, Bryan[manning.bryan@epa.gov]
From: Samulski, Michael
Sent: Tue 1/31/2017 6:12:14 PM
Subject: FW: Draft Analytic Blueprint- Aircraft GHG Standards and Test Procedures
Aircraft GHG draft analytic blueprint January 27+mt.doc

Lucie,

Ex. 5 - Deliberative Process

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Thrift, Mike
Sent: Monday, January 30, 2017 7:35 PM
To: Audette, Lucie <audette.lucie@epa.gov>; Schillo, Bruce <Schillo.Bruce@epa.gov>;

Griffiths, Charles <Griffiths.Charles@epa.gov>; Benner, Tim <Benner.Tim@epa.gov>; Dutton, Steven <Dutton.Steven@epa.gov>; McDow, Stephen <McDow.Stephen@epa.gov>; Belser, Evan <Belser.Evan@epa.gov>; Birkett, Daniel <Birkett.Daniel@epa.gov>; Castro, Marina <Castro.Marina@epa.gov>; Aspy, Dale <Aspy.Dale@epa.gov>; Powell, Alan <Powell.Alan@epa.gov>; Aumann, Ethan <Aumann.Ethan@epa.gov>; Russ, Timothy <Russ.Tim@epa.gov>
Cc: Manning, Bryan <manning.bryan@epa.gov>; Samulski, Michael <samulski.michael@epa.gov>; Orlin, David <Orlin.David@epa.gov>
Subject: RE: Draft Analytic Blueprint- Aircraft GHG Standards and Test Procedures

Everyone—

Here are my comments and suggested edits.

From: Audette, Lucie
Sent: Friday, January 27, 2017 10:04 AM
To: Schillo, Bruce <Schillo.Bruce@epa.gov>; Griffiths, Charles <Griffiths.Charles@epa.gov>; Benner, Tim <Benner.Tim@epa.gov>; Dutton, Steven <Dutton.Steven@epa.gov>; McDow, Stephen <McDow.Stephen@epa.gov>; Belser, Evan <Belser.Evan@epa.gov>; Thrift, Mike <thrift.mike@epa.gov>; Birkett, Daniel <Birkett.Daniel@epa.gov>; Castro, Marina <Castro.Marina@epa.gov>; Aspy, Dale <Aspy.Dale@epa.gov>; Powell, Alan <Powell.Alan@epa.gov>; Aumann, Ethan <Aumann.Ethan@epa.gov>; Russ, Timothy <Russ.Tim@epa.gov>
Cc: Manning, Bryan <manning.bryan@epa.gov>; Samulski, Michael <samulski.michael@epa.gov>
Subject: Draft Analytic Blueprint- Aircraft GHG Standards and Test Procedures

Dear workgroup members,

Attached is the draft Analytic Blueprint for the aircraft GHG standards and test procedures rule development. Please let me know if you have any questions or comments with regard to the attached materials by February 9th. Let me know if you will need additional time as well. Thanks so much for your participation. Lucie

From: Audette, Lucie
Sent: Wednesday, October 19, 2016 4:05 PM
To: Schillo, Bruce <Schillo.Bruce@epa.gov>; Griffiths, Charles <Griffiths.Charles@epa.gov>; Benner, Tim <Benner.Tim@epa.gov>; Dutton, Steven <Dutton.Steven@epa.gov>; McDow, Stephen <McDow.Stephen@epa.gov>; Belser, Evan <Belser.Evan@epa.gov>; Thrift, Mike <thrift.mike@epa.gov>; Birkett, Daniel <Birkett.Daniel@epa.gov>; Castro, Marina <Castro.Marina@epa.gov>; Aspy, Dale <Aspy.Dale@epa.gov>; Powell, Alan <Powell.Alan@epa.gov>; Aumann, Ethan <Aumann.Ethan@epa.gov>; Russ, Timothy <Russ.Tim@epa.gov>
Cc: Manning, Bryan <manning.bryan@epa.gov>
Subject: Early Guidance Briefing Materials- Aircraft GHG Standards

Dear workgroup members,

Attached is the Early Guidance Briefing for the Proposed Aircraft GHG Emissions Standards and Test Procedures which is schedule with Janet McCabe for this coming Tuesday, October 25 from 3-4 pm. Your respective AAs and you should each have received a meeting invite along with room number/call-in number.

Please let me know if you have any questions or comments with regard to the attached materials.

Thanks so much. Lucie

To: Manning, Bryan[manning.bryan@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]; Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]; yen.david@epa.gov[yen.david@epa.gov]; Davidson, Ken[Davidson.Ken@epa.gov]
Cc: Mueller, John[mueller.john@epa.gov]; Zawacki, Margaret[zawacki.margaret@epa.gov]; Hoyer, Marion[hoyer.marion@epa.gov]; sargeant.kathryn@epa.gov[sargeant.kathryn@epa.gov]
From: Samulski, Michael
Sent: Thur 7/7/2016 7:07:10 PM
Subject: Aircraft CO2 Rulemaking Analyses
Rulemaking Analyses for Aircraft CO2 Standard Rule - Draft 7 7 16.pptx

A number of you have gotten an invitation to brief Bill on our plans for the aircraft CO2 rulemaking analyses (Thursday 7/14 at 1:00). If you were not on the invitation list and would like to be, please let me know and I will ask Gail to add you.

I am sending the draft briefing to you for your feedback. You will see that there are a number of open questions, some marked in red. Cullen is already following up on the questions noted for FAA.

I think we need to do a little more work before we brief Bill. For each of the open questions, I would like us to pull together PROS and CONS, and also a staff recommendations. For this reason, I will be setting up a meeting for next Tuesday, which is the only day Bryan, Cullen, and Lucie are all in the office in the next week.

Thanks,

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

To: Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]
From: Samulski, Michael
Sent: Thur 1/26/2017 2:16:08 PM
Subject: FW: OTAQ Submission: Fall 2016 Reg Agenda SAB Review Templates
SAB Review_for 2018 RFS annual rule otaq final2.docx
EPA action description_Aviation Lead Endangerment otaq final2.docx
EPA action description Aircraft GHG rule otaq final2.docx

FYI

From: Sargeant, Kathryn
Sent: Thursday, January 26, 2017 8:09 AM
To: Machiele, Paul <machiele.paul@epa.gov>; Burkholder, Dallas <burkholder.dallas@epa.gov>; Hoyer, Marion <hoyer.marion@epa.gov>; Parsons, Christy <Parsons.Christy@epa.gov>; Samulski, Michael <samulski.michael@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>; Orlin, David <Orlin.David@epa.gov>; Dubois, Roland <Dubois.Roland@epa.gov>; Thrift, Mike <thrift.mike@epa.gov>
Cc: Simon, Karl <Simon.Karl@epa.gov>; Cook, Leila <cook.leila@epa.gov>
Subject: FYI: OTAQ Submission: Fall 2016 Reg Agenda SAB Review Templates

FYI, attached is the information for the SAB that we have sent up to OAR/OAPPS for their review before sending on to the next step of the process.

From: Sargeant, Kathryn
Sent: Wednesday, January 25, 2017 4:46 PM
To: Shoaff, John <Shoaff.John@epa.gov>
Cc: Mazza, Carl <Mazza.Carl@epa.gov>; Hockstad, Leif <Hockstad.Leif@epa.gov>; Burch, Julia <Burch.Julia@epa.gov>; Hengst, Benjamin <Hengst.Benjamin@epa.gov>; Schenk, Ruth <schenk.ruth@epa.gov>; Charmley, William <charmley.william@epa.gov>
Subject: OTAQ Submission: Fall 2016 Reg Agenda SAB Review Templates

Attached please find OTAQ's three submissions, as you requested.

These have been reviewed within OTAQ and by OGC.

Please let me know if you have any questions or feedback you'd like us to consider.

From: Shoaff, John
Sent: Wednesday, January 04, 2017 1:04 PM
To: Sargeant, Kathryn <sargeant.kathryn@epa.gov>; Rimer, Kelly <Rimer.Kelly@epa.gov>
Cc: Mazza, Carl <Mazza.Carl@epa.gov>; Hockstad, Leif <Hockstad.Leif@epa.gov>
Subject: FW: Happy Holidays and a few things for the new year -- Fall 2016 Reg Agenda SAB Review Templates due 1/25

Kathryn and Kelly,

Happy new year! I wanted to follow up on my note below and before the holidays though apologies Kelly, I missed you on the distribution. Need to circle back on the request for SAB templates related to actions from the Fall 2016 Reg Agenda. We've 14 actions listed and **SABSO had a few questions on the long term actions (12 – mostly RTRs and a couple other actions from OTAQ) that we'd like to update them on circa tomorrow AM if at all possible** – you're welcome to join the call at 9:30 as you like [Call in Ex. 6 - Personal Privacy Ex. 6 - Personal Privacy or we can do our best to relay current thinking to the best we can or follow up as needed. Here are Tom C's (SABSO) questions with some preliminary response notions in *italics*:

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Let me know your preference – joining call and/or us relaying notions above with your additions please. If there are others we should include on this, happy to forward or feel free to pass. Thank you!

John

John Shoaff | Leader, Policy Support Group

Office of Air Policy & Program Support (OAPPS)

Office of Air & Radiation | U.S. EPA | WJC North 5442-B

1200 Pennsylvania Ave. NW | MC 6103A | Washington, D.C. | 20460 | USA

Shoaff.john@epa.gov | **1-202-564-0531 Direct | 1-202-257-1755 Mobile**

From: Shoaff, John
Sent: Thursday, December 22, 2016 2:31 PM
To: Hubbell, Bryan <Hubbell.Bryan@epa.gov>; Moltzen, Michael <Moltzen.Michael@epa.gov>; Sargeant, Kathryn <sargeant.kathryn@epa.gov>; Cook, Rich <Cook.Rich@epa.gov>; Birnbaum, Rona <Birnbaum.Rona@epa.gov>; Bacanskas, Lisa <Bacanskas.Lisa@epa.gov>; Kolb, Laura <Kolb.Laura@epa.gov>
Cc: Koerber, Mike <Koerber.Mike@epa.gov>; Hengst, Benjamin <Hengst.Benjamin@epa.gov>; Cook, Leila <cook.leila@epa.gov>; Krieger, Jackie <Krieger.Jackie@epa.gov>; Gitlin, Bonnie <Gitlin.Bonnie@epa.gov>; DeMocker, Jim <DeMocker.Jim@epa.gov>; Mazza, Carl <Mazza.Carl@epa.gov>; Hockstad, Leif <Hockstad.Leif@epa.gov>
Subject: Happy Holidays and a few things for the new year -- Fall 2016 Reg Agenda SAB Review Templates due 1/25

All,

Hope all have a safe and nice holiday not to mention a well-deserved break if you're so inclined. Wanted to relay a few quick updates in follow-up to my missive toward the end of November with all that was approaching this month. –

SAB Templates

Ex. 5 - Deliberative Process

C-PORT

Ex. 5 - Deliberative Process

Annual Research Meeting & STPC

Ex. 5 - Deliberative Process

Finally, am unsure whether we've had an opportunity to announce this as of yet, but we are very fortunate to have Leif Hockstad join our group. Leif was formerly with OAP CCD and has a wealth of expertise leading the annual U.S. Inventory of Greenhouse Gases among other roles and responsibilities. Welcome Leif and Happy holidays to all! Best,

John

John Shoaff | Leader, Policy Support Group

Office of Air Policy & Program Support (OAPPS)

Office of Air & Radiation | U.S. EPA | WJC North 5442-B

1200 Pennsylvania Ave. NW | MC 6103A | Washington, D.C. | 20460 | USA

Shoaff.john@epa.gov | **1-202-564-0531 Direct | 1-202-257-1755 Mobile**

From: Carpenter, Thomas
Sent: Tuesday, December 13, 2016 4:55 PM
To: Fegley, Robert <Fegley.Robert@epa.gov>; Cogliano, Gerain <Cogliano.Gerain@epa.gov>; Chun, Melissa <Chun.Melissa@epa.gov>; Mazza, Carl <Mazza.Carl@epa.gov>; Williams, Pat <Williams.Pat@epa.gov>; Evalenko, Sandy <Evalenko.Sandy@epa.gov>; Owens, Nicole <Owens.Nicole@epa.gov>; Muellerleile, Caryn <Muellerleile.Caryn@epa.gov>; Mazza, Carl <Mazza.Carl@epa.gov>; Shoaff, John <Shoaff.John@epa.gov>
Cc: Sheppard, Tracy <Sheppard.Tracy@epa.gov>; Zarba, Christopher <Zarba.Christopher@epa.gov>; Johnston, Khanna <Johnston.Khanna@epa.gov>; Brennan, Thomas <Brennan.Thomas@epa.gov>
Subject: Fall 2016 Reg Agenda SAB Review Templates due 6/24

Greetings,

The Office of Policy identified 14 actions to be considered by the SAB in their evaluation of the supporting science for planned actions based on the protocols developed by EPA. The 14 actions that need a completed template are listed in the table below. Also attached are the abstracts posted on the OMB webpage (*New planned actions Fall 2016.docx*) Please note that 11 actions are in the long-term action stage of rulemaking.

On March 31, 2015 the Office of Policy distributed the Process and Best Practices for EPA Engagement with the Science Advisory Board in SAB Screening of the Scientific Basis for Major Agency Planned Actions to program offices. It provides the best practices for developing and sharing information with the SAB for the this process. I have attached a PDF of that document for your convenience.

Attached is a word version of the annotated template for you to complete. Please provide your Office's completed templates to me by February 1, 2017. The SAB Staff Office will convene the Work Group as soon as possible after materials are provided.

Please call if you have any questions.

Best,

Tom

RIN	Title	Agency	Agenda Stage of Rulemaking
2060-AT04	Renewable Fuel Volume Standards for 2018 and Biomass Based Diesel Volume (BBD) for 2019	EPA/OAR	Proposed Rule Stage
2070-AK20	Procedures for Evaluating Existing Chemical Risks Under the Toxic Substances Control Act	EPA/OCSPP	Proposed Rule Stage
2070-AK23	Procedures for Prioritization of Chemicals for Risk Evaluation Under the Toxic Substances Control Act	EPA/OCSPP	Proposed Rule Stage
2060-AT00	Stationary Combustion Turbine RTR	EPA/OAR	Long-Term Actions

2060-AT01	Engine Test Cells NESHAP RTR	EPA/OAR	Long-Term Actions
2060-AT02	National Emission Standards for Hazardous Air Pollutants for Source Categories: Generic Maximum Achievable Control Technology Standards--Ethylene Production (Subparts XX and YY)	EPA/OAR	Long-Term Actions
2060-AT03	National Emission Standards for Hazardous Air Pollutants for Integrated Iron and Steel Manufacturing Facilities	EPA/OAR	Long-Term Actions
2060-AT05	National Emission Standards for Hazardous Air Pollutants: Taconite Iron Ore Processing Risk and Technology Review	EPA/OAR	Long-Term Actions
2060-AT07	Rubber Tire Manufacturing Risk and Technology Review	EPA/OAR	Long-Term Actions
2060-AT08	Lime Manufacturing Risk and Technology Review	EPA/OAR	Long-Term Actions
2060-AT10	Endangerment Finding for Lead Emissions From Piston-Engine Aircraft Using Leaded Aviation Gasoline	EPA/OAR	Long-Term Actions
2060-AT12	National Emission Standard for Hazardous Air Pollutants (NESHAP) Risk and Technology Review: Reinforced Plastics Composites and Boat Manufacturing	EPA/OAR	Long-Term Actions
2060-AT26	Control of Air Pollution From Aircraft and Aircraft Engines: Proposed GHG Emissions Standards and Test Procedures	EPA/OAR	Long-Term Actions
2060-AT29	Emission Guidelines for the Existing Oil and Natural Gas Sector	EPA/OAR	Long-Term Actions

To: Bryan Manning (manning.bryan@epa.gov)[manning.bryan@epa.gov]
Cc: Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]; yen.david@epa.gov[yen.david@epa.gov]; maeroff.bruce@epa.gov[maeroff.bruce@epa.gov]; mueller.john@epa.gov[mueller.john@epa.gov]
From: Samulski, Michael
Sent: Tue 9/29/2015 5:11:18 PM
Subject: My edits on FAA's draft CO2 position paper
FAA-OST Breifing-ICAO CO2 Standard_2015-09-28_final review draft - epa comments.docx

Bryan,

Here's the edits we discussed. Please have a look. (Also I have a couple of questions in comment boxes for you).

Thanks,

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

To: Bryan Manning (manning.bryan@epa.gov)[manning.bryan@epa.gov]
From: Samulski, Michael
Sent: Tue 6/23/2015 4:37:42 PM
Subject: Revised Janet Briefing
Janet McCabe Brfg ICAO SG15 Mtg 6-22-15 - mjs.pptx

Bryan,

I made some revisions to the briefing, mostly in terms of trying to get the information level right for Janet.

See what you think.

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

To: charmley.william@epa.gov[charmley.william@epa.gov]
From: Samulski, Michael
Sent: Thur 6/18/2015 12:06:14 PM
Subject: US papers to ICAO Steering Group
12.150-CAEP-SG 3-WP-Non-Volatile PM Emmission Standard-RESP.doc
12.155-CAEP-SG 3-WP-Aeroplane CO2 Emmissions-RESP.doc
12.151-CAEP-SG 3-WP-Views on Future Work-RESP+EPA.doc
CAEPSG 20153 WP 44 en-CO2 Exclusion Criteria Proposal_v8_final+EPA.docx
CAEPSG 20153 IP US Endang Finding_ANPR YY en_15-6-15.docx

Bill,

Here are the most recent versions of the US working papers that we will discuss with Chris later today. These papers are currently in the IGIA process.

I'm also attaching our IP on the ANPR.

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

To: OTAQ Materials[OTAQMaterials@epa.gov]; charmley.william@epa.gov[charmley.william@epa.gov]
Cc: JoNell Iffland (iffland.jonell@epa.gov)[iffland.jonell@epa.gov]; Bryan Manning (manning.bryan@epa.gov)[manning.bryan@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]; yen.david@epa.gov[yen.david@epa.gov]; mueller.john@epa.gov[mueller.john@epa.gov]
From: Samulski, Michael
Sent: Wed 6/17/2015 7:02:46 PM
Subject: Materials for Thursday meeting with Chris on aircraft
Chris Briefing on CAEP SG15 US WPs 6-17-15.docx

Here are the materials for our 1:00 briefing with Chris on the upcoming ICAO steering group meeting.

Mike

****
Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov
****

To: Mike Samulski[samulski.michael@gmail.com]
From: Samulski, Michael
Sent: Fri 7/10/2015 6:40:00 PM
Subject: Fwd: Materials for aircraft meetings next Monday and Tuesday
FAA-EPA CO2 Standard briefing_10 July 2015_final.docx
ATT00001.htm
Notes for Call with Rich Swayze 7-13-15.docx
ATT00002.htm

Sent from my iPhone

Begin forwarded message:

From: "Hengst, Benjamin" <Hengst.Benjamin@epa.gov>
Date: July 10, 2015 at 1:54:41 PM EDT
To: "Charmley, William" <charmley.william@epa.gov>, "Samulski, Michael" <samulski.michael@epa.gov>, "Manning, Bryan" <manning.bryan@epa.gov>
Cc: "Grundler, Christopher" <grundler.christopher@epa.gov>
Subject: FW: Materials for aircraft meetings next Monday and Tuesday

Just so you have what is being sent forward for next week.

Thanks,
Ben

From: Hengst, Benjamin
Sent: Friday, July 10, 2015 1:50 PM
To: OAR Briefings
Cc: Sutton, Tia
Subject: Materials for aircraft meetings next Monday and Tuesday

Hello,

Attached are (1) talking points/backgrounder for Janet's call with FAA on Monday, and (2) the final version of the briefing for next Tuesday's WH meeting.

Thanks,
Ben

To: charmley.william@epa.gov[charmley.william@epa.gov]
Cc: sargeant.kathryn@epa.gov[sargeant.kathryn@epa.gov]; Hoyer, Marion[hoyer.marion@epa.gov]; Davidson, Ken[Davidson.Ken@epa.gov]; Bryan Manning (manning.bryan@epa.gov)[manning.bryan@epa.gov]
From: Samulski, Michael
Sent: Fri 11/13/2015 3:21:48 PM
Subject: FW: Summary of issues with FAA/MIT cost-benefit analysis (ICAO aircraft CO2 standard) - PLEASE REVIEW
Overview of FAA CBA for Laura (11 12 15) v2.docx

Bill,

I just got off the phone with Kate Shouse at OAP.

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Mike

PS. The attached one-pager, which OP staff used to brief their AA, does a nice job of summarizing the issue.

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Shouse, Kate
Sent: Friday, November 13, 2015 10:01 AM
To: Samulski, Michael
Cc: Manning, Bryan
Subject: RE: Summary of issues with FAA/MIT cost-benefit analysis (ICAO aircraft CO2

standard) - PLEASE REVIEW

Thanks, Mike, for reaching out. As we discussed, I have attached the outline that presents the policy questions and technical comments that OP discussed with the new OP AA yesterday afternoon. Please feel free to let me know if you have additional questions; also feel free to reach out to Al McGartland, the NCEE Director. Also sounds like Al is reaching out to Ben Hengst soon.

Thanks,
Kate

To: Shouse, Kate[Shouse.Kate@epa.gov]
Cc: Bryan Manning (manning.bryan@epa.gov)[manning.bryan@epa.gov]
From: Samulski, Michael
Sent: Fri 11/13/2015 2:15:21 PM
Subject: RE: Summary of issues with FAA/MIT cost-benefit analysis (ICAO aircraft CO2 standard) - PLEASE REVIEW

Kate,

I also left you a voicemail in the hopes that we can catch up this morning. Bryan (who is out today) forwarded me your voicemail regarding the OP AA briefing and next steps. Thanks for keeping us up-to-date.

Ex. 5 - Deliberative Process

Thanks,

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Shouse, Kate
Sent: Wednesday, October 28, 2015 2:52 PM
To: Manning, Bryan; Davidson, Ken; Jantarasami, Lesley; Sarofim, Marcus
Cc: Samulski, Michael; Leggett, Cullen; Maeroff, Bruce
Subject: RE: Summary of issues with FAA/MIT cost-benefit analysis (ICAO aircraft CO2 standard) - PLEASE REVIEW

Thanks, Bryan.

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Thanks,
Kate

From: Manning, Bryan
Sent: Wednesday, October 28, 2015 2:25 PM
To: Davidson, Ken <Davidson.Ken@epa.gov>; Shouse, Kate <Shouse.Kate@epa.gov>; Jantarasami, Lesley <Jantarasami.Lesley@epa.gov>; Sarofim, Marcus <Sarofim.Marcus@epa.gov>
Cc: Samulski, Michael <samulski.michael@epa.gov>; Leggett, Cullen <Leggett.Cullen@epa.gov>; Maeroff, Bruce <Maeroff.Bruce@epa.gov>
Subject: Summary of issues with FAA/MIT cost-benefit analysis (ICAO aircraft CO2 standard) - PLEASE REVIEW

Hello,

I appreciate all your thoughts on the draft FAA/MIT cost-benefit analysis for the ICAO aircraft CO2 standard. Below is a summary of the issues you all have raised, and I was thinking of sending this summary to FAA (& MIT) before we eventually have a call with them next week (time TBD). Any comments on the below summary? Is it okay to send this summary (with your comments eventually incorporated) to FAA/MIT prior to our call next week?

SUMMARY of ISSUES with FAA/MIT COST-BENEFIT ANALYSIS

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]
Cc: Bryan Manning (manning.bryan@epa.gov)[manning.bryan@epa.gov]
From: Samulski, Michael
Sent: Thur 11/12/2015 2:15:07 PM
Subject: FW: Request to help prep Janet for her 11/18 CAAAC speech
V1_LJ.docx

Lucie,

I thought you should have a look at this as well.

Thanks,

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Manning, Bryan
Sent: Tuesday, November 10, 2015 4:54 PM
To: Samulski, Michael
Subject: FW: Request to help prep Janet for her 11/18 CAAAC speech

FYI, see the below email and attached document Lesley is running by OGC. Janet McCabe's staff asked Lesley to review Janet's draft speech for the bi-annual air program update for the CAAAC meeting. Lesley thought it would focus on the science, but this section of the draft speech (on aviation) focuses on ANPR items. Thanks.

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Jantarasami, Lesley
Sent: Tuesday, November 10, 2015 4:44 PM
To: Manning, Bryan <manning.bryan@epa.gov>; Thrift, Mike <thrift.mike@epa.gov>; Williams, Melina <Williams.Melina@epa.gov>
Subject: FW: Request to help prep Janet for her 11/18 CAAAC speech

Hello Bryan, Mike, and Melina-

Could you please take a quick look at the 3 bullets in the attached? Janet is giving a public presentation where press might be in attendance, and so I want to be sure we are stating things accurately. I made comments in a few places already.

Thanks so much,

Lesley

From: Lemon, Mollie
Sent: Tuesday, November 10, 2015 4:01 PM
To: Jantarasami, Lesley <Jantarasami.Lesley@epa.gov>; DeLuca, Isabel <DeLuca.Isabel@epa.gov>; Newberg, Cindy <Newberg.Cindy@epa.gov>; Maranion, Bella <Maranion.Bella@epa.gov>; Horwitz, Paul <Horwitz.Paul@epa.gov>; Wilson, Erika <Wilson.Erika@epa.gov>
Cc: Birnbaum, Rona <Birnbaum.Rona@epa.gov>; Haeuber, Richard <Haeuber.Richard@epa.gov>
Subject: FW: Request to help prep Janet for her 11/18 CAAAC speech

Hi all – just a reminder on this for Thursday morning. Thanks!

From: Dennis, Allison
Sent: Thursday, November 05, 2015 11:35 AM
To: Mills, Kathy <Mills.Kathy@epa.gov>; Bremer, Kristen <Bremer.Kristen@epa.gov>; Birgfeld, Erin <Birgfeld.Erin@epa.gov>; Cherepy, Andrea <Cherepy.Andrea@epa.gov>; Lemon, Mollie <Lemon.Mollie@epa.gov>; Walters, Margaret <Walters.Margaret@epa.gov>
Cc: Ketcham-Colwill, Jim <Ketcham-Colwill.Jim@epa.gov>
Subject: Request to help prep Janet for her 11/18 CAAAC speech

Hi all!

On Wednesday, Nov. 18th, Janet will give her bi-annual air program update that the CAAAC meeting. She will have a 50-minute timeslot, where she will use 30 minutes for remarks, followed by Q&A. This session is open to the press. I put together a draft speech for your review. Please feel free to add/remove topics as you see fit. **I will need all edits by next Thursday (12th) COB.** Her last speech to this group was in April so if you have any major accomplishments made since then that are not mentioned in these talkers, please feel free to add them.

Additionally, if you have Q&As/backgrounders for topics that may not rise to her talkers but Janet may get asked about, please send those materials to me as well (ex. VW, MERL, etc.)

Thank you!

Allison

To: Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]
From: Samulski, Michael
Sent: Tue 6/23/2015 7:33:37 PM
Subject: FW: Draft briefing for Janet on Aircraft CO2
Janet McCabe Briefing ICAO SG15 Mtg 6-22-15.pptx

From: Samulski, Michael
Sent: Tuesday, June 23, 2015 1:30 PM
To: charmley.william@epa.gov
Cc: Bryan Manning (manning.bryan@epa.gov)
Subject: Draft briefing for Janet on Aircraft CO2

Bill,

Attached is a draft briefing for Janet on Aircraft CO2 for your review.

If possible, we would like to get this sent up to her office on Thursday, so that Bryan doesn't have to work on his CDO (He is preapproved for overtime if necessary). Will Chris need to review this as well?

Two other documents that we are working on are 1) talking points for Janet to use with FAA and 2) draft WH briefing for July 14.

Ex. 5 - Deliberative Process

On the draft WH briefing, we just got FAA's DOT briefing a few minutes ago, which we should be able to use as a starting point. I don't expect the briefing will be ready in time to share with Janet on Monday.

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

To: Blubaugh, Jim[Blubaugh.Jim@epa.gov]; Charmley, William[charmley.william@epa.gov]; Ben Hengst (hengst.benjamin@epa.gov)[hengst.benjamin@epa.gov]
Cc: Manning, Bryan[manning.bryan@epa.gov]; Audette, Lucie[audette.lucie@epa.gov]; Leggett, Cullen[Leggett.Cullen@epa.gov]
From: Samulski, Michael
Sent: Tue 11/10/2015 5:12:35 PM
Subject: RE: ICAO + Canada
Aviation CO2 standards key messages draft 11 10 15.docx

Here is an updated set of talking points which includes Bill's comments.

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

The areas where I made edits are highlighted in yellow.

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Blubaugh, Jim
Sent: Tuesday, November 10, 2015 11:09 AM
To: Samulski, Michael; Charmley, William
Cc: Manning, Bryan; Audette, Lucie; Leggett, Cullen
Subject: RE: ICAO + Canada

Thanks Mike. I can add this to the paper I'm creating and wait a little for Bill to weigh in. One

thing to note;

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Jim

From: Samulski, Michael
Sent: Tuesday, November 10, 2015 10:32 AM
To: Blubaugh, Jim <Blubaugh.Jim@epa.gov>; Hengst, Benjamin <Hengst.Benjamin@epa.gov>; Charmley, William <charmley.william@epa.gov>
Cc: Manning, Bryan <manning.bryan@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>; Leggett, Cullen <Leggett.Cullen@epa.gov>
Subject: RE: ICAO + Canada

Jim,

Here is my current draft, which has not yet been reviewed. I left a paper copy with JoNell to give to Bill when he gets out of his 10:00 meeting.

I will get you any updates before 2:00.

Mike

PS

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Blubaugh, Jim
Sent: Tuesday, November 10, 2015 10:24 AM
To: Samulski, Michael; Hengst, Benjamin; Charmley, William
Cc: Manning, Bryan
Subject: RE: ICAO + Canada

Thanks Mike. I just heard from OAR and it looks like they want this material by 2 PM today. Can you quickly pull a half pager together on our work with Canada here and send it to me? I will combine it with a little info on our ongoing transportation collaboration as well as VW. Sorry for the quick turnaround…

Jim

From: Samulski, Michael
Sent: Tuesday, November 10, 2015 7:33 AM
To: Hengst, Benjamin <Hengst.Benjamin@epa.gov>; Charmley, William <charmley.william@epa.gov>
Cc: Blubaugh, Jim <Blubaugh.Jim@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>
Subject: RE: ICAO + Canada

This sounds great! We will pull together a 1-pager and get it to Bill today.

Unless you have any objection, I had planned to reach out to Richard Holt as well (Richard is

my contact at Environment Canada).

So you are aware: We received some minor comments from the White House IPC group yesterday on the CO2 paper. These came from Kevin Welsh (NSC) and Candace Vahlsing (OMB) who we and FAA spoke with last night. The comments were mostly editorial and were helpful.

Clean and redline copies are attached.

Candace said they would be giving this paper to Dan Utech and Brian Deese today for a quick review (then it will go into the IGIA process today or Thursday). My main point being that Brian Deese should have some background on this issue.

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Hengst, Benjamin
Sent: Monday, November 09, 2015 8:50 PM
To: Samulski, Michael
Cc: Charmley, William; Blubaugh, Jim

Subject: ICAO + Canada

Mike,

Ex. 5 - Deliberative Process

I don't have much detail on timing -- either I or Jim Blubaugh will provide more as we get it -- but this may be needed as soon as later this week (Thurs? Friday? Sorry I don't have more than that for now).

Bill may have additional thoughts, but I wanted to pass on what I could for now.

thanks,

Ben

To: charmley.william@epa.gov[charmley.william@epa.gov]
Cc: Bryan Manning (manning.bryan@epa.gov)[manning.bryan@epa.gov]
From: Samulski, Michael
Sent: Tue 6/23/2015 5:30:51 PM
Subject: Draft briefing for Janet on Aircraft CO2
Janet McCabe Briefing ICAO SG15 Mtg 6-22-15.pptx

Bill,

Attached is a draft briefing for Janet on Aircraft CO2 for your review.

If possible, we would like to get this sent up to her office on Thursday, so that Bryan doesn't have to work on his CDO (He is preapproved for overtime if necessary). Will Chris need to review this as well?

Two other documents that we are working on are 1) talking points for Janet to use with FAA and 2) draft WH briefing for July 14.

On the talking points, Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

On the draft WH briefing, we just got FAA's DOT briefing a few minutes ago, which we should be able to use as a starting point. I don't expect the briefing will be ready in time to share with Janet on Monday.

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

To: Blubaugh, Jim[Blubaugh.Jim@epa.gov]; Hengst, Benjamin[Hengst.Benjamin@epa.gov]; Charmley, William[charmley.william@epa.gov]
Cc: Manning, Bryan[manning.bryan@epa.gov]; Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]
From: Samulski, Michael
Sent: Tue 11/10/2015 3:31:45 PM
Subject: RE: ICAO + Canada
Aviation CO2 standards key messages draft 11 10 15.docx

Jim,

Here is my current draft, which has not yet been reviewed. I left a paper copy with JoNell to give to Bill when he gets out of his 10:00 meeting.

I will get you any updates before 2:00.

Mike

PS

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Blubaugh, Jim
Sent: Tuesday, November 10, 2015 10:24 AM
To: Samulski, Michael; Hengst, Benjamin; Charmley, William
Cc: Manning, Bryan
Subject: RE: ICAO + Canada

Thanks Mike. I just heard from OAR and it looks like they want this material by 2 PM today. Can you quickly pull a half pager together on our work with Canada here and send it to me? I will combine it with a little info on our ongoing transportation collaboration as well as VW. Sorry for the quick turnaround…

Jim

From: Samulski, Michael
Sent: Tuesday, November 10, 2015 7:33 AM
To: Hengst, Benjamin <Hengst.Benjamin@epa.gov>; Charmley, William <charmley.william@epa.gov>
Cc: Blubaugh, Jim <Blubaugh.Jim@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>
Subject: RE: ICAO + Canada

This sounds great! We will pull together a 1-pager and get it to Bill today.

Unless you have any objection, I had planned to reach out to Richard Holt as well (Richard is my contact at Environment Canada).

So you are aware: We received some minor comments from the White House IPC group yesterday on the CO2 paper. These came from Kevin Welsh (NSC) and Candace Vahlsing (OMB) who we and FAA spoke with last night. The comments were mostly editorial and were helpful.

Clean and redline copies are attached.

Candace said they would be giving this paper to Dan Utech and Brian Deese today for a quick review (then it will go into the IGIA process today or Thursday). My main point being that Brian Deese should have some background on this issue.

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Hengst, Benjamin
Sent: Monday, November 09, 2015 8:50 PM
To: Samulski, Michael
Cc: Charmley, William; Blubaugh, Jim
Subject: ICAO + Canada

Mike,

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

I don't have much detail on timing -- either I or Jim Blubaugh will provide more as we get it -- but this may be needed as soon as later this week (Thurs? Friday? Sorry I don't have more than that for now).

Bill may have additional thoughts, but I wanted to pass on what I could for now.

thanks,

Ben

To: Ben Hengst (hengst.benjamin@epa.gov)[hengst.benjamin@epa.gov]; Birgfeld, Erin[Birgfeld.Erin@epa.gov]
Cc: charmley.william@epa.gov[charmley.william@epa.gov]; Bryan Manning (manning.bryan@epa.gov)[manning.bryan@epa.gov]; Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]
From: Samulski, Michael
Sent: Wed 6/10/2015 2:09:51 PM
Subject: Chris's questions from last night on aircraft

Ben,

Below are draft responses to the additional question that Chris sent out late last night. We are still working on the questions from this morning. I did not include Chris on this email and will leave it to you on how to get back to him.

Mike

Ex. 5 - Deliberative Process

The two Q/A's he seems to be referring to are copied below. On the first one, we ran this by FAA and they concur. On the second one, this language is consistent with text in the ANPR, which was cleared by FAA in the interagency review

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

-----Original Message-----

From: Grundler, Christopher

Sent: Wednesday, June 10, 2015 1:40 AM

To: Hengst, Benjamin; Birgfeld, Erin; Charmley, William; Samulski, Michael

Subject: New tough aircraft Q

Ex. 5 - Deliberative Process

Christopher Grundler, Director

Office of Transportation and Air Quality U.S. EPA

202-564-1682 (DC)

734-214-4207 (Ann Arbor)

EPA-HQ-2018-004348

To: Audette, Lucie[audette.lucie@epa.gov]
From: Samulski, Michael
Sent: Fri 12/19/2014 9:09:58 PM
Subject: US paper to SG
12.137A-CAEP-SG 2-WP-U.S. Views on CO2 Standard-FINAL.doc

****

Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov

****

To: OTAQ Materials[OTAQMaterials@epa.gov]
Cc: charmley.william@epa.gov[charmley.william@epa.gov]; Manning, Bryan[manning.bryan@epa.gov]; Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]
From: Samulski, Michael
Sent: Thur 10/20/2016 12:39:17 PM
Subject: Draft Email for Chris to send to Janet: Aircraft Early Guidance
Early Guidance Briefing_Aircraft GHG Std_October 25 2016.pptx

Chris,

On Tuesday you said that you wanted to send the Aircraft Early Guidance Briefing to Janet and ask if she wanted to cancel the Monday pre-brief. The updated briefing is attached and we took the liberty of drafting a note you could use to send to Janet.

Ex. 5 - Deliberative Process

Mike

Hi Janet,

On Monday, you are scheduled to have a Pre-Meeting for the Early Guidance Meeting on the aircraft GHG standards NPRM, and the meeting itself (with the workgroup) is scheduled for Tuesday. Attached please find the materials for this meeting. Since the briefing materials are uncontroversial and straight forward, I suggest that we skip the Monday meeting, which will free up time on you schedule. We are happy to go through the Early Guidance briefing twice if you prefer, but we do not think it is necessary. If you have any comments over the weekend on the materials, pass them along, and we will make the revisions in time for the Tuesday meeting. Let me know if you have any questions.

Thanks,

Chris

To: charmley.william@epa.gov[charmley.william@epa.gov]
From: Samulski, Michael
Sent: Mon 10/30/2017 3:01:51 PM
Subject: FW: Revised Aircraft CO2 Rule Briefing (for Mandy on Nov 2)
Briefing_Aircraft CO2 Rule 10-25-17.pptx

Bill,

I'm just checking in to see if you want to review this before we send it up to OTAQ materials?

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Manning, Bryan
Sent: Wednesday, October 25, 2017 12:29 PM
To: Charmley, William <charmley.william@epa.gov>
Cc: Samulski, Michael <samulski.michael@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>
Subject: Revised Aircraft CO2 Rule Briefing (for Mandy on Nov 2)

Hi Bill,

Attached please find a revised Mandy briefing on the aircraft CO2 rule. Mike is out of the office today, and he asked me to send this updated briefing to you. As you know, we pre-briefed Sarah on Oct 23, and she asked for some minor edits to the briefing Ex. 5 - Deliberative Process Ex. 5 - Deliberative Process After making these edits, Sarah and Chris wanted us to send the briefing around again before our meeting with Mandy on Nov 2. Note, the meeting with Mandy was pushed back a few days so that we would have some time between the Oct 31 Boeing/GE meeting and the Mandy briefing – to incorporate any new information. Let us know if you have any comments or questions.

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Bryan Manning (manning.bryan@epa.gov)[manning.bryan@epa.gov]; Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]; mueller.john@epa.gov[mueller.john@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]; yen.david@epa.gov[yen.david@epa.gov]; maeroff.bruce@epa.gov[maeroff.bruce@epa.gov]; Thrift, Mike[thrift.mike@epa.gov]; Davidson, Ken[Davidson.Ken@epa.gov]
Cc: JoNell Iffland (iffland.jonell@epa.gov)[iffland.jonell@epa.gov]; Gonzalez, Gail[Gonzalez.Gail@epa.gov]
From: Samulski, Michael
Sent: Tue 3/1/2016 1:30:33 PM
Subject: Materials for today's briefing with Bill
Bill Briefing_Implementing Aircraft CO2_PM std 3-1-16.docx

Here are the materials for today's meeting, with the most recent version of the timelines attached. Thanks for your input on this.

Cullen is also working on Gantt charts to better show the timelines. We'll send those around later.

Mike

****
Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov
****

To: charmley.william@epa.gov[charmley.william@epa.gov]; Ben Hengst (hengst.benjamin@epa.gov)[hengst.benjamin@epa.gov]
Cc: sargeant.kathryn@epa.gov[sargeant.kathryn@epa.gov]; Burch, Julia[Burch.Julia@epa.gov]; Manning, Bryan[manning.bryan@epa.gov]; Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]; Schenk, Ruth[schenk.ruth@epa.gov]
From: Samulski, Michael
Sent: Wed 6/21/2017 7:39:43 PM
Subject: SAB prep call
Aviation GHG Pages from Fall 2016 WkGrp Memo Appendix.pdf
Agenda SAB-June 29 post.pdf
SAB - Aircraft GHG Emissons Standards.docx
Fall 2016 WkGrp Memo attAB.PDF

Bill and Ben,

We just had a call with John Shoaff and Carl Mazza at OAPPS (formerly OPAR) on preparing for the upcoming SAB teleconference next week. The OTAQ attendees are copied on this message.

Ex. 5 - Deliberative Process

Julia, is there anything you would like to add?

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Shoaff, John
Sent: Tuesday, June 20, 2017 2:57 PM
To: Shoaff, John; Sargeant, Kathryn; Samulski, Michael; Manning, Bryan; Audette, Lucie; Mazza, Carl
Cc: Charmley, William
Subject: SAB Prep Call
When: Wednesday, June 21, 2017 2:00 PM-3:00 PM (UTC-05:00) Eastern Time (US & Canada).
Where: teleconference Ex. 6 - Personal Privacy conf. code

Added supplementary info, scroll down under original note below, and attachments.

All,

In follow-up to Leif's note on Friday at 2:39 (see also for background re: SAB agenda and supporting docs), I wanted to schedule a quick call to check in on the typical process for these SAB discussions and strategize on how we might wish to prepare for the discussion as needed.

Carl is also reviewing the SAB's peer review suggestions vs. the PR Handbook to see how they might jive with time frames and in order to assist with potential clarifications or responses.

Thanks!

John

Supplementary info. for our conversation:

Ex. 5 - Deliberative Process

Cost

Estimated cost is $25K per review using both ERG and Versar – their rates are comparable.

Ex. 5 - Deliberative Process

Attachments

1. Key Pages from SAB WG Memo Appendix
2. SAB Agenda
3. Full SAB WG Memo & Appendices
4. GHG Aviation Template submitted in follow up to Fall 2016 Reg Agenda

-

-

To: Thrift, Mike[thrift.mike@epa.gov]; Davidson, Ken[Davidson.Ken@epa.gov]
Cc: maeroff.bruce@epa.gov[maeroff.bruce@epa.gov]; mueller.john@epa.gov[mueller.john@epa.gov]; yen.david@epa.gov[yen.david@epa.gov]; Bryan Manning (manning.bryan@epa.gov)[manning.bryan@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]; Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]
From: Samulski, Michael
Sent: Fri 2/26/2016 7:25:23 PM
Subject: Draft materials for Tuesday's briefing with Bill on implementation of CO2 and PM standards for aircraft.
Draft Bill Briefing_Implementing Aircraft CO2 & PM std 2-26-16.docx

Mike and Ken,

Attached is a draft briefing for Bill which Bryan pulled together (along with my edits). We are seeking to answer the following four questions on implementing aircraft standards domestically:

Ex. 5 - Attorney Client

Cullen is currently developing a detailed schedule and will work with Lucie on Monday towards having a draft to share with Bill.

I would appreciate your review of this briefing.

(Ken, I flagged one specific question for you in the document.) (Mike, I understand if you are not up to reading yet, but heard you are back in the office next week hope you can call in to Tuesday's meeting)

Thanks,

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

To: OTAQ Materials[OTAQMaterials@epa.gov]
Cc: charmley.william@epa.gov[charmley.william@epa.gov]; JoNell Iffland (iffland.jonell@epa.gov)[iffland.jonell@epa.gov]; Bryan Manning (manning.bryan@epa.gov)[manning.bryan@epa.gov]; Thrift, Mike[thrift.mike@epa.gov]; Orlin, David[Orlin.David@epa.gov]; Williams, Melina[Williams.Melina@epa.gov]; Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]
From: Samulski, Michael
Sent: Tue 10/27/2015 3:09:37 PM
Subject: For Chris's review: ICAO briefing for Administrator
ICAO Aircraft CO2 Std_Gina briefing 10-27-15.pptx

Here are the draft materials for our briefing with Gina on Friday regarding Aircraft CO2. Note that we have a pre-brief with Janet on Thursday.

Mike

****
Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov
****

EPA-HQ-2018-004348

To: OTAQ Materials[OTAQMaterials@epa.gov]; charmley.william@epa.gov[charmley.william@epa.gov]; Manning, Bryan[manning.bryan@epa.gov]; Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]; Thrift, Mike[thrift.mike@epa.gov]; Orlin, David[Orlin.David@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]; maeroff.bruce@epa.gov[maeroff.bruce@epa.gov]; Mueller, John[mueller.john@epa.gov]; yen.david@epa.gov[yen.david@epa.gov]; sargeant.kathryn@epa.gov[sargeant.kathryn@epa.gov]; Hoyer, Marion[hoyer.marion@epa.gov]
Cc: JoNell Iffland (iffland.jonell@epa.gov)[iffland.jonell@epa.gov]; Gonzalez, Gail[Gonzalez.Gail@epa.gov]
From: Samulski, Michael
Sent: Fri 9/16/2016 7:51:12 PM
Subject: Materials for Monday Briefing with Chris on the Aircraft CO2 Rule
Rulemaking Analyses for Aircraft CO2 Standard Rule - 9 19 16.pptx

****
Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov
****

To: charmley.william@epa.gov[charmley.william@epa.gov]
Cc: Bryan Manning (manning.bryan@epa.gov)[manning.bryan@epa.gov]; Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]; Thrift, Mike[thrift.mike@epa.gov]; Orlin, David[Orlin.David@epa.gov]; mueller.john@epa.gov[mueller.john@epa.gov]; yen.david@epa.gov[yen.david@epa.gov]
From: Samulski, Michael
Sent: Mon 10/26/2015 3:44:28 PM
Subject: Draft Aircraft CO2 Briefing for Gina
ICAO Aircraft CO2 Std_Gina briefing 10-23-15.pptx

Bill,

Here is the draft aircraft CO2 briefing for Gina. This has been updated per the most recent discussions on stringency for InP > 60 tonnes.

OGC is reviewing the draft briefing concurrently. I know that you wanted to get this to Chris today or tomorrow.

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

To: Orlin, David[Orlin.David@epa.gov]; Thrift, Mike[thrift.mike@epa.gov]
From: Samulski, Michael
Sent: Thur 9/15/2016 11:22:57 AM
Subject: RE: Aircraft CO2 Rulemaking Analysis
Rulemaking Analyses for Aircraft CO2 Standard Rule - v3.pptx

David,

I just forwarded the invite to you. Glad you can join us. The current version of the briefing is attached.

Mike

****
Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov
****

From: Orlin, David
Sent: Wednesday, September 14, 2016 11:17 PM
To: Thrift, Mike <thrift.mike@epa.gov>; Samulski, Michael <samulski.michael@epa.gov>
Subject: RE: Aircraft CO2 Rulemaking Analysis

I can make it (and would be interested in attending) - can someone forward the invite?

thanks

David Orlin
U.S. EPA, Office of General Counsel
(202) 564-1222

From: Thrift, Mike
Sent: Wednesday, September 14, 2016 2:09 PM
To: Grundler, Christopher <grundler.christopher@epa.gov>; Charmley, William <charmley.william@epa.gov>; Samulski, Michael <samulski.michael@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>; Leggett, Cullen <Leggett.Cullen@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>; Yen, David <Yen.David@epa.gov>; Mueller, John <mueller.john@epa.gov>; Maeroff, Bruce <Maeroff.Bruce@epa.gov>; Sargeant, Kathryn <sargeant.kathryn@epa.gov>; Hoyer, Marion <hoyer.marion@epa.gov>
Cc: Iffland, JoNell <Iffland.JoNell@epa.gov>; Orlin, David <Orlin.David@epa.gov>

Subject: RE: Aircraft CO2 Rulemaking Analysis

Sorry, I can't do this call - it conflicts with the DOJ moot court in prep for the Clean Power Plan oral argument.

-----Original Appointment-----
From: Stewart, Gwen **On Behalf Of** Grundler, Christopher
Sent: Wednesday, September 14, 2016 11:05 AM
To: Charmley, William; Samulski, Michael; Manning, Bryan; Leggett, Cullen; Audette, Lucie; Yen, David; Mueller, John; Maeroff, Bruce; Sargeant, Kathryn; Hoyer, Marion; Thrift, Mike
Cc: Iffland, JoNell
Subject: Aircraft CO2 Rulemaking Analysis
When: Monday, September 19, 2016 1:00 PM-2:00 PM (UTC-05:00) Eastern Time (US & Canada).
Where: RM. 6520 DC/RM. C-174 DOD AA

MEETING REQUEST:

OTAQ MEETING REQUEST FORM

Requesting Meeting/Conference Call with: **Christopher Grundler**
Send form to: Gwen Stewart - 202 564-1682

Date of this Request: 8/1/16

Point of Contact (Name/Number): Mike Samulski 734/214-4532

Title of Meeting: Aircraft CO2 Rulemaking Analysis

Purpose of Meeting: To brief Chris on our planned analysis approach for the CO2 standard rulemaking Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Priority Status: Ex. 5 - Deliberative Process

Last possible date for meeting: Prefer to have the meeting the week of August 15-19

If the meeting is critical, please explain why: Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Location of Meeting: C174/video

Length of Meeting: 1 hour

Key Participants: (List all who need to be notified of the meeting)

Office/Organization	Email Address	Number
OTAQ/ASD	*charmley.william@epa.gov*	*734-214-4466*
ASD	samulski.michael@epa.gov	734-214-4532
ASD	manning.bryan@epa.gov	
ASD	Leggett.cullen@epa.gov	
ASD	Audette.lucie@epa.gov	
ASD	Yen.david@epa.gov	
ASD	mueller.john@epa.gov	
SEE	Maeroff.bruce@epa.gov	
Optional		
ASD	sargeant.kathryn@epa.gov	
ASD	hoyer.marion@epa.gov	
OGC	thrift.mike@epa.gov	

NOTE: All briefing materials must be sent by 4:00 PM the day prior in whatever format you are most comfortable, PPT Slides are not required. If briefing materials are not submitted by 4 pm, the meeting will be rescheduled, unless approved by Chris. (Briefing Materials are to be sent to: OTAQMaterials@epa. OTAQMaterials@epa.gov).

To: Hoyer, Marion[hoyer.marion@epa.gov]
From: Samulski, Michael
Sent: Tue 10/21/2014 4:15:20 PM
Subject: RE: briefing for Chris on aircraft GHG rule
McCabe Update on ICAO progress Grundler Prebrief Oct 20.docx

Marion,

It's a pre-brief for Janet. We will be giving her an overview of our work at ICAO, as background for the ANPRM we are working on.

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Hoyer, Marion
Sent: Tuesday, October 21, 2014 12:09 PM
To: Samulski, Michael
Subject: briefing for Chris on aircraft GHG rule

Hi Mike,

When you have a sec (no hurry), could you share the briefing you gave/will give Chris on

aircraft GHG today?

Thanks,

M

To: OTAQ Materials[OTAQMaterials@epa.gov]
Cc: sargeant.kathryn@epa.gov[sargeant.kathryn@epa.gov]; Manning, Bryan[manning.bryan@epa.gov]; Mueller, John[mueller.john@epa.gov]; Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]; yen.david@epa.gov[yen.david@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]; Orlin, David[Orlin.David@epa.gov]; Thrift, Mike[thrift.mike@epa.gov]; JoNell Iffland (iffland.jonell@epa.gov)[iffland.jonell@epa.gov]; charmley.william@epa.gov[charmley.william@epa.gov]
From: Samulski, Michael
Sent: Thur 10/19/2017 5:08:38 PM
Subject: Materials for Oct 23 Briefing with Sarah on Aircraft CO2
Briefing_Aircraft CO2 Rule 10-19-17.pptx

Here are the materials for Monday's meeting with Sarah. This version incorporates Chris' comments.

Mike

****
Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov
****

To: Hoyer, Marion[hoyer.marion@epa.gov]
From: Samulski, Michael
Sent: Mon 11/13/2017 6:27:27 PM
Subject: RE: aircraft C02 rule plans
Briefing_Aircraft CO2 Rule 11-2-17.pptx

Marion,

Here is the briefing we gave. Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

I would be interested in your thoughts in terms of economic analysis.

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Hoyer, Marion
Sent: Monday, November 13, 2017 1:19 PM
To: Samulski, Michael <samulski.michael@epa.gov>
Subject: aircraft C02 rule plans

Hi Mike,

I meant to ask about the status of the aircraft rule this morning.

Are we planning on an economic impact analysis? Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Thx much,

Marion

To: OTAQ Materials[OTAQMaterials@epa.gov]
Cc: charmley.william@epa.gov[charmley.william@epa.gov]; Manning, Bryan[manning.bryan@epa.gov]; Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]
From: Samulski, Michael
Sent: Thur 10/19/2017 4:42:10 PM
Subject: FOR CHRIS' REVIEW: Draft Materials for Monday Meeting with Sarah on Aircraft
Briefing_Aircraft CO2 Std_for Mandy Gunasekara_10-19-17.pptx

Chris,

Here is a draft aircraft briefing for your review. I was just made aware that Sarah would like to have this by 4:00 today. My apologies for the short turnaround time.

Mike

****
Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov
****

To: OTAQ Materials[OTAQMaterials@epa.gov]
Cc: JoNell Iffland (iffland.jonell@epa.gov)[iffland.jonell@epa.gov]; charmley.william@epa.gov[charmley.william@epa.gov]; Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]; Thrift, Mike[thrift.mike@epa.gov]; Manning, Bryan[manning.bryan@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]; yen.david@epa.gov[yen.david@epa.gov]; Orlin, David[Orlin.David@epa.gov]; Mueller, John[mueller.john@epa.gov]; sargeant.kathryn@epa.gov[sargeant.kathryn@epa.gov]
From: Samulski, Michael
Sent: Mon 10/30/2017 4:03:04 PM
Subject: For Chris' Review: Revised Draft Aircraft CO2 Briefing
Briefing_Aircraft CO2 Rule DRAFT 10-30-17.pptx

We are scheduled to meet with Mandy G. on aircraft CO2 standards Thursday at 3:00.

When we pre-briefed Sarah on Oct 23, she asked for some minor edits to the briefing Ex. 5 - Deliberative Process **Ex. 5 - Deliberative Process** After making these edits, Sarah wanted us to send the briefing around again, for review, before our meeting with Mandy.

Here is the revised draft briefing.

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

To: charmley.william@epa.gov[charmley.william@epa.gov]
From: Samulski, Michael
Sent: Fri 9/9/2016 2:28:01 PM
Subject: FW: Aircraft CO2 Analysis meeting with Chris
Rulemaking Analyses for Aircraft CO2 Standard Rule - v2.pptx

Bill,

I'm working with JoNell to get back on Chris' calendar for this briefing.

I revised the briefing materials to:

Ex. 5 - Deliberative Process

Please let me know if you have any comments (I will also drop a paper copy on your chair).

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Grundler, Christopher
Sent: Monday, August 15, 2016 10:26 AM
To: Charmley, William <charmley.william@epa.gov>; Samulski, Michael <samulski.michael@epa.gov>
Subject: Aircraft CO2 Analysis

Sorry to have to cancel---Bill and I need to see janet on trucks. We will reschedule.

Ex. 5 - Deliberative Process

5 - Deliberative Process

To: Manning, Bryan[manning.bryan@epa.gov]; Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]; yen.david@epa.gov[yen.david@epa.gov]; Mueller, John[mueller.john@epa.gov]; maeroff.bruce@epa.gov[maeroff.bruce@epa.gov]
From: Samulski, Michael
Sent: Thur 9/8/2016 3:32:09 PM
Subject: Updated CO2 (and PM) briefing for Chris
Rulemaking Analyses for Aircraft CO2 Standard Rule - v2.pptx

I requested that our cancelled meeting with Chris from August 15 be rescheduled for next week.

Attached is an updated briefing. **Ex. 5 - Deliberative Process**

Ex. 5 - Deliberative Process

I also added a couple of slides on PM. One to give an overview of the ICAO work on PM. The second explains our ICR effort and timing.

Let me know if you have any comments.

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

EPA-HQ-2018-004348

To: OTAQ Materials[OTAQMaterials@epa.gov]; charmley.william@epa.gov[charmley.william@epa.gov]; Manning, Bryan[manning.bryan@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]; Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]; yen.david@epa.gov[yen.david@epa.gov]; Mueller, John[mueller.john@epa.gov]; maeroff.bruce@epa.gov[maeroff.bruce@epa.gov]; sargeant.kathryn@epa.gov[sargeant.kathryn@epa.gov]; Hoyer, Marion[hoyer.marion@epa.gov]; Thrift, Mike[thrift.mike@epa.gov]
From: Samulski, Michael
Sent: Fri 8/12/2016 7:40:36 PM
Subject: Materials for Monday Chris Brief on Aircraft CO2 Rulemaking Analysis
Rulemaking Analyses for Aircraft CO2 Standard Rule - 8 15 16.pptx

Please find attached the materials for our Monday meeting with Chris on aircraft CO2 rulemaking analysis.

Mike

****

Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov
****

To: Manning, Bryan[manning.bryan@epa.gov]
Cc: charmley.william@epa.gov[charmley.william@epa.gov]
From: Samulski, Michael
Sent: Fri 8/12/2016 4:25:23 PM
Subject: Draft Aircraft Briefing for Chris (Monday at 11:00am)
Rulemaking Analyses for Aircraft CO2 Standard Rule - DRAFT 8 12 16.pptx

Here is a draft cost briefing to use with Chris on Monday. It is based on the one we gave to Bill last month, **Ex. 5 - Deliberative Process**

Please let me know if you have any comments. I plan to send it up to OTAQ Materials by 4:00.

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

To: charmley.william@epa.gov[charmley.william@epa.gov]
Cc: Bryan Manning (manning.bryan@epa.gov)[manning.bryan@epa.gov]; Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]
From: Samulski, Michael
Sent: Wed 12/16/2015 2:47:56 PM
Subject: Draft Aircraft CO2 Materials for Janet
Materials for Janet on Aircraft CO2 - draft 12 16 15.docx

Bill,

Here are the draft materials for your review.

Mike

****
Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov
****

To: Bryan Manning (manning.bryan@epa.gov)[manning.bryan@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]; Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]
From: Samulski, Michael
Sent: Tue 12/15/2015 12:57:16 PM
Subject: updated briefing
Chris Briefing Next Steps Possible CAEP Outcomes 12-14-15.docx

I added more comments to appendix A. I will bring 4 copies of the briefing.

Mike

****
Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov
****

To: OTAQ Materials[OTAQMaterials@epa.gov]
Cc: charmley.william@epa.gov[charmley.william@epa.gov]; JoNell Iffland (iffland.jonell@epa.gov)[iffland.jonell@epa.gov]; Bryan Manning (manning.bryan@epa.gov)[manning.bryan@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]; mueller.john@epa.gov[mueller.john@epa.gov]; yen.david@epa.gov[yen.david@epa.gov]; maeroff.bruce@epa.gov[maeroff.bruce@epa.gov]
From: Samulski, Michael
Sent: Mon 12/14/2015 8:49:07 PM
Subject: Briefing materials meeting with Chris on Aircraft CO2 Standards
Chris Briefing Next Steps Possible CAEP Outcomes 12-14-15.docx

Here are the materials for tomorrow morning's meeting.

Mike

****
Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov
****

To: simon.joseph@epa.gov[simon.joseph@epa.gov]
From: Samulski, Michael
Sent: Wed 2/25/2015 2:14:31 PM
Subject: draft aircraft letters
AX-15-000-5135 Airlines for America draft 2 25 15.docx
AX-15-000-4615 CBD draft 2 25 15.docx

Joe,

Here are the 2 draft letters. Please format them as we discussed, and I will send them back to FAA for final review.

Thanks,

Mike

****
Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov
****

To: Manning, Bryan[manning.bryan@epa.gov]; Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]; yen.david@epa.gov[yen.david@epa.gov]; Davidson, Ken[Davidson.Ken@epa.gov]; Zawacki, Margaret[zawacki.margaret@epa.gov]; sargeant.kathryn@epa.gov[sargeant.kathryn@epa.gov]; Cullen Leggett (leggett.cullen@epa.gov)[leggett.cullen@epa.gov]
Cc: Mueller, John[mueller.john@epa.gov]; maeroff.bruce@epa.gov[maeroff.bruce@epa.gov]; Hoyer, Marion[hoyer.marion@epa.gov]
From: Samulski, Michael
Sent: Wed 7/13/2016 8:09:17 PM
Subject: Draft briefing on Aircraft CO2 analyses
Rulemaking Analyses for Aircraft CO2 Standard Rule - Draft 7 13 16.pptx

Here is an updated briefing based on yesterday's discussion. Please let me know if you have any comments.

The meeting tomorrow is at 1:00 ET. I asked Gail to add a call-in number (and invite Ken and Molly).

Mike

****
Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov
****

To: Charmley, William[charmley.william@epa.gov]; Samulski, Michael[samulski.michael@epa.gov]; Burch, Julia[Burch.Julia@epa.gov]; Sutton, Tia[sutton.tia@epa.gov]
Cc: Hengst, Benjamin[Hengst.Benjamin@epa.gov]
From: Sargeant, Kathryn
Sent: Wed 8/30/2017 8:19:22 PM
Subject: FYI: Agency Response to the Fall 2016 Reg Agenda SAB Review
Fall 2016 Response.pdf

FYI—see attached for EPA's final signed response to the SAB's recommendations on the science related to the Fall 2016 Reg Agenda. On aircraft it says: "The Board recommended that the Chartered SAB provide advice on Control of Air Pollution for Aircraft and Aircraft Engines: Proposed GHG Emissions Standards and Test Actions (2060-AT26) or that EPA conduct a panel peer review of the technical support documents. However, as of the Update to the 2017 Agenda, this action is listed as inactive."

From: Shoaff, John
Sent: Wednesday, August 30, 2017 3:01 PM
To: Koerber, Mike <Koerber.Mike@epa.gov>; Rimer, Kelly <Rimer.Kelly@epa.gov>; Jenkins, Scott <Jenkins.Scott@epa.gov>; Culligan, Kevin <Culligan.Kevin@epa.gov>; Sargeant, Kathryn <sargeant.kathryn@epa.gov>; Moltzen, Michael <Moltzen.Michael@epa.gov>; Cook, Leila <cook.leila@epa.gov>; Hengst, Benjamin <Hengst.Benjamin@epa.gov>
Cc: Mazza, Carl <Mazza.Carl@epa.gov>; Hockstad, Leif <Hockstad.Leif@epa.gov>
Subject: Agency Response to the Fall 2016 Reg Agenda SAB Review

All,

Just an FYI on the Agency's final response to the SAB re: last fall's regulatory actions/templates, see attached. Would also note that in the final session reviewing the status of activities at today's SAB meeting, a member recalled his/her interest in methods for technology reviews for which our willingness to provide a future informational briefing was also noted in the response letter. Thanks.

John

John Shoaff | Leader, Policy Support Group

Office of Air Policy & Program Support (OAPPS)

Office of Air & Radiation | U.S. EPA | WJC North 5442-B

1200 Pennsylvania Ave. NW | MC 6103A | Washington, D.C. | 20460 | USA

Shoaff.john@epa.gov | **1-202-564-0531 Direct | 1-202-257-1755 Mobile**

EPA-HQ-2018-004348

To: Samulski, Michael[samulski.michael@epa.gov]
From: Bonnefoy, Philippe [USA]
Sent: Tue 2/2/2016 4:06:18 PM
2016-02-02_CO2_STD_DST_v2.8.xlsx

Philippe A. Bonnefoy, Ph.D.
Lead Associate
Booz | Allen | Hamilton
22 Batterymarch Street
Boston, MA 02109
Office: (617) 428 4437
Mobile: (617) 513 9211
bonnefoy_philippe@bah.com

To: Samulski, Michael[samulski.michael@epa.gov]
Cc: Yen, David[Yen.David@epa.gov]; Leggett, Cullen[Leggett.Cullen@epa.gov]; Mueller, John[mueller.john@epa.gov]; Maeroff, Bruce[Maeroff.Bruce@epa.gov]; Audette, Lucie[audette.lucie@epa.gov]
From: Manning, Bryan
Sent: Wed 11/8/2017 9:44:43 PM
Subject: Work Assignment Approved: Peer Review of 2 reports for aircraft CO2 rule
EP-C-16-021 WA 1-15 SOW.PDF

Hi Mike,

A few minutes ago, the Contracting Officer in Cincinnati approved our work assignment for the peer review of the two reports needed to support the aircraft CO2 standard rule. We will likely receive the work plan from the contractor (RTI) in a couple weeks.

Ex. 5 - Deliberative Process

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Young, Gerold
Sent: Wednesday, November 08, 2017 4:18 PM
To: Cooper, Donna <cooper@rti.org>
Cc: Vermeulen, Luke <vermeulen.luke@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>; Mueller, John <mueller.john@epa.gov>
Subject: EP-C-16-021 WA 1-15 SOW

Greetings,

Attached is WA 1-15 SOW. Please reply in receipt of this email. If you have any questions or concerns please contact me.

Thanks

Gerold Young II

Contracting Officer

Cincinnati Procurement Operations Division (CPOD)

OAM/CPOD/OOOOSC/OAR-ORD

OOOO Service Center Supporting ORD

U.S. Environmental Protection Agency

513.487.2660

"Leadership is not about titles, but the trust and values others have for you." ~ Morris Chestnut - Rosewood

To: Samulski, Michael[samulski.michael@epa.gov]; Audette, Lucie[audette.lucie@epa.gov]; Sargeant, Kathryn[sargeant.kathryn@epa.gov]
From: Manning, Bryan
Sent: Wed 10/18/2017 7:26:02 PM
Subject: Chris Signed Peer Review Decision Maker Documentation (aircraft CO2 rule)
Chris Signed Peer Review Decision Documentation_10-18-17.pdf

Hi,

Attached please find the peer review decision maker documentation, which was signed by Chris (for aircraft CO2 rule). I will keep this signed form in our records according to EPA record retention procedures. We have now completed documenting Chris' decision.

Thanks,

Bryan

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

From: Burch, Julia
Sent: Wednesday, October 18, 2017 3:04 PM
To: Manning, Bryan <manning.bryan@epa.gov>
Subject: FW: Chris signature on Peer Review Decision Maker Documentation

See attached with CG's signature.

Let me know if you need anything else.
Thanks!

Regards,

Julia Burch
Office of Transportation and Air Quality
U.S. Environmental Protection Agency
202-564-0961

From: Soth, Judith
Sent: Wednesday, October 18, 2017 3:02 PM
To: Burch, Julia <Burch.Julia@epa.gov>
Subject: Chris signature on Peer Review Decision Maker Documentation

EPA-HQ-2018-004348

To: Manning, Bryan[manning.bryan@epa.gov]; Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]
From: Samulski, Michael
Sent: Thur 8/31/2017 5:39:14 PM
Subject: FW: Agency Response to the Fall 2016 Reg Agenda SAB Review
Fall 2016 Response.pdf

From: Sargeant, Kathryn
Sent: Wednesday, August 30, 2017 4:19 PM
To: Charmley, William <charmley.william@epa.gov>; Samulski, Michael <samulski.michael@epa.gov>; Burch, Julia <Burch.Julia@epa.gov>; Sutton, Tia <sutton.tia@epa.gov>
Cc: Hengst, Benjamin <Hengst.Benjamin@epa.gov>
Subject: FYI: Agency Response to the Fall 2016 Reg Agenda SAB Review

FYI—see attached for EPA's final signed response to the SAB's recommendations on the science related to the Fall 2016 Reg Agenda. On aircraft it says: "The Board recommended that the Chartered SAB provide advice on Control of Air Pollution for Aircraft and Aircraft Engines: Proposed GHG Emissions Standards and Test Actions (2060-AT26) or that EPA conduct a panel peer review of the technical support documents. However, as of the Update to the 2017 Agenda, this action is listed as inactive."

From: Shoaff, John
Sent: Wednesday, August 30, 2017 3:01 PM
To: Koerber, Mike <Koerber.Mike@epa.gov>; Rimer, Kelly <Rimer.Kelly@epa.gov>; Jenkins, Scott <Jenkins.Scott@epa.gov>; Culligan, Kevin <Culligan.Kevin@epa.gov>; Sargeant, Kathryn <sargeant.kathryn@epa.gov>; Moltzen, Michael <Moltzen.Michael@epa.gov>; Cook, Leila <cook.leila@epa.gov>; Hengst, Benjamin <Hengst.Benjamin@epa.gov>
Cc: Mazza, Carl <Mazza.Carl@epa.gov>; Hockstad, Leif <Hockstad.Leif@epa.gov>
Subject: Agency Response to the Fall 2016 Reg Agenda SAB Review

All,

Just an FYI on the Agency's final response to the SAB re: last fall's regulatory actions/templates, see attached. Would also note that in the final session reviewing the status of activities at today's SAB meeting, a member recalled his/her interest in methods for technology reviews for which our willingness to provide a future informational briefing was also noted in the response letter. Thanks.

John

JOHN SHOAFF | LEADER, POLICY SUPPORT GROUP
OFFICE OF AIR POLICY & PROGRAM SUPPORT (OAPPS)
OFFICE OF AIR & RADIATION | U.S. EPA | WJC NORTH 5442-B
1200 PENNSYLVANIA AVE. NW | MC 6103A | WASHINGTON, D.C. | 20460 | USA
Shoaff.john@epa.gov | **1-202-564-0531 DIRECT** | **1-202-257-1755 MOBILE**

EPA-HQ-2018-004348

To: Lucie Audette (audette.lucie@epa.gov)[audette.lucie@epa.gov]
From: Samulski, Michael
Sent: Mon 10/30/2017 3:53:46 PM
Subject: FYI EDF letters and responses
AX-15-000-4798 Resp Ltr joint w FAA (EDF).pdf
CO2-standards-aircraft-EDF-letter-EPA-FAA-012215.pdf
FAA-150129-004.pdf
OAR-15-000-6153 FYI Correspondence.pdf

****

Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov

****

January 22, 2015

Gina McCarthy, Administrator
Environmental Protection Agency
Mail Code 1101A
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Janet McCabe, Acting Assistant Administrator
Office of Air and Radiation
U.S. EPA Headquarters
Mail Code 6101A
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Michael Huerta, Administrator
Federal Aviation Administration
800 Independence Avenue, SW
Washington, DC 20591

RE: Request for Strong Clean Air Act Standards to Curb Aircraft Greenhouse Gas Emissions

Dear Administrators McCarthy and Huerta and Acting Assistant Administrator McCabe:

We write to express strong support for the important rulemaking process now underway at the Environmental Protection Agency, in consultation with the Federal Aviation Administration, to set emission standards to curb greenhouse gas pollution from the nation's aircraft fleet. Greenhouse gas emissions from aircraft are currently responsible for more than 3 percent of total U.S. emissions[i] and are one of the fastest-growing carbon pollution sources, on track to *triple* by 2050 under business-as-usual scenarios.[ii] Yet, if the world is to hold the average global temperature increase to or below 2°C in order to avoid the worst effects of climate change, greenhouse gas emissions from all sources must be substantially *reduced* over that same time period.[iii] If global emissions from the aviation industry were compared to those of countries, in 2011 aviation would have ranked seventh, just after Germany and well ahead of Korea.[iv] Aviation emissions play a major part in global warming and must be curbed as quickly as possible.

We hope that EPA has now begun that process in earnest, and will, in May of this year, issue a proposed endangerment finding under Section 231 for aircraft greenhouse gas emissions. If that proposed finding is positive, we hope that EPA will also issue an ANPR considering, inter alia, (a) efforts by the International Civil Aviation Organization (ICAO) to establish, by 2016, global

greenhouse gas emission standards for international civil aviation; (b) work now underway in ICAO to finalize and adopt, by 2016, a global market-based measure to ensure the industry's "carbon neutral growth" from 2020 (i.e., a cap on its net emissions at 2020 levels); and (c) steps that will be needed internationally if the industry is to meet its pledge of a 50% cut in its emissions from 2005 levels by 2050.

Notwithstanding the potential actions by ICAO, however, EPA has an acknowledged duty under the Clean Air Act to set emission standards for the U.S. aviation industry. EPA's regulatory authority over aircraft carbon pollution is broad.[v] EPA is well equipped to employ this authority to increase the efficiency of the nation's aircraft fleet, as part of a multi-pillar approach to reducing the total carbon emissions of U.S. aviation. In that context, we hope that in its ANPR EPA will go beyond a discussion of ICAO's efforts, and to consider all means available to EPA and FAA to reduce aircraft carbon emissions, including inviting views on the scope of application of an aircraft greenhouse gas emission standard under the Clean Air Act; analyzing what can be achieved with such a standard in terms of emission reductions; and identifying how improvements in aircraft emissions under the standard can be monitored, reported, and verified. We hope that in fulfilling its mandate under the Clean Air Act, EPA's action will also help catalyze action at ICAO.

EPA has been analyzing measures to reduce carbon emissions from aviation since at least 2008, when it discussed technological controls, operational measures to reduce emissions, and standard-setting approaches in an ANPR.[vi] There, EPA analyzed available technological changes to future and existing aircraft engines, alterations or additions to airframes to reduce drag and weight, air traffic management and operational changes, and modifications of aircraft fuels.[vii] EPA estimated greenhouse gas reductions available from engine and airframe changes alone at 13.3 percent.[viii] EPA also discussed setting declining airline fleet average greenhouse gas emission standards similar to those it later promulgated for passenger vehicles, based either on engine emissions or as "an operational declining fleet average program . . . designed to consider the whole range of engine, aircraft and operational GHG control opportunities" EPA had analyzed.[ix] The Environmental Defense Fund supports the consideration of these kinds of flexibility tools in crafting environmentally strong standards under the Clean Air Act.

In sum, we urge EPA, in the forthcoming advanced notice of proposed rulemaking (ANPR), to consider all measures available to reduce greenhouse gas emissions from new and existing aircraft under Section 231 of the Clean Air Act[x], with the goal of proposing final standards no later than the end of 2015.

We look forward to working with you as you move forward in this important area.

Annie Petsonk
International Counsel, Environmental Defense Fund

[i] U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012 (April 2014)* at ES-2, Tables 2-15, 3-12, 3-50, 3-52, *available at* http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html#fullreport.

[ii] Lee, D.S., Lim, L., & Owen, B., *The Impact of the "2020 Carbon Neutral Goal" on Aviation CO_2 Radiative Forcing and Temperature Response* (2013), *available at* http://www.cate.mmu.ac.uk/docs/climate-impacts-from-aviation-CNG2020.pdf.

[iii] Intergovernmental Panel on Climate Change, *Climate Change 2014, Synthesis Report* at 20 (2014), *available at* http://ipcc.ch/report/ar5/syr/.

[iv] Kwan, Irene and Rutherford, Daniel, International Council on Clean Transportation, *U.S. Domestic Airline Fuel Efficiency Ranking, 2013* ("ICCT Report") at 1, 2 (2014), *available at* http://www.theicct.org/us-domestic-airline-fuel-efficiency-ranking-2013.

[v] Section 231 requires EPA to investigate emissions of air pollutants from aircraft and set pollution standards for any class or classes of aircraft engines, 42 U.S.C. §§ 7471(a), 7471(a)(2)(A), and EPA has previously set pollution standards for future and existing engines. U.S. EPA, *Control of Pollution from Aircraft and Aircraft Engines*, 38 Fed. Reg. 19088 (July 17, 1973).

[vi] U.S. EPA, *Advanced Notice of Proposed Rulemaking: Regulating Greenhouse Gas Emissions Under the Clean Air Act,* 73 Fed. Reg. 44354, 44470-44473 (July 30, 2008).

[vii] *Id.*

[viii] *Id.* at 44470.

[ix] *Id.* at 44473.

[x] 42 U.S.C. § 7471.

EDF
ENVIRONMENTAL DEFENSE FUND
Finding the ways that work

January 22, 2015

Gina McCarthy, Administrator
Environmental Protection Agency
Mail Code 1101A
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Janet McCabe, Acting Assistant Administrator
Office of Air and Radiation
U.S. EPA Headquarters
Mail Code 6101A
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Michael Huerta, Administrator
Federal Aviation Administration
800 Independence Avenue, SW
Washington, DC 20591

RE: Request for Strong Clean Air Act Standards to Curb Aircraft Greenhouse Gas Emissions

Dear Administrators McCarthy and Huerta and Acting Assistant Administrator McCabe:

We write to express strong support for the important rulemaking process now underway at the Environmental Protection Agency, in consultation with the Federal Aviation Administration, to set emission standards to curb greenhouse gas pollution from the nation's aircraft fleet. Greenhouse gas emissions from aircraft are currently responsible for more than 3 percent of total U.S. emissions[i] and are one of the fastest-growing carbon pollution sources, on track to *triple* by 2050 under business-as-usual scenarios.[ii] Yet, if the world is to hold the average global temperature increase to or below 2°C in order to avoid the worst effects of climate change, greenhouse gas emissions from all sources must be substantially *reduced* over that same time period.[iii] If global emissions from the aviation industry were compared to those of countries, in 2011 aviation would have ranked seventh, just after Germany and well ahead of Korea.[iv] Aviation emissions play a major part in global warming and must be curbed as quickly as possible.

We hope that EPA has now begun that process in earnest, and will, in May of this year, issue a proposed endangerment finding under Section 231 for aircraft greenhouse gas emissions. If that proposed finding is positive, we hope that EPA will also issue an ANPR considering, inter alia, (a) efforts by the International Civil Aviation Organization (ICAO) to establish, by 2016, global

1875 Connecticut Avenue, NW
Washington, DC 20009
T 202 387 3500
F 202 234 6049
www.edf.org
New York, NY / Austin, TX / Bentonville, AR / Boston, MA / Boulder, CO / Raleigh, NC
Sacramento, CA / San Francisco, CA / Washington, DC / Beijing, China
Totally chlorine free 100% post-consumer recycled paper

OAR-15-000-5176

greenhouse gas emission standards for international civil aviation; (b) work now underway in ICAO to finalize and adopt, by 2016, a global market-based measure to ensure the industry's "carbon neutral growth" from 2020 (i.e., a cap on its net emissions at 2020 levels); and (c) steps that will be needed internationally if the industry is to meet its pledge of a 50% cut in its emissions from 2005 levels by 2050.

Notwithstanding the potential actions by ICAO, however, EPA has an acknowledged duty under the Clean Air Act to set emission standards for the U.S. aviation industry. EPA's regulatory authority over aircraft carbon pollution is broad.[v] EPA is well equipped to employ this authority to increase the efficiency of the nation's aircraft fleet, as part of a multi-pillar approach to reducing the total carbon emissions of U.S. aviation. In that context, we hope that in its ANPR EPA will go beyond a discussion of ICAO's efforts, and to consider all means available to EPA and FAA to reduce aircraft carbon emissions, including inviting views on the scope of application of an aircraft greenhouse gas emission standard under the Clean Air Act; analyzing what can be achieved with such a standard in terms of emission reductions; and identifying how improvements in aircraft emissions under the standard can be monitored, reported, and verified. We hope that in fulfilling its mandate under the Clean Air Act, EPA's action will also help catalyze action at ICAO.

EPA has been analyzing measures to reduce carbon emissions from aviation since at least 2008, when it discussed technological controls, operational measures to reduce emissions, and standard-setting approaches in an ANPR.[vi] There, EPA analyzed available technological changes to future and existing aircraft engines, alterations or additions to airframes to reduce drag and weight, air traffic management and operational changes, and modifications of aircraft fuels.[vii] EPA estimated greenhouse gas reductions available from engine and airframe changes alone at 13.3 percent.[viii] EPA also discussed setting declining airline fleet average greenhouse gas emission standards similar to those it later promulgated for passenger vehicles, based either on engine emissions or as "an operational declining fleet average program . . . designed to consider the whole range of engine, aircraft and operational GHG control opportunities" EPA had analyzed.[ix] The Environmental Defense Fund supports the consideration of these kinds of flexibility tools in crafting environmentally strong standards under the Clean Air Act.

In sum, we urge EPA, in the forthcoming advanced notice of proposed rulemaking (ANPR), to consider all measures available to reduce greenhouse gas emissions from new and existing aircraft under Section 231 of the Clean Air Act[x], with the goal of proposing final standards no later than the end of 2015.

We look forward to working with you as you move forward in this important area.

Annie Petsonk

Annie Petsonk
International Counsel, Environmental Defense Fund

EDF
ENVIRONMENTAL DEFENSE FUND
Finding the ways that work

[i] U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012 (April 2014)* at ES-2, Tables 2-15, 3-12, 3-50, 3-52, *available at* http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html#fullreport.

[ii] Lee, D.S., Lim, L., & Owen, B., *The Impact of the "2020 Carbon Neutral Goal" on Aviation CO_2 Radiative Forcing and Temperature Response* (2013), *available at* http://www.cate.mmu.ac.uk/docs/climate-impacts-from-aviation-CNG2020.pdf.

[iii] Intergovernmental Panel on Climate Change, *Climate Change 2014, Synthesis Report* at 20 (2014), *available at* http://ipcc.ch/report/ar5/syr/.

[iv] Kwan, Irene and Rutherford, Daniel, International Council on Clean Transportation, *U.S. Domestic Airline Fuel Efficiency Ranking, 2013* ("ICCT Report") at 1, 2 (2014), *available at* http://www.theicct.org/us-domestic-airline-fuel-efficiency-ranking-2013.

[v] Section 231 requires EPA to investigate emissions of air pollutants from aircraft and set pollution standards for any class or classes of aircraft engines, 42 U.S.C. §§ 7471(a), 7471(a)(2)(A), and EPA has previously set pollution standards for future and existing engines. U.S. EPA, *Control of Pollution from Aircraft and Aircraft Engines*, 38 Fed. Reg. 19088 (July 17, 1973).

[vi] U.S. EPA, *Advanced Notice of Proposed Rulemaking: Regulating Greenhouse Gas Emissions Under the Clean Air Act,* 73 Fed. Reg. 44354, 44470-44473 (July 30, 2008).

[vii] *Id.*

[viii] *Id.* at 44470.

[ix] *Id.* at 44473.

[x] 42 U.S.C. § 7471.

1875 Connecticut Avenue, NW
Washington, DC 20009
T 202 387 3500
F 202 234 6049
www.edf.org
New York, NY / Austin, TX / Bentonville, AR / Boston, MA / Boulder, CO / Raleigh, NC
Sacramento, CA / San Francisco, CA / Washington, DC / Beijing, China
Totally chlorine free 100% post-consumer recycled paper

To: charmley.william@epa.gov[charmley.william@epa.gov]
Cc: Bryan Manning (manning.bryan@epa.gov)[manning.bryan@epa.gov]
From: Samulski, Michael
Sent: Fri 1/8/2016 12:48:08 PM
Subject: FW: Slides & Info for Boeing mtg: per Bill's request
Slides for Boeing mtg Jan 8 2016.pptx
Hybrid Options.xlsx
Fleet Effect.pptx
Definition Technical Feasibility CO2 Standard.docx
bjm010616_BoeingSummary.xlsx

Bill,

Here are the materials you requested to have available for the Boeing meeting.

Ex. 5 - Deliberative Process

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Manning, Bryan
Sent: Thursday, January 07, 2016 8:56 PM
To: Samulski, Michael; Yen, David; Leggett, Cullen; Audette, Lucie
Cc: Maeroff, Bruce
Subject: Slides & Info for Boeing mtg: per Bill's request (PLEASE REVIEW)

Hello,

In the first attachment, please find PPT slides for the Boeing meeting, as Bill requested. Let me know if you have any comments.

Ex. 5 - Deliberative Process The second attachment is

Ex. 5 - Deliberative Process

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Yen, David[Yen.David@epa.gov]
From: Lindsey, Leah
Sent: Tue 3/20/2018 2:13:44 PM
Subject: RE: Fleet Evolution Slides for FAA Review
CO2_FleetEvolution_FAA_032018.pptx

Hi David,

Here are the slides with the updated plots. I added a few more plots at the end of the presentation. I wasn't sure how you wanted to organize them. Let me know if you would like to see anymore plots.

Leah

From: Yen, David
Sent: Monday, March 19, 2018 1:45 PM
To: Lindsey, Leah <lindsey.leah@epa.gov>
Subject: Fleet Evolution Slides for FAA Review

Hi Leah,

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

What do you think? Let me know if you have strong feelings about the approach.

Thanks,

David

To: Yen, David[Yen.David@epa.gov]
From: Maeroff, Bruce
Sent: Thur 12/22/2016 4:49:06 PM
Subject: FW: Response to Reconsideration Petition FRN + cover letter (OTAQ aviation webpage): aircraft GHG finding FRM
Biogenic CO2 Coalition Petition for Reconsideration of Aircraft Endangerment.pdf
Aircraft Endangerment Reconsideration Petition Response.pdf

Hi David, we will take care of this – it is finally signed. Thank you for volunteering.

Bruce Maeroff

Senior Service America, Inc.

Supporting the U.S. EPA through a Cooperative

Agreement under the SEE Program,

Assessment and Standards Division,

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105 U.S.A.

Cube N130

ph (734) 214-4404 fax (734) 214-4816

maeroff.bruce@epa.gov

From: Jantarasami, Lesley
Sent: Thursday, December 22, 2016 11:36 AM
To: Manning, Bryan <manning.bryan@epa.gov>
Cc: Maeroff, Bruce <Maeroff.Bruce@epa.gov>; Page, Margaret <Page.Margaret@epa.gov>; Levin, David <Levin.David@epa.gov>
Subject: RE: Response to Reconsideration Petition FRN + cover letter (OTAQ aviation webpage): aircraft GHG finding FRM

Hello everyone,

Good news – the Administrator signed the response last evening, so we can move ahead with posting. Attached is the scanned letter + response enclosure in one PDF. The other PDF is just a resend of the petition I've sent to you previously. Ex. 5 - Attorney Client

Ex. 5 - Attorney Client

Please let me know if you have questions or if I can helpful in any way. Have a great holiday!

Thanks,

Lesley

From: Manning, Bryan
Sent: Wednesday, December 21, 2016 12:56 PM
To: Jantarasami, Lesley <Jantarasami.Lesley@epa.gov>
Cc: Maeroff, Bruce <Maeroff.Bruce@epa.gov>; Page, Margaret <Page.Margaret@epa.gov>; Levin, David <Levin.David@epa.gov>
Subject: RE: Response to Reconsideration Petition FRN + cover letter (OTAQ aviation webpage): aircraft GHG finding FRM

Hi Lesley,

Sorry to bother you, but any news on the Administrator signing the response to the reconsideration petition?

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Jantarasami, Lesley
Sent: Tuesday, December 20, 2016 2:26 PM
To: Manning, Bryan <manning.bryan@epa.gov>
Cc: Maeroff, Bruce <Maeroff.Bruce@epa.gov>; Page, Margaret <Page.Margaret@epa.gov>
Subject: RE: Response to Reconsideration Petition FRN + cover letter (OTAQ aviation webpage): aircraft GHG finding FRM

Actually, Ex. 5 - Attorney Client
Ex. 5 - Attorney Client
Ex. 5 - Attorney Client Will the right people be in the office tomorrow?

Thanks so much,

Lesley

From: Jantarasami, Lesley
Sent: Tuesday, December 20, 2016 12:46 PM
To: Manning, Bryan <manning.bryan@epa.gov>
Cc: Maeroff, Bruce <Maeroff.Bruce@epa.gov>; Page, Margaret <Page.Margaret@epa.gov>
Subject: RE: Response to Reconsideration Petition FRN + cover letter (OTAQ aviation

webpage): aircraft GHG finding FRM

I forgot that one more document that we can prepare now is the actual petition itself (attached).

From: Manning, Bryan
Sent: Monday, December 19, 2016 4:05 PM
To: Jantarasami, Lesley <Jantarasami.Lesley@epa.gov>
Cc: Maeroff, Bruce <Maeroff.Bruce@epa.gov>; Page, Margaret <Page.Margaret@epa.gov>
Subject: RE: Response to Reconsideration Petition FRN + cover letter (OTAQ aviation webpage): aircraft GHG finding FRM

Okay, Lesley. Thanks for the reply. Just to confirm, the letter will be placed before the enclosure in the PDF file. Correct? Sorry for the obvious question, but folks here just wanted to make sure.

Thanks again,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Jantarasami, Lesley
Sent: Monday, December 19, 2016 2:46 PM
To: Manning, Bryan <manning.bryan@epa.gov>
Cc: Maeroff, Bruce <Maeroff.Bruce@epa.gov>; Page, Margaret <Page.Margaret@epa.gov>
Subject: RE: Response to Reconsideration Petition FRN + cover letter (OTAQ aviation webpage): aircraft GHG finding FRM

Hi everyone,

We are still aiming for tomorrow, with potential to slip until Wed. The web blurb looked good to me. Attached are the current drafts of the letter and response document, which we could PDF into one file once we have the Administrator's signature on the letter. So I suppose the only part we can do in advance is to PDF the file that says "Enclosure." Let me know if you need anything else!

Thanks,

Lesley

Lesley Jantarasami

U.S. EPA, Climate Change Division

Office of Air & Radiation

jantarasami.lesley@epa.gov

(202)-343-9929

From: Manning, Bryan
Sent: Monday, December 19, 2016 11:20 AM

To: Jantarasami, Lesley <Jantarasami.Lesley@epa.gov>
Cc: Maeroff, Bruce <Maeroff.Bruce@epa.gov>; Page, Margaret <Page.Margaret@epa.gov>
Subject: RE: Response to Reconsideration Petition FRN + cover letter (OTAQ aviation webpage): aircraft GHG finding FRM

Hi Lesley,

Sorry to bother you. In the spirit of helping OTAQ's website folks be prepared, any thoughts on the timing of this response (still aiming for Dec 20)? Of course, if we are trying to issue it tomorrow, then we probably need to see the documents fairly soon? We are assuming that you are okay with the web blurb that OGC commented on late last week.

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Jantarasami, Lesley
Sent: Thursday, December 15, 2016 10:11 AM
To: Manning, Bryan <manning.bryan@epa.gov>
Cc: Audette, Lucie <audette.lucie@epa.gov>; Maeroff, Bruce <Maeroff.Bruce@epa.gov>;

Williams, Melina <Williams.Melina@epa.gov>; Thrift, Mike <thrift.mike@epa.gov>; Birgfeld, Erin <Birgfeld.Erin@epa.gov>; Page, Margaret <Page.Margaret@epa.gov>
Subject: RE: Response to Reconsideration Petition FRN + cover letter (OTAQ aviation webpage): aircraft GHG finding FRM

Thanks, Bryan, it would be really helpful if you could take a crack at the web blurb. I'm slammed over here with getting things ready for the Administrator's signature.

Thanks!

Lesley

From: Manning, Bryan
Sent: Thursday, December 15, 2016 9:45 AM
To: Jantarasami, Lesley <Jantarasami.Lesley@epa.gov>
Cc: Audette, Lucie <audette.lucie@epa.gov>; Maeroff, Bruce <Maeroff.Bruce@epa.gov>; Williams, Melina <Williams.Melina@epa.gov>; Thrift, Mike <thrift.mike@epa.gov>; Birgfeld, Erin <Birgfeld.Erin@epa.gov>; Page, Margaret <Page.Margaret@epa.gov>
Subject: Response to Reconsideration Petition FRN + cover letter (OTAQ aviation webpage): aircraft GHG finding FRM

Hi again Lesley,

As I mentioned earlier, our OTAQ web folks are ready to begin the steps put this on our aviation web page. We can take a crack at the web blurb for this if you like. Or, if you or OGC want to draft a blurb for the web page that is fine as well. Let us know your preference. By the way, are web folks realize that Dec 20 is the target date for getting things on the web.

Thanks,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Jantarasami, Lesley
Sent: Tuesday, December 13, 2016 9:55 AM
To: Manning, Bryan <manning.bryan@epa.gov>
Cc: Audette, Lucie <audette.lucie@epa.gov>
Subject: RE: Reconsideration Petition FRN + cover letter

One more question – would it be ok to post these things to your website? We have this sentence in the FRN:

This action, the petition for reconsideration and the EPA's response addressing the petition can also be found on the EPA's Web site at *https://www.epa.gov/regulations-emissions-vehicles-and-engines/final-rule-finding-greenhouse-gas-emissions-aircraft*.

Thanks,

Lesley

From: Manning, Bryan

Sent: Tuesday, December 13, 2016 8:17 AM
To: Jantarasami, Lesley <Jantarasami.Lesley@epa.gov>
Cc: Audette, Lucie <audette.lucie@epa.gov>
Subject: RE: Reconsideration Petition FRN + cover letter

Hi Lesley,

I left you a voice mail on the final sentence of the cover letter. If you did not get this voice mail, let me know.

Thank you,

Bryan

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

From: Jantarasami, Lesley
Sent: Monday, December 12, 2016 9:52 AM
To: Audette, Lucie <audette.lucie@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>
Subject: RE: Reconsideration Petition FRN + cover letter

Hi Lucie and Bryan,

Ex. 5 - Deliberative Process

Thanks!

Lesley

Lesley Jantarasami

U.S. EPA, Climate Change Division

Office of Air & Radiation

jantarasami.lesley@epa.gov

(202)-343-9929

From: Jantarasami, Lesley
Sent: Friday, December 09, 2016 2:35 PM
To: Williams, Melina <Williams.Melina@epa.gov>; Thrift, Mike <thrift.mike@epa.gov>; Greenglass, Nora <Greenglass.Nora@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>
Cc: Orlin, David <Orlin.David@epa.gov>; Rona Birnbaum <Birnbaum.Rona@epa.gov>
Subject: Reconsideration Petition FRN + cover letter

Hi all,

Here is the FR notice of availability and the cover letter that will go with the petition response. Neither of these docs is very long, so I think we can do a concurrent review. Please let me know if you have comments as soon as you can – we aim to send these draft and revisions back to Janet by early next week (COB Tuesday at the latest).

I've also attached for your reference a clean(er) version of the petition response as it stands now. We've responded to Janet's comments and most of David's Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Lesley

From: Williams, Melina
Sent: Monday, December 05, 2016 6:01 PM
To: Thrift, Mike <thrift.mike@epa.gov>; Greenglass, Nora <Greenglass.Nora@epa.gov>; Jantarasami, Lesley <Jantarasami.Lesley@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>; Audette, Lucie <audette.lucie@epa.gov>
Cc: Orlin, David <Orlin.David@epa.gov>
Subject: Reconsideration Petition Response_draft111616 rb+pg+mkw rev 11-29 do 12-4 mkw 12-5

Hi all,

Ex. 5 - Deliberative Process

Lesley, in terms of the mechanics of the Administrator's signature, we should also prepare both a cover letter for the denial for the Administrator to sign, and an FR notice of availability. I have samples of both of those documents -- if you need them let me know.

Thanks,

Melina

From: Manning, Bryan
Location: AA-Room-Office-N62-ASDCDConfRoom/AA-OTAQ-OFFICE
Importance: Normal
Subject: Aircraft CO2 NPRM: Baseline Emissions Inventory - EPA GHG & Sinks Report or David Yen's Model
Start Date/Time: Wed 10/12/2016 6:00:00 PM
End Date/Time: Wed 10/12/2016 7:00:00 PM

Earlier, we discussed that we need to have a meeting to consider whether our aircraft baseline for the U.S. emissions inventory (aircraft CO2 std. NPRM) should be according to the EPA GHG & Sinks Report (utilized for aircraft GHG endangerment finding FRM) or David Yen's model.

Thanks,

Bryan

To: Yen, David[Yen.David@epa.gov]
From: Zawacki, Margaret
Sent: Thur 3/17/2016 2:03:01 PM
Subject: RE: additional questions about aircraft emissions

Great, talk to you soon!

From: Yen, David
Sent: Thursday, March 17, 2016 10:02 AM
To: Zawacki, Margaret <zawacki.margaret@epa.gov>
Subject: RE: additional questions about aircraft emissions

Okay, let's do Monday at 3 since we do want Ken in the meeting. Cullen is in Rome this week for ICAO Working Group 3 meetings. We can bring him up to speed later. Thanks.

From: Zawacki, Margaret
Sent: Thursday, March 17, 2016 9:51 AM
To: Yen, David <Yen.David@epa.gov>
Subject: RE: additional questions about aircraft emissions

Ken's calendar is busy Tuesday afternoon but it looks like Monday at 3 would work for everyone (you, me, Ken, Harvey Michaels, Sarah Roberts, and Bryan) except Cullen. I'm not sure about Cullen, his calendar shows that he isn't working on Monday or Tuesday afternoon.

From: Yen, David
Sent: Thursday, March 17, 2016 9:14 AM
To: Zawacki, Margaret <zawacki.margaret@epa.gov>
Cc: Davidson, Ken <Davidson.Ken@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>; Leggett, Cullen <Leggett.Cullen@epa.gov>
Subject: RE: additional questions about aircraft emissions

Hi Molly,

It would be great if you don't mind setting up an initial meeting. Looking at my calendar, next Tuesday afternoon (any time) would be better for us. I would like to invite Bryan Manning and Cullen Leggett from my group (Large Marine and Aviation center). If you can invite Ken and Ed's folks, that would be super.

Thanks,

David

From: Zawacki, Margaret
Sent: Thursday, March 17, 2016 6:54 AM
To: Yen, David <Yen.David@epa.gov>
Cc: Davidson, Ken <Davidson.Ken@epa.gov>
Subject: RE: additional questions about aircraft emissions

Hi David,

Thanks, your email helps clarify things for me. It sounds like the next step is an exploratory, staff-level meeting, with you and me and Ken and some folks from Ed's group. I can set up a meeting for us to start brainstorming and we can see where we need to go next. I just started poking around calendars and it looks like next Monday afternoon works – let me know if that is too soon.

Molly

From: Yen, David
Sent: Wednesday, March 16, 2016 10:31 AM
To: Zawacki, Margaret <zawacki.margaret@epa.gov>
Subject: RE: additional questions about aircraft emissions

Hi Molly

Ex. 5 - Deliberative Process

Best regards,

David Yen

Assessment and Standards Division

Office of Transportation and Air Quality

U.S. Environmental Protection Agency

2000 Tarverwood Drive

Ann Arbor, MI 48105

Office phone: (734)214-4103

Email: yen.david@epa.gov

From: Zawacki, Margaret
Sent: Monday, March 14, 2016 3:35 PM
To: Yen, David <Yen.David@epa.gov>
Subject: additional questions about aircraft emissions

Hi David,

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Molly Zawacki

US EPA Office of Transportation and Air Quality
Assessment and Standards Division
2000 Traverwood Drive
Ann Arbor, MI 48105
Phone: 734.214.4472

Available:

Mondays and Wednesdays 8:30 to 5

Tuesdays and Thursdays 6 to 2:30

To: Yen, David[Yen.David@epa.gov]
From: Zawacki, Margaret
Sent: Thur 3/17/2016 1:51:10 PM
Subject: RE: additional questions about aircraft emissions

Ken's calendar is busy Tuesday afternoon but it looks like Monday at 3 would work for everyone (you, me, Ken, Harvey Michaels, Sarah Roberts, and Bryan) except Cullen. I'm not sure about Cullen, his calendar shows that he isn't working on Monday or Tuesday afternoon.

From: Yen, David
Sent: Thursday, March 17, 2016 9:14 AM
To: Zawacki, Margaret <zawacki.margaret@epa.gov>
Cc: Davidson, Ken <Davidson.Ken@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>; Leggett, Cullen <Leggett.Cullen@epa.gov>
Subject: RE: additional questions about aircraft emissions

Hi Molly,

It would be great if you don't mind setting up an initial meeting. Looking at my calendar, next Tuesday afternoon (any time) would be better for us. I would like to invite Bryan Manning and Cullen Leggett from my group (Large Marine and Aviation center). If you can invite Ken and Ed's folks, that would be super.

Thanks,

David

From: Zawacki, Margaret
Sent: Thursday, March 17, 2016 6:54 AM
To: Yen, David <Yen.David@epa.gov>
Cc: Davidson, Ken <Davidson.Ken@epa.gov>
Subject: RE: additional questions about aircraft emissions

Hi David,

Thanks, your email helps clarify things for me. It sounds like the next step is an exploratory, staff-level meeting, with you and me and Ken and some folks from Ed's group. I can set up a meeting for us to start brainstorming and we can see where we need to go next. I just started poking around calendars and it looks like next Monday afternoon works – let me know if that is too soon.

Molly

From: Yen, David
Sent: Wednesday, March 16, 2016 10:31 AM
To: Zawacki, Margaret <zawacki.margaret@epa.gov>
Subject: RE: additional questions about aircraft emissions

Hi Molly

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Best regards,

David Yen

Assessment and Standards Division

Office of Transportation and Air Quality

U.S. Environmental Protection Agency

2000 Tarverwood Drive

Ann Arbor, MI 48105

Office phone: (734)214-4103

Email: yen.david@epa.gov

From: Zawacki, Margaret
Sent: Monday, March 14, 2016 3:35 PM
To: Yen, David <Yen.David@epa.gov>
Subject: additional questions about aircraft emissions

Hi David,

Ex. 5 - Deliberative Process

Hope this is helpful! Let me know if you have questions - Molly

Molly Zawacki

US EPA Office of Transportation and Air Quality
Assessment and Standards Division
2000 Traverwood Drive
Ann Arbor, MI 48105
Phone: 734.214.4472

Available:

Mondays and Wednesdays 8:30 to 5

Tuesdays and Thursdays 6 to 2:30

To: Yen, David[Yen.David@epa.gov]
Cc: Davidson, Ken[Davidson.Ken@epa.gov]
From: Zawacki, Margaret
Sent: Thur 3/17/2016 10:53:56 AM
Subject: RE: additional questions about aircraft emissions

Hi David,

Thanks, your email helps clarify things for me. It sounds like the next step is an exploratory, staff-level meeting, with you and me and Ken and some folks from Ed's group. I can set up a meeting for us to start brainstorming and we can see where we need to go next. I just started poking around calendars and it looks like next Monday afternoon works – let me know if that is too soon.

Molly

From: Yen, David
Sent: Wednesday, March 16, 2016 10:31 AM
To: Zawacki, Margaret <zawacki.margaret@epa.gov>
Subject: RE: additional questions about aircraft emissions

Hi Molly

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Best regards,

David Yen

Assessment and Standards Division

Office of Transportation and Air Quality

U.S. Environmental Protection Agency

2000 Tarverwood Drive

Ann Arbor, MI 48105

Office phone: (734)214-4103

Email: yen.david@epa.gov

From: Zawacki, Margaret
Sent: Monday, March 14, 2016 3:35 PM
To: Yen, David <Yen.David@epa.gov>
Subject: additional questions about aircraft emissions

Hi David,

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Molly Zawacki

US EPA Office of Transportation and Air Quality
Assessment and Standards Division
2000 Traverwood Drive
Ann Arbor, MI 48105
Phone: 734.214.4472

Available:

Mondays and Wednesdays 8:30 to 5

Tuesdays and Thursdays 6 to 2:30

From: Manning, Bryan
Location: AA-Room-Office-C34-ConfRoom/AA-OTAQ-OFFICE
Importance: Normal
Subject: Aircraft CO2 rule: economic and benefits analysis (call Ex. 6 - Personal Privacy, code Ex. 6 - Personal Privacy)
Start Date/Time: Wed 12/13/2017 6:00:00 PM
End Date/Time: Wed 12/13/2017 7:00:00 PM
Outline_Preamble_Aircraft CO2 Stds NPRM 12-12-17.docx
Outline_RIA_Aircraft CO2 Stds NPRM 12-12-17.docx
Aircraft GHG draft analytic blueprint March 10 clean.doc

Hi,

Attached please find the current outlines for the preamble and RIA of the aircraft CO2 standard NPRM. We will use these outlines to help with our discussions.

The call-in number is Ex. 6 - Personal Privacy code Ex. 6 - Personal Privacy.

Also, I am attaching the latest version of the Analytic Blueprint, which was last worked on back in March 2017.

Kind regards,

Bryan

Message

From: Gerring, Holly [gerring.holly@epa.gov]
Sent: 1/2/2018 8:09:01 PM
To: Yen, David [Yen.David@epa.gov]
Subject: RE: Peer review work assignment (WA 1-15): Documents
Attachments: ICF - EPA Aerospace Industry Characterization_11-3-2017_HGDecEdits.docx; ICF - EPA 2017 Aircraft CO2 Cost Assessment_11-3-2017_HGDecEdits.docx; Copy of Tech Response Spreadsheet_11-6-7v2+LL_12-18-17_GR-Type_FR-MPL_121917 (002).xlsx

Flag: Follow up

Hi David,

As requested, here are my thoughts on the ICF reports & spreadsheet to make them as clean as possible for review. I've added comments to the word files attached & below are my only thoughts on the spreadsheet. If there are things I flagged which look ok to you, feel free to delete my comments. And if you have any questions on any of this, just let me know.

Ex. 5 - Deliberative Process

-Holly

From: Yen, David
Sent: Wednesday, December 20, 2017 12:29 PM
To: Gerring, Holly <gerring.holly@epa.gov>
Subject: FW: Peer review work assignment (WA 1-15): Documents

Hi Holly,

I am forwarding to you the ICF reports we sent out to RI for peer review. We are using the ICF Tech Response

Ex. 5 - Deliberative Process

Thanks,
David

From: Manning, Bryan
Sent: Tuesday, November 14, 2017 1:43 PM
To: Yen, David <Yen.David@epa.gov>; Lindsey, Leah <lindsey.leah@epa.gov>
Subject: FYI: Peer review work assignment (WA 1-15): Documents

Hi David and Leah, FYI, this morning I sent the below message and attachments (including tech response spreadsheet) to RTI, the contractor facilitating the peer review of the ICF tech/cost report and David's technical report on the inventory. RTI is currently developing the work plan. They received the work assignment late last week. Thanks. Bryan

From: Manning, Bryan
Sent: Tuesday, November 14, 2017 10:35 AM
To: 'Viator, Catherine' <viator@rti.org>
Cc: Amy Doll <adoll@endyna.com>; siddhanti@endyna.com; Mueller, John <mueller.john@epa.gov>
Subject: New peer review work assignment (WA 1-15): Documents

Hi Catherine et al,

It was good to talk with you yesterday. In the 1st attachment, please find the draft charge questions for the first report (to be peer reviewed), *Aircraft CO2 Cost and Technology Refresh and Aerospace Industry Characterization*, in WA 1-15. Let me know if you have any comments on these charge questions.

Ex. 5 - Deliberative Process

Let me know if you have any questions.

Thank you,

Bryan

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

From: Viator, Catherine [mailto:viator@rti.org]
Sent: Monday, November 13, 2017 10:56 AM
To: Manning, Bryan <manning.bryan@epa.gov>
Subject: new peer review work assignment

Hi Bryan,
We received the new WA last week to continue the aircraft emissions peer review, and we look forward to completing this work! Do you have time for a quick call this morning before noon EST? We just want to ask if the first report is ready for peer review and discuss the schedule.

Thanks!

Catherine

Catherine Viator
Food, Nutrition, & Obesity Policy Research
RTI International
3040 Cornwallis Road
Research Triangle Park, NC 27709

TEL: 919.597.5127
EMAIL: viator@rti.org

To: Yen, David[Yen.David@epa.gov]
From: Maeroff, Bruce
Sent: Tue 3/24/2015 12:42:17 PM
Subject: RE: draft paper on asset value loss
bjm032415FedEx_Corp_FY14_10K_1.pdf

Bruce Maeroff

Senior Service America, Inc.

Supporting the U.S. EPA through a Cooperative

Agreement under the SEE Program,

Assessment and Standards Division,

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105 U.S.A.

Cube N130

ph (734) 214-4304 fax (734) 214-4816

maeroff.bruce@epa.gov

From: Yen, David
Sent: Monday, March 23, 2015 12:03 PM
To: Samulski, Michael; Manning, Bryan; Leggett, Cullen; Maeroff, Bruce
Subject: RE: draft paper on asset value loss

Hi all,

Here is a revision of the draft paper and a companion spreadsheet for the AVL calculations.

Please give it a quick further review and edit. I like to send it to the small group today for review if possible. The spreadsheet has AVL computed two ways, one (in tab "AVL estimation) with aircraft price depreciated to 2023 and the other (in tab "AVL estimation_0") just use 15% residual value at scrappage for all impacted aircraft.

Ex. 5 - Deliberative Process

Thanks,

David

From: Samulski, Michael
Sent: Thursday, March 19, 2015 2:39 PM
To: Yen, David; Manning, Bryan; Leggett, Cullen; Maeroff, Bruce
Subject: RE: draft paper on asset value loss

Here are my comments on the paper.

Ex. 5 - Deliberative Process

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

From: Yen, David
Sent: Thursday, March 19, 2015 2:29 PM
To: Samulski, Michael; Manning, Bryan; Leggett, Cullen; Maeroff, Bruce
Subject: RE: draft paper on asset value loss

Here is the worked out example for AVL and other costs with our proposed AVL methodology. Note that the first chart is the total of all costs. The second chart is the cost/CO2 saved. The third chart is AVL although labelled as AO/OP NRC. **Ex. 5 - Deliberative Process**

Ex. 5 - Deliberative Process

Best,

David

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

From: Yen, David
Sent: Thursday, March 19, 2015 1:39 PM
To: Samulski, Michael; Manning, Bryan; Leggett, Cullen; Maeroff, Bruce
Subject: RE: draft paper on asset value loss

Here is my input to the draft AVL paper. Please review and edit.

Thanks,

David

From: Samulski, Michael
Sent: Tuesday, March 17, 2015 3:37 PM
To: Manning, Bryan; Leggett, Cullen; Yen, David; Maeroff, Bruce
Subject: draft paper on asset value loss

For your review, here is a draft paper on asset value loss. This is based on the conversation in today's meeting.

Ex. 5 - Deliberative Process

I left the final section for Cullen and David, which is the recommended calculation methodology. (The previous sections outline my thinking)

Thanks,

Mike

****

Michael Samulski

U.S. Environmental Protection Agency

Office of Transportation and Air Quality

Director, Large Marine and Aircraft Center

1 (734) 214-4532

samulski.michael@epa.gov

****

To: Yen, David[Yen.David@epa.gov]
From: Leggett, Cullen
Sent: Mon 3/16/2015 5:28:34 PM
Subject: FW: Round 2 results query for Effectiveness of the Standard.
RE: Communication of CO2 Standard Effectiveness Proposal Part 1 - Communication to CAEP Members

From: Chris Eyers [mailto:chris@limitedskies.com]
Sent: Wednesday, March 11, 2015 4:48 PM
To: Leggett, Cullen
Subject: RE: Round 2 results query for Effectiveness of the Standard.

Hi Cullen,

Please see my thoughts against each of your questions below

Chris

From: Leggett, Cullen [mailto:Leggett.Cullen@epa.gov]
Sent: 11 March 2015 21:13
To: Chris Eyers
Subject: RE: Round 2 results query for Effectiveness of the Standard.

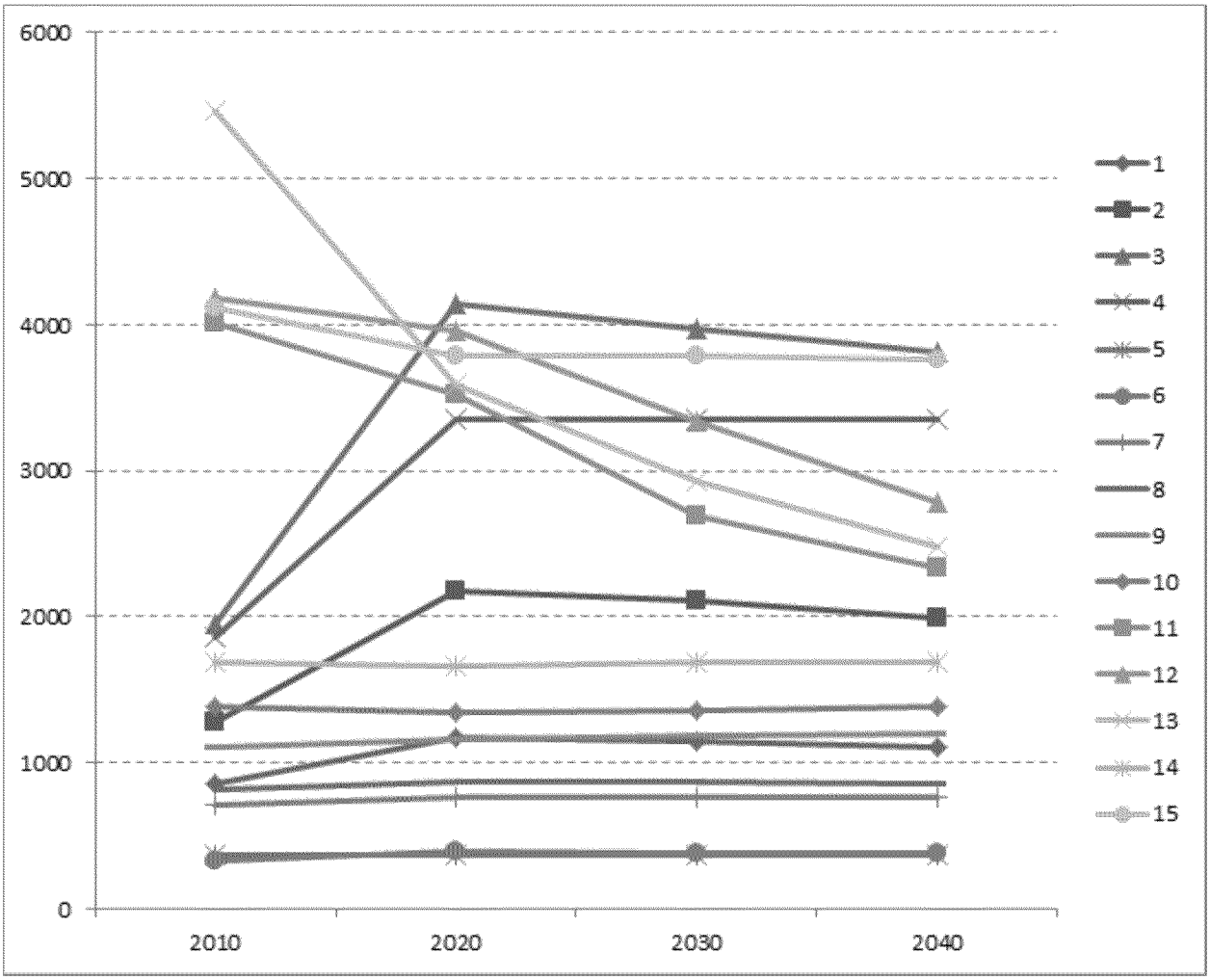
Chris,

Sorry for the delay getting back to you. I can get that chart as well when I calculate the year on year changes for FB and ASK. Based on Sathya's responses to my questions though, I'm not sure if it is what we are wanting to look at. Are we wanting to look at only the FB/ASK for aircraft delivered that year? I was thinking we would be wanting to look at the total FB/ASK for all aircraft that will be effected by the standard for year they are produced onward. This should give us a downward shaped curve similar to what I provided on the last call.

CJE: We could look at either – but I know I want a statistic with a similar basis to the trends analysis annual %ages (0.57%, 0.96% pa etc).That would be based on improvements in deliveries year-on-year (deltaMVmargin pa or deltaFB/ASK pa). What message do you get from the downward curve?

As we discussed on the call, I think the lumps are based on how the deliveries are set up. I'm not sure what is causing the worsening average over time. Maybe it is a function of the aircraft utilization not being constant across the years?

CJE: Agree on the lumps. No real problem from this. On the increasing average over time, maybe it is partially utilization. But Ivan came up with the following plot showing average trip distance by CB by analysis year. The large types (CB 11, 12 and 13) are used on shorter routes in later years which is v weird. This would cause the effect of worsening fuel burn. However, unless there has been an error, this shortening must be a feature of the forecast, in which case AAT would have the same feature. I don't have the data to say whether it does or not. However, the large aircraft route shortening is a cause of the worsening FB in APMT. I am surprised by this route shortening and do not like it whatever the cause.



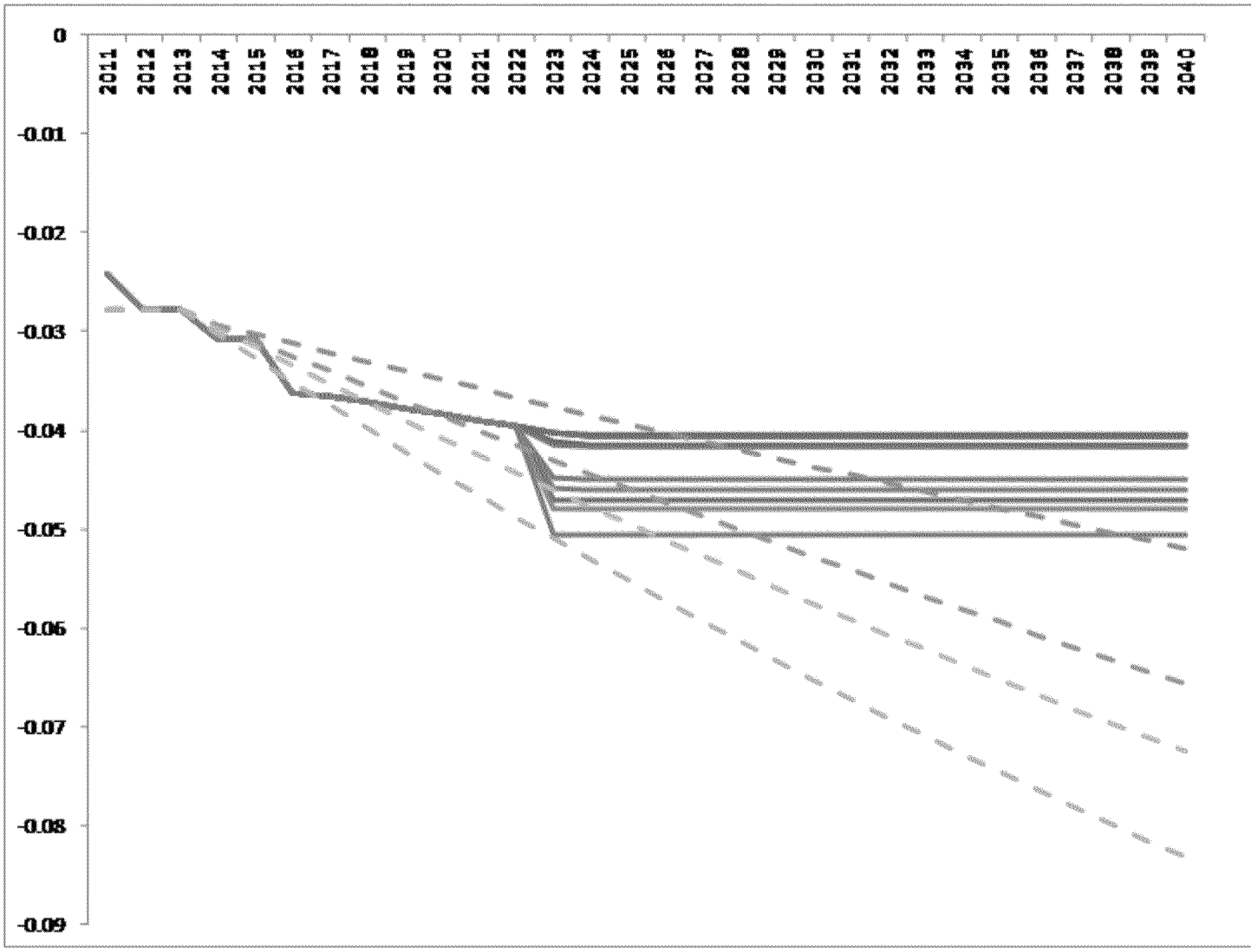
The other chart that I have been thinking about is the absolute FB/CO2 reduction over time. Similar to the 2020CNG plots that CAEP has put together in the past. What would you think of something like that? I think we would need to use the full fleet data for this rather than only the new deliveries.

CJE: Agree that such a chart would need full fleet data. But what are we trying to show? The absolute CO2 or FB saving calculated by the CO2ma is the effectiveness problem, not the answer – it's too high due to the assumptions re lack of technology progress after 2012 (InP Types) and 2016+ (project aircraft) and no new types after 2014. But maybe you have a way forward here.

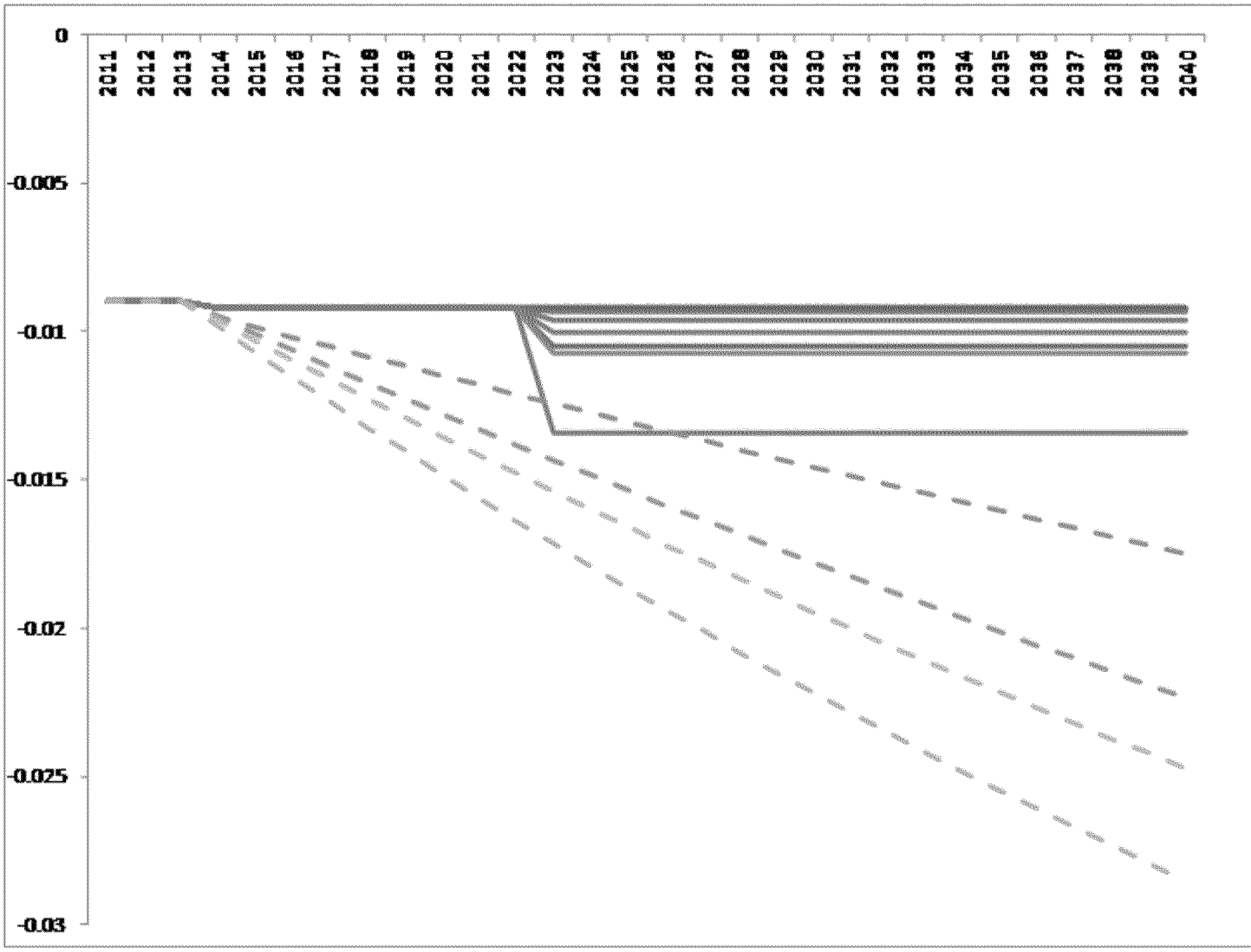
I'm looking forward to seeing the MVmargin chart in more detail. Have you received the official data yet? Are you doing this with a fleet average MV (1 count for each individual aircraft produced that year) or by type (1 count for each type an OEM produces)?

CJE: Its in the updated version of the proposal sent on 4 March (attached). The data won't change but I haven't received the officially formatted data from Ivan yet. Count is based on each aircraft delivery produced in year.

I can produce CB charts if required but for the main group I'm trying to keep it simple. For your info, here is CB11 – which looks sensible:



And CB1 which doesn't looks so sensible:



Other CBs are variations between these two.

Hope this helps. If I have misunderstood, please get back to me.

Cheers

Chris

From: Chris Eyers [mailto:chris@limitedskies.com]
Sent: Wednesday, March 04, 2015 2:23 AM
To: Leggett, Cullen
Subject: RE: Round 2 results query for Effectiveness of the Standard.

Morning Cullen,

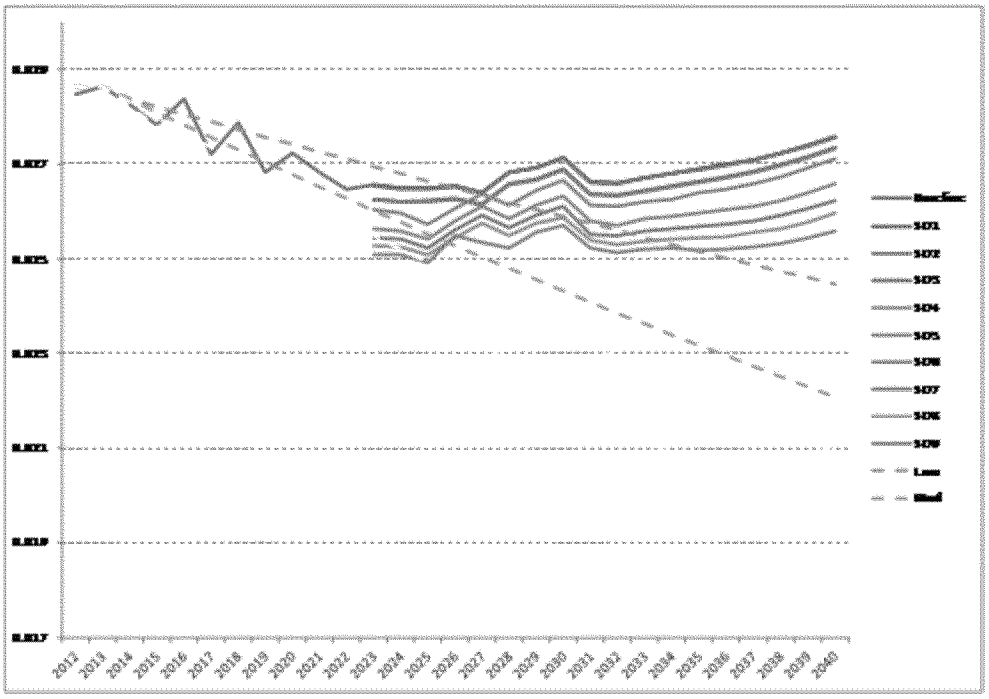
For some reason, Ivan has already done the year-on-year analysis using the data Sathya forwarded. He got the following plot. Assuming it is a correct interpretation, you should get the same answer. Please shout if you don't. I believe it shows the effect of some of the additional constraints used in APMT which affect which aircraft can be delivered year-on-year. The lumpiness in all the years up to 2025 is expected as we have different project and transition types entering/leaving each year. However, the lumps from 2026 to 2030 and the worsening average from 2030 onwards are not expected by me.

If this is indeed the outcome from APMT, I am inclined just to use the AAT MVmargin approach in our effectiveness proposal. I don't want to be distracted by modelling artefacts if we can avoid it.

Hope this helps

Chris

PS For information, he low/med lines are from the fuel burn technology goals analysis



-----Original Message-----
From: Leggett, Cullen [mailto:Leggett.Cullen@epa.gov]
Sent: 03 March 2015 17:37
To: Chris Eyers
Subject: RE: Round 2 results query for Effectiveness of the Standard.

Chris,

I'm glad to see we are on the same page. After reading that exchange, I was thinking we need the year on year changes as well. I think I can derive them from the data he has provided by just looking at the difference between years. I'll ask though.

-----Original Message-----

From: Chris Eyers [mailto:chris@limitedskies.com]

Sent: Tuesday, March 03, 2015 9:59 AM

To: Leggett, Cullen

Subject: FW: Round 2 results query for Effectiveness of the Standard.

Hi Cullen,

For the Part 1 Effectiveness paper (Info for CAEP Members), I would prefer the year on year deliveries FB/ASK as it is more comparable with the goals data. That said we could make some use of the current version, but as I said earlier, we shouldn't put the goals trends on the same plot.

Are you going to ask Sathya for the year-on-year data instead?

Cheers

Chris

-----Original Message-----

From: S.Balasubramania.CTR@dot.gov [mailto:S.Balasubramania.CTR@dot.gov]

Sent: 03 March 2015 15:52

To: ivan.de-lepinay@easa.europa.eu; Leggett.Cullen@epa.gov; Gregg.Fleming@dot.gov; urs.ziegler@bazl.admin.ch

Cc: TThrasher@icao.int; Chris Eyers; Gareth.Horton@ricardo-aea.com; karin@theicct.org; David.Pace@dot.gov; Jacob.Wishart@dot.gov

Subject: RE: Round 2 results query for Effectiveness of the Standard.

Ex. 5 - Deliberative Process

-----Original Message-----

From: DE LEPINAY Ivan [mailto:ivan.de-lepinay@easa.europa.eu]

Sent: Tuesday, March 03, 2015 9:51 AM

To: Balasubramanian, Sathya CTR (VOLPE); Leggett.Cullen@epa.gov; Fleming, Gregg G (VOLPE); urs.ziegler@bazl.admin.ch

Cc: TThrasher@icao.int; chris@LimitedSkies.com; Gareth.Horton@ricardo-aea.com; karin@theicct.org; Pace, David (VOLPE); Wishart, Jacob (VOLPE)

Subject: RE: Round 2 results query for Effectiveness of the Standard.

Ex. 5 - Deliberative Process

Ivan

-----Original Message-----

From: S.Balasubramania.CTR@dot.gov [mailto:S.Balasubramania.CTR@dot.gov]

Sent: 03 March 2015 15:46

To: DE LEPINAY Ivan; Leggett.Cullen@epa.gov; Gregg.Fleming@dot.gov; urs.ziegler@bazl.admin.ch

Cc: TThrasher@icao.int; chris@LimitedSkies.com; Gareth.Horton@ricardo-aea.com; karin@theicct.org; David.Pace@dot.gov; Jacob.Wishart@dot.gov

Subject: RE: Round 2 results query for Effectiveness of the Standard.

Ivan

Ex. 5 - Deliberative Process

Thanks

Sathya

-----Original Message-----

From: DE LEPINAY Ivan [mailto:ivan.de-lepinay@easa.europa.eu]

Sent: Tuesday, March 03, 2015 9:24 AM

To: Balasubramanian, Sathya CTR (VOLPE); Leggett.Cullen@epa.gov; Fleming, Gregg G (VOLPE); urs.ziegler@bazl.admin.ch

Cc: TThrasher@icao.int; chris@LimitedSkies.com; Gareth.Horton@ricardo-aea.com; karin@theicct.org; Pace, David (VOLPE); Wishart, Jacob (VOLPE)

Subject: RE: Round 2 results query for Effectiveness of the Standard.

Sathya,

Ex. 5 - Deliberative Process

Many thanks,

Ivan

-----Original Message-----

From: S.Balasubramania.CTR@dot.gov [mailto:S.Balasubramania.CTR@dot.gov]

Sent: 28 February 2015 15:52

To: Leggett.Cullen@epa.gov; DE LEPINAY Ivan; Gregg.Fleming@dot.gov; urs.ziegler@bazl.admin.ch

Cc: TThrasher@icao.int; chris@LimitedSkies.com; Gareth.Horton@ricardo-aea.com; karin@theicct.org; David.Pace@dot.gov; Jacob.Wishart@dot.gov

Subject: RE: Round 2 results query for Effectiveness of the Standard.

Cullen

Ex. 5 - Deliberative Process

Please review and let us know if you have any questions.

Thanks

Sathya

-----Original Message-----

From: Leggett, Cullen [mailto:Leggett.Cullen@epa.gov]

Sent: Wednesday, February 25, 2015 10:00 AM

To: Balasubramanian, Sathya CTR (VOLPE); ivan.de-lepinay@easa.europa.eu; Fleming, Gregg G (VOLPE); urs.ziegler@bazl.admin.ch

Cc: TThrasher@icao.int; chris@LimitedSkies.com; Gareth.Horton@ricardo-aea.com; karin@theicct.org; Pace, David (VOLPE); Wishart, Jacob (VOLPE)

Subject: RE: Round 2 results query for Effectiveness of the Standard.

Stahya,

Great to hear. Thanks for the update, and thanks for putting this together for us.

Cullen

-----Original Message-----

From: S.Balasubramania.CTR@dot.gov [mailto:S.Balasubramania.CTR@dot.gov]

Sent: Wednesday, February 25, 2015 6:30 AM

To: Leggett, Cullen; ivan.de-lepinay@easa.europa.eu; Gregg.Fleming@dot.gov; urs.ziegler@bazl.admin.ch

Cc: TThrasher@icao.int; chris@LimitedSkies.com; Gareth.Horton@ricardo-aea.com; karin@theicct.org; David.Pace@dot.gov; Jacob.Wishart@dot.gov

Subject: RE: Round 2 results query for Effectiveness of the Standard.

Cullen

Ex. 5 - Deliberative Process

Thanks

Sathya

From: Leggett, Cullen [Leggett.Cullen@epa.gov]

Sent: Monday, February 23, 2015 9:30 AM

To: DE LEPINAY Ivan; Balasubramanian, Sathya CTR (VOLPE); Fleming, Gregg G (VOLPE); urs.ziegler@bazl.admin.ch

Cc: TThrasher@icao.int; chris@LimitedSkies.com; Gareth.Horton@ricardo-aea.com; karin@theicct.org; Pace, David (VOLPE); Wishart, Jacob (VOLPE)

Subject: RE: Round 2 results query for Effectiveness of the Standard.

Sathya, Ivan,

Ex. 5 - Deliberative Process

Cullen

+1 734-214-4514

From: DE LEPINAY Ivan [mailto:ivan.de-lepinay@easa.europa.eu]

Sent: Friday, February 20, 2015 11:44 AM

To: S.Balasubramania.CTR@dot.gov; Gregg.Fleming@dot.gov; urs.ziegler@bazl.admin.ch; Leggett, Cullen

Cc: TThrasher@icao.int; chris@LimitedSkies.com; Gareth.Horton@ricardo-aea.com; karin@theicct.org; David.Pace@dot.gov; Jacob.Wishart@dot.gov

Subject: RE: Round 2 results query for Effectiveness of the Standard.

Ex. 5 - Deliberative Process

Ivan

From: S.Balasubramania.CTR@dot.gov<mailto:S.Balasubramania.CTR@dot.gov> [mailto:S.Balasubramania.CTR@dot.gov]

Sent: 20 February 2015 17:35

To: DE LEPINAY Ivan; Gregg.Fleming@dot.gov<mailto:Gregg.Fleming@dot.gov>; urs.ziegler@bazl.admin.ch<mailto:urs.ziegler@bazl.admin.ch>; Leggett.Cullen@epa.gov<mailto:Leggett.Cullen@epa.gov>

Cc: TThrasher@icao.int<mailto:TThrasher@icao.int>; chris@LimitedSkies.com<mailto:chris@LimitedSkies.com>; Gareth.Horton@ricardo-aea.com<mailto:Gareth.Horton@ricardo-aea.com>;

karin@theicct.org<mailto:karin@theicct.org>;
David.Pace@dot.gov<mailto:David.Pace@dot.gov>;
Jacob.Wishart@dot.gov<mailto:Jacob.Wishart@dot.gov>

Subject: RE: Round 2 results query for Effectiveness of the Standard.

Ivan

Ex. 5 - Deliberative Process

Thanks

Sathya

From: DE LEPINAY Ivan [mailto:ivan.de-lepinay@easa.europa.eu]

Sent: Friday, February 20, 2015 11:27 AM

To: Balasubramanian, Sathya CTR (VOLPE); Fleming, Gregg G (VOLPE); urs.ziegler@bazl.admin.ch<mailto:urs.ziegler@bazl.admin.ch>; Leggett.Cullen@epa.gov<mailto:Leggett.Cullen@epa.gov>

Cc: Ted Thrasher; Chris Eyers; Gareth Horton; Anastasia Kharina

Subject: RE: Round 2 results query for Effectiveness of the Standard.

Sathya,

Ex. 5 - Deliberative Process

Many thanks,

Ivan

From: S.Balasubramania.CTR@dot.gov<mailto:S.Balasubramania.CTR@dot.gov> [mailto:S.Balasubramania.CTR@dot.gov]

Sent: 18 February 2015 17:38

To: Gregg.Fleming@dot.gov<mailto:Gregg.Fleming@dot.gov>;
urs.ziegler@bazl.admin.ch<mailto:urs.ziegler@bazl.admin.ch>;
Leggett.Cullen@epa.gov<mailto:Leggett.Cullen@epa.gov>

Cc: DE LEPINAY Ivan

Subject: RE: Round 2 results query for Effectiveness of the Standard.

Cullen

Ex. 5 - Deliberative Process

Thanks

Sathya

From: Leggett, Cullen [mailto:Leggett.Cullen@epa.gov]

Sent: Tuesday, February 17, 2015 5:16 PM

To: Balasubramanian, Sathya CTR (VOLPE)

Subject: Round 2 results query for Effectiveness of the Standard.

Sathya,

Ex. 5 - Deliberative Process

Thanks for the help.

Cullen

+1 734-214-4514

To: Lindsey, Leah[lindsey.leah@epa.gov]
From: Yen, David
Sent: Mon 3/19/2018 5:44:31 PM
Subject: Fleet Evolution Slides for FAA Review
CO2_FleetEvolution_FAA_031918a.pptx

Hi Leah,

Attached is the updated fleet evolution slides for FAA review. Based on the input from Mike, I

Ex. 5 - Deliberative Process

What do you think? Let me know if you have strong feelings about the approach.

Thanks,

David

To: Mueller, John[mueller.john@epa.gov]; Maeroff, Bruce[Maeroff.Bruce@epa.gov]
From: Yen, David
Sent: Tue 1/30/2018 7:59:46 PM
Subject: ICF Reports and Tech Response Spreadsheet
ICF - EPA Aerospace Industry Characterization_Jan 16 2018.docx
ICF - EPA Aircraft CO2 Cost Assessment_Jan 16 2018.docx
Tech Response Spreadsheet_Jan 16 2018.xlsx

Hi John and Bruce,

Attached please find the ICF tech reports and spreadsheet. Note that column H in "MVdb – PIANO DATA" tab has the ICF Aircraft End-of-Production data we talked about. Let me know if you have any questions.

Best,
David

To: Lindsey, Leah[lindsey.leah@epa.gov]; Gerring, Holly[gerring.holly@epa.gov]
From: Yen, David
Sent: Wed 1/17/2018 9:00:18 PM
Subject: FW: WA 1-15 -- Updated Volumes of ICF Report & Tech Response Spreadsheet
ICF - EPA Aircraft CO2 Cost Assessment_Jan 16 2018.docx
Tech Response Spreadsheet_Jan 16 2018.xlsx
ICF - EPA Aerospace Industry Characterization_Jan 16 2018.docx

From: Manning, Bryan
Sent: Wednesday, January 17, 2018 2:53 PM
To: Amy Doll <adoll@endyna.com>; Viator, Catherine (viator@rti.org) <viator@rti.org>
Cc: Jones, Jason <jasonjones@rti.org>; siddhanti@endyna.com; Mueller, John <mueller.john@epa.gov>; Yen, David <Yen.David@epa.gov>
Subject: WA 1-15 -- Updated Volumes of ICF Report & Tech Response Spreadsheet

Hi Amy,

As we discussed last week (for WA 1-15), attached please find the updated volumes of the ICF report and the updated technology response spreadsheet. All three documents are now dated January 16, 2018, and thus, as you know, the dates in your cover letter to the peer reviewers will need to be revised to this date. These documents are now ready to go to the peer reviewers (when you are ready to send them). Let me know if you have any questions.

Thank you,

Bryan

P.S. Also, you should already have the March 17, 2015 ICF report, but let me know if you misplaced it.

Bryan Manning

U.S. EPA Office of Transportation and Air Quality

Large Marine and Aviation Center

2000 Traverwood Drive

Ann Arbor, MI 48105

(ph) 734-214-4832 (fax) 734-214-4816

manning.bryan@epa.gov

To: Bethan Owen[B.Owen@mmu.ac.uk]
From: Yen, David
Sent: Wed 1/15/2014 8:32:40 PM
Subject: GHG modeling for CO2 standard

Hello Bethan,

Hope all is well with you. I am sorry to miss you in today's modeler's telecon, I was hoping to catch you there. As a matter of fact, I think we should start working together in order to report progress to the modeler's team meetings. From my perspective, we have to first (between now and April) work with MMU validating our model and data processing methodology and then as confidence in our model is better established we can offer ways to complement you and other modeler's work and share some of the workload.

As I explained to you in Washington DC, our modeling approach is to run PIANO offline and generate a set of 50x50 fuel burn matrixes in terms of flight distance and payload. Then use that to compute fleet wide fuel burn by interpolating the fuel burn for a particular flight and sum up all flights for annual global CO2 emissions. The model is designed to be flexible in implementing varieties of high level stringency and model assumptions so that we can evaluate impacts of these assumptions quickly and help answer policy questions and facilitate the decision making process or iterations. We intend to use these 50x50 fuel burn tables in all the near term GHG computations, so the first priority is to validate them against your data. The comparison should be quite straight forward since the underlying models are the same. Currently, we are using PIANO v5.2 and have most of the new project aircraft in our database as well. Our existing 50x50 fuel burn tables simply use the default mission settings in PIANO. If you are using the same default PIANO settings, the comparison will be trivial. But if you are not, harmonizing our PIANO modeling assumptions will be the obvious next step. Since you model is well established in the CAEP world, I think it would be best to let MMU lead the way to set our "common" PIANO model assumptions for the CO2 standard work. So if you don't mind, I would defer to you to suggest the best ways to harmonize our model assumptions. We can work with you to compare our existing data and do some supplementary PIANO runs before finalizing the agreed "common" model assumptions. Note that our PIANO runs are not automated so to regenerate all the fuel burn tables is a big deal and very time consuming for us, but we are willing to rerun our fuel burn tables, if necessary, in order to be harmonized with your fuel burn model. I understand that we don't have to use the same assumptions everywhere but we'd better know the differences and be able to explain the differences before mixing in with other high-level stringency option assumptions.

Let me know what you think and any ideas on where we should start.

Best regards,

David Yen
Assessment and Standards Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency
2000 Traverwood Drive
Ann Arbor, MI 48105

Office Phone: 734-214-4103
Email: yen.david@epa.gov

Message

From: Yen, David [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=865CA449DD0F405A949A635615E68827-YEN, DAVID]
Sent: 1/8/2018 4:10:00 PM
To: Gerring, Holly [gerring.holly@epa.gov]
CC: Lindsey, Leah [lindsey.leah@epa.gov]
Subject: FW: Peer review work assignment (WA 1-15): Documents
Attachments: Aircrft Cost-Technology Rpt_Charge Questions_11-14-17.docx; ICF - EPA 2017 Aircraft CO2 Cost Assessment_11-3-2017.docx; Tech Response Spreadsheet_11-6-7v2.xlsx; ICF - EPA Aerospace Industry Characterization_11-3-2017.docx

Hi Holly,

Per our discussion, please update the spreadsheet (in the attachment) Bryant sent to RTI for peer review.

Ex. 5 - Deliberative Process

Make sure all affected sheets are changed consistently.

Thanks,
David

From: Manning, Bryan
Sent: Tuesday, November 14, 2017 1:43 PM
To: Yen, David <Yen.David@epa.gov>; Lindsey, Leah <lindsey.leah@epa.gov>
Subject: FYI: Peer review work assignment (WA 1-15): Documents

Hi David and Leah, FYI, this morning I sent the below message and attachments (including tech response spreadsheet) to RTI, the contractor facilitating the peer review of the ICF tech/cost report and David's technical report on the inventory. RTI is currently developing the work plan. They received the work assignment late last week. Thanks. Bryan

From: Manning, Bryan
Sent: Tuesday, November 14, 2017 10:35 AM
To: 'Viator, Catherine' <viator@rti.org>
Cc: Amy Doll <adoll@endyna.com>; siddhanti@endyna.com; Mueller, John <mueller.john@epa.gov>
Subject: New peer review work assignment (WA 1-15): Documents

Hi Catherine et al,

It was good to talk with you yesterday. In the 1st attachment, please find the draft charge questions for the first report (to be peer reviewed), *Aircraft CO2 Cost and Technology Refresh and Aerospace Industry Characterization*, in WA 1-15. Let me know if you have any comments on these charge questions.

Ex. 5 - Deliberative Process

Ex. 5 - Deliberative Process

In addition, as you may recall, this report is an update to the March 2015 ICF report. I believe I sent the March 2015 report to you last summer (under WA 0-15). If you would like me to send the March 2015 report to you again, let me know. It is not a problem.

Let me know if you have any questions.

Thank you,

Bryan

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

From: Viator, Catherine [mailto:viator@rti.org]
Sent: Monday, November 13, 2017 10:56 AM
To: Manning, Bryan <manning.bryan@epa.gov>
Subject: new peer review work assignment

Hi Bryan,
We received the new WA last week to continue the aircraft emissions peer review, and we look forward to completing this work! Do you have time for a quick call this morning before noon EST? We just want to ask if the first report is ready for peer review and discuss the schedule.

Thanks!
Catherine

Catherine Viator
Food, Nutrition, & Obesity Policy Research
RTI International
3040 Cornwallis Road
Research Triangle Park, NC 27709

TEL: 919.597.5127
EMAIL: viator@rti.org

Message

From: Yen, David [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=865CA449DD0F405A949A635615E68827-YEN, DAVID]
Sent: 1/5/2018 9:11:16 PM
To: Lindsey, Leah [lindsey.leah@epa.gov]; Gerring, Holly [gerring.holly@epa.gov]
Subject: FW: Materials for Monday's 3:00 briefing with Chris on Aircraft CO2 standards
Attachments: Briefing_Aircraft CO2 Rule DRAFT 1 5 18.pptx

Hi Leah and Holly,

Ex. 5 - Deliberative Process

Thanks,
David

From: Samulski, Michael
Sent: Friday, January 05, 2018 2:37 PM
To: OTAQ Materials <OTAQMaterials@epa.gov>
Cc: Charmley, William <charmley.william@epa.gov>; Manning, Bryan <manning.bryan@epa.gov>; Leggett, Cullen <Leggett.Cullen@epa.gov>; Mueller, John <mueller.john@epa.gov>; Yen, David <Yen.David@epa.gov>; Orlin, David <Orlin.David@epa.gov>; Thrift, Mike <thrift.mike@epa.gov>; Iffland, JoNell <Iffland.JoNell@epa.gov>; Gonzalez, Gail <Gonzalez.Gail@epa.gov>; Lindsey, Leah <lindsey.leah@epa.gov>; Gerring, Holly <gerring.holly@epa.gov>
Subject: Materials for Monday's 3:00 briefing with Chris on Aircraft CO2 standards

Monday's meeting is a pre-brief for our January 17th meeting with Bill Wehrum. The attached file is a draft briefing that we would use with Bill W.

Mike

****
Michael Samulski
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Director, Large Marine and Aircraft Center
1 (734) 214-4532
samulski.michael@epa.gov
****

From: Yen, David
Location: AA-Room-Office-N125-ConfRoom/AA-OTAQ-OFFICE
Importance: Normal
Subject: FW: Aircraft CO2 Rulemaking - Workgroup Meeting Call-in Number: Ex. 6 - Personal Privacy Code: Ex. 6 - Personal Privacy
Start Date/Time: Tue 12/12/2017 6:00:00 PM
End Date/Time: Tue 12/12/2017 7:00:00 PM
Briefing_Aircraft CO2 Rule DRAFT 10-30-17.pptx

FYI.

-----Original Appointment-----
From: Audette, Lucie
Sent: Tuesday, December 12, 2017 9:30 AM
To: Audette, Lucie; Mueller, John; Manning, Bryan; Burch, Julia; Thrift, Mike; Griffiths, Charles; Schillo, Bruce; Dutton, Steven; McDow, Stephen; Birkett, Daniel; Castro, Marina; Aspy, Dale; Russ, Timothy; Farris, Laura; Sarofim, Marcus; Yen, David; Leggett, Cullen; Powell, Alan
Cc: Samulski, Michael
Subject: Aircraft CO2 Rulemaking - Workgroup Meeting Call-in Number: 866-299-3188 Conf. Code:7342144532
When: Tuesday, December 12, 2017 1:00 PM-2:00 PM (UTC-05:00) Eastern Time (US & Canada).
Where: AA-Room-Office-N125-ConfRoom/AA-OTAQ-OFFICE

Dear Workgroup Members,

Thank you for your responses confirming your membership in the Aircraft CO2 Rulemaking workgroup. Since my last e-mail, and prior to the confirmation of Bill Wehrum as OAR's AA, we briefed OAR, OGC, and OP political leadership on November 2 regarding the history of our aircraft work, the planned NPRM Analyses, and the draft rule schedule. The briefing went well, and we are proceeding on refining the rulemaking schedule and developing the underlying analysis and outlines for the preamble and RIA. The briefing which we presented is attached.

As we move forward, John Mueller will assume the duties of workgroup chair as I will be retiring at the end of this year. I have checked your schedules and it appears that most everyone is available to meet on December 12 from 1-2pm. The purpose of this meeting will be to (1) review the briefing attached and answer your questions, (2) provide a status of the analysis work, (3) discuss next steps.

In advance, thank you for your help on this rulemaking. Lucie and John

Workgroup Members –

OTAQ: Workgroup Chair: John Mueller (alternate: Bryan Manning)

Julia Burch

OAP: Marcus Sarofim

OGC: Mike Thrift

OP: Charles Griffiths

Bruce Schillo

ORD: Tim Benner

Steve Dutton

Stephen McDow

Region 2: Dan Birkett (alternate: Marina Castro)

Region 4: Dale Aspy

Region 8: Tim Russ (alternate: Laura Farris)

Message

From: Yen, David [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=865CA449DD0F405A949A635615E68827-YEN, DAVID]
Sent: 7/19/2017 5:16:45 PM
To: Lindsey, Leah [lindsey.leah@epa.gov]; Gerring, Holly [gerring.holly@epa.gov]
Subject: FW: 2nd round of Comments on tech/costs sections of report
Attachments: ICF - EPA - Aircraft CO2 Cost Assessment 2017 - DRAFT 2017-07-14.docx

From: Zimm, Peter [mailto:Peter.Zimm@icf.com]
Sent: Tuesday, July 18, 2017 1:19 AM
To: Manning, Bryan <manning.bryan@epa.gov>
Cc: Yen, David <Yen.David@epa.gov>; Harli, Kent <Kent.Harli@icf.com>; Joaquim R.R.A. Martins <jrram@umich.edu>; Mueller, John <mueller.john@epa.gov>; Leggett, Cullen <Leggett.Cullen@epa.gov>; Maeroff, Bruce <Maeroff.Bruce@epa.gov>; Samulski, Michael <samulski.michael@epa.gov>
Subject: RE: 2nd round of Comments on tech/costs sections of report

Bryan,

Please see attached revised Tech Response report for the peer reviewers. Let me know if you have any questions.

Best regards,

PETER C. ZIMM | Principal | +1.347.843.9746 mobile | peter.zimm@icf.com
ICF | 630 Third Avenue, 11th Floor, New York, NY 10017 USA | icf.com/aviation

Learn how ICF makes big things possible for its clients.

From: Manning, Bryan [mailto:manning.bryan@epa.gov]
Sent: Thursday, July 13, 2017 12:42 PM
To: Zimm, Peter <Peter.Zimm@icf.com>
Cc: Yen, David <Yen.David@epa.gov>; Harli, Kent <Kent.Harli@icf.com>; Joaquim R.R.A. Martins <jrram@umich.edu>; Mueller, John <mueller.john@epa.gov>; Leggett, Cullen <Leggett.Cullen@epa.gov>; Maeroff, Bruce <Maeroff.Bruce@epa.gov>; Samulski, Michael <samulski.michael@epa.gov>
Subject: 2nd round of Comments on tech/costs sections of report

Hi Peter,

See the below message, which I sent back on June 15. I realize that you have been out of the office a fair amount over the last month. Any updates on incorporating the below/attached comments? Any questions or thoughts?

Thanks,

Bryan

****
Hi Peter,

Nice job on the revised version of the tech/costs sections of the report. We are very close. See our general comments in comment bubbles on the first page -- highlighted in yellow. Then see our redline/strikeout comments throughout the report. Also, I have comment bubbles throughout the report, but these comment bubbles are not highlighted in yellow (so be careful to not miss them).

Ex. 5 - Deliberative Process

In addition, I still need to review the industry characterization section, and I will work on that tomorrow.

Let me know if you have any questions or thoughts.

Thank you,

Bryan

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

From: Zimm, Peter [mailto:Peter.Zimm@icf.com]
Sent: Monday, June 12, 2017 1:58 AM
To: Manning, Bryan <manning.bryan@epa.gov>
Cc: Yen, David <Yen.David@epa.gov>; Harli, Kent <Kent.Harli@icf.com>; Joaquim R.R.A. Martins <jrram@umich.edu>; Mueller, John <mueller.john@epa.gov>
Subject: RE: NDA for peer review contract

Bryan,

Attached please find draft tech response report for your review. I believe we've addressed all the comments

Ex. 5 - Deliberative Process

I am in a lot of meetings tomorrow and Tuesday but re-emerge late Tuesday afternoon if you need to talk.

Best regards,

PETER C. ZIMM | Principal | +1.347.843.9746 mobile | peter.zimm@icf.com
ICF | 630 Third Avenue, 11th Floor, New York, NY 10017 USA | icf.com/aviation

Learn how ICF makes big things possible for its clients.

From: Manning, Bryan [mailto:manning.bryan@epa.gov]
Sent: Wednesday, June 07, 2017 11:46 AM
To: Zimm, Peter <Peter.Zimm@icf.com>
Cc: Yen, David <Yen.David@epa.gov>; Harli, Kent <Kent.Harli@icf.com>; Joaquim R.R.A. Martins <jrram@umich.edu>; Mueller, John <mueller.john@epa.gov>
Subject: NDA for peer review contract

Hi Peter,

I talked with the contractor for the peer review today. They confirmed that all the peer reviewers will have a non-disclosure agreement (NDA). Also, if you are still concerned about the tech response spreadsheet, the contractor said that they can easily set up an FTP protected site for the spreadsheet. Are there any more questions or thoughts about providing information to the peer reviewers?

By the way, if you do not mind me asking, how is the 2nd draft of the technology/cost section of the report going? Also, how are things going with the 1st draft of the industry characterization section?

Thank you,

Bryan

Bryan Manning
U.S. EPA Office of Transportation and Air Quality
Large Marine and Aviation Center
2000 Traverwood Drive
Ann Arbor, MI 48105
(ph) 734-214-4832 (fax) 734-214-4816
manning.bryan@epa.gov

From: Yen, David
Location: AA-Room-Office-N66-ConfRoom/AA-OTAQ-OFFICE
Importance: Normal
Subject: FESG-FTG Call
Start Date/Time: Mon 7/24/2017 2:30:00 PM
End Date/Time: Mon 7/24/2017 4:00:00 PM
CAEP 11 Traffic forecast writeup for SG draft 170719.docx
nvPM_SP_Baseline_Combining_CBin_9_10_752017_dmp.pdf

Attached are 2 files that are background for discussion today.

1. Updated report on CAEP/11 traffic forecast for SG
2. Presentation on results of sample problem when combine CBin9 and CB10

Agenda

Ex. 5 - Deliberative Process

Please note the later start time. I may be a few minutes late to start of call because I have a meeting right before the call.

Dial in number: Ex. 6 - Personal Privacy

Conference Code: Ex. 6 - Personal Privacy

Thanks,

Roger

To: Yen, David[Yen.David@epa.gov]; Lindsey, Leah[lindsey.leah@epa.gov]
From: Gerring, Holly
Sent: Wed 2/21/2018 8:01:13 PM
Subject: Updated ppt
CO2_InventoryWork_022118.pptx

There was a change made to the pass/fail status slide at the end so here's the most recent version of the ppt.

-Holly

To: Yen, David[Yen.David@epa.gov]; Lindsey, Leah[lindsey.leah@epa.gov]
From: Gerring, Holly
Sent: Wed 2/21/2018 7:16:25 PM
Subject: RE: Previous presentation materials we used to brief Bill Charmley
CO2_InventoryWork_022118.pptx

Attached is the fleet evolution ppt with the pass/fail status slide updated at the end. I also inserted the references for the non-US, general & turboprop growth rates as a footnote on slide 10.

-Holly

From: Yen, David
Sent: Wednesday, February 21, 2018 12:38 PM
To: Lindsey, Leah <lindsey.leah@epa.gov>; Gerring, Holly <gerring.holly@epa.gov>
Subject: RE: Previous presentation materials we used to brief Bill Charmley

Thanks, Leah. Here is the updated slides for Bill Charmley.

David

From: Lindsey, Leah
Sent: Wednesday, February 21, 2018 11:56 AM
To: Yen, David <Yen.David@epa.gov>; Gerring, Holly <gerring.holly@epa.gov>
Subject: RE: Previous presentation materials we used to brief Bill Charmley

Here are the fleet evolution slides I made. I will add updated plots to the H: drive and let you know when they are up.

Leah

From: Yen, David
Sent: Wednesday, February 21, 2018 9:33 AM
To: Gerring, Holly <gerring.holly@epa.gov>
Cc: Lindsey, Leah <lindsey.leah@epa.gov>
Subject: Previous presentation materials we used to brief Bill Charmley

FYI.

EPA-HQ-2018-004348

Atmospheric Environment 67 (2013) 184–192

Contents lists available at SciVerse ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv

Air quality and public health impacts of UK airports. Part II: Impacts and policy assessment

Steve H.L. Yim [a], Marc E.J. Stettler [b], Steven R.H. Barrett [a,*]

[a] *Laboratory for Aviation and the Environment, Department of Aeronautics and Astronautics, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139, United States*

[b] *Energy Efficient Cities Initiative, Department of Engineering, University of Cambridge, Trumpington Street, Cambridge CB2 1PZ, United Kingdom*

HIGHLIGHTS

- UK airport emissions are estimated for the present-day and 2030 scenarios.
- 2030 Scenarios considered include expanding Heathrow and a new Thames Hub airport.
- A multi-scale approach to assessing air quality impacts of airports is used.
- The air quality and public health impacts of UK airports are estimated.
- A Thames Hub airport results in lower health impacts than Heathrow expansion.

ARTICLE INFO

Article history:
Received 6 September 2012
Received in revised form
11 October 2012
Accepted 12 October 2012

Keywords:
Aviation
Airports
Aircraft
Emissions
Air quality
Particulate matter
Dispersion

ABSTRACT

The potential adverse human health impacts of emissions from UK airports have become a significant issue of public concern. We produce an inventory of UK airport emissions – including emissions from aircraft landing and takeoff operations, aircraft auxiliary power units (APUs) and ground support equipment (GSE) – with quantified uncertainty. Emissions due to more than 95% of UK passenger enplanements are accounted for. We apply a multi-scale air quality modelling approach to assess the air quality impacts of UK airports. Using a concentration-response function we estimate that 110 (90% CI: 72–160) early deaths occur in the UK each year (based on 2005 data) due to UK airport emissions. We estimate that up to 65% of the health impacts of UK airports could be mitigated by desulphurising jet fuel, electrifying GSE, avoiding use of APUs and use of single engine taxiing. Two plans for the expansion of UK airport capacity are examined – expansion of London Heathrow and new hub airport in the Thames Estuary. Even if capacity is constrained, we find that the health impacts of UK airports still increases by 170% in 2030 due to an increasing and aging population, increasing emissions, and a changing atmosphere. We estimate that if Heathrow were to be expanded as per previous UK Government plans, UK-wide health impacts in 2030 would increase by 4% relative to the 2030 constrained case, but this increase could become a 48% reduction if emissions mitigation measures were employed. We calculate that 24% of UK-wide aviation-attributable early deaths could be avoided in 2030 if Heathrow were replaced by a new airport in Thames Estuary because the location is downwind of London, where this reduction occurs notwithstanding the increase in aircraft emissions. A Thames hub airport would (isolated from knock-on effects at other airports) cause 60–70% fewer early deaths than an expanded Heathrow, or 55–63% fewer early deaths than an unexpanded Heathrow. Finally, replacing Heathrow by a Thames Estuary airport combined with emissions mitigation measures would reduce UK-wide aviation-attributable early deaths by 56% in 2030 while increasing aircraft movements, which would represent aviation causing about the same level of adverse health impacts as today in absolute terms. We note that because aviation emissions are included in the EU Emissions Trading Scheme, all options are CO_2-neutral in terms of direct emissions (but not climate-neutral).

2012 Elsevier Ltd. All rights reserved.

* Corresponding author. Tel.: +1 617 452 2550.
E-mail address: sbarrett@mit.edu (S.R.H. Barrett).

1352-2310/$ – see front matter 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.atmosenv.2012.10.017

ED_001734_00032593-00001

EPA-HQ-2018-004348

1. Introduction

1.1. Context

The UK Department for Transport (DfT, 2011) recently forecast that the number of air passengers using UK airports will increase from 211 million passengers per annum (mppa) in 2010 to 335 mppa in 2030 and to 470 mppa in 2050 if current airport runway capacity is maintained. Without runway capacity constraints, the passenger forecasts for 2030 and 2050 are 3% and 11% greater, respectively. Airports in London currently account for 60% of the UK-wide aviation demand. The Greater London Authority (2011) argues that the capacity of London's five primary airports is insufficient to fulfil long-term UK aviation needs. The British government is currently considering various aviation policies to address the airport capacity issue under environmental constraints.

Ambient pollutant concentrations in the proximity of airports are positively correlated with aircraft landing and takeoff (LTO) activities (Hsu et al., 2012). Various studies have investigated the air quality impacts of airport emissions. For example, Carslaw et al. (2006) applied both bivariate polar plots and data filtering techniques to quantify the contribution of aircraft emissions to NO_x concentrations for a network of seven measurement sites close to the Heathrow airport. The results showed that aircraft emissions account for approximately 23% of annual mean NO_x and NO_2 near the airports and <15% 2–3 km downwind of the airport. Carslaw et al. (2012) and CERC (2007) also estimated that emissions of NO_x from Heathrow airport contributed 12–16 μg m ^{3} at Oaks Road, which is a measurement site located at the south boundary of Heathrow airport. Hsu et al. (2012) monitored ultrafine particulate matter and other pollutants in order to correlate airport operations at T.F. Green Airport with airport-vicinity pollutant concentrations. Similarly, Westerdahla et al. (2008) found a positive correlation between aircraft operations and increases in ultrafine particle concentrations at Los Angeles International Airport.

It is known that poor air quality adversely impacts human health (USEPA, 2011). Epidemiological studies have found that long-term exposure to fine particulate matter ($PM_{2.5}$) is associated with increased risk of early death, and such exposure accounts for the majority (>80%) of the health costs of air pollution (USEPA, 2011). Specifically, each μg m ^{3} of long-term exposure results in an increase in all-cause mortality of 1%, with a range of 0.4–1.8% (USEPA, 2011).

Ratliff et al. (2009) employed CMAQ to study the impact of aircraft LTO emissions (i.e. emissions below 3000 ft above ground level) on regional air quality in the United States. The study estimated that aircraft LTO emissions at 325 airports account for ~160 (range: 64–270) annual incidences of PM-related premature mortality in US. Beyond LTO emissions, Barrett et al. (2010) found that aircraft cruise emissions also impact surface air quality and human health. However, the impacts of cruise emissions are hemispheric in nature and are not sensitive to the specific location of emission because emissions occur in high speed westerly winds at ~10 km altitude, where impacts mix zonally.

1.2. Purpose of paper

In this paper, we quantify the regional and local air quality and health impacts due to emissions of current and future UK airport operations, including emissions from aircraft LTO operations, ground support equipment (GSE), and aircraft auxiliary power units (APUs). We assess options for mitigating both present-day and future impacts: (i) desulphurising jet fuel; (ii) electrifying GSE; (iii) widespread use of single engine taxiing; and (iv) use of fixed ground electrical power so as to avoid use of aircraft APUs. We assess future aviation impacts on UK air quality and public health under three scenarios: (i) no capacity increase; (ii) unconstrained growth with a third runway at Heathrow Airport; and (iii) unconstrained growth with Heathrow replaced by a new Thames Estuary hub airport.

2. Methods

Here we provide an overview of the methods employed, which will be described in greater detail in the following subsections. UK aviation emissions are estimated based on Stettler et al. (2011) [Part I] for 2005 to be representative of the present-day, while the future year modelled is 2030. The top 20 UK airports by passenger numbers are accounted for, capturing >95% of passengers. We use a regional chemistry-transport model with multiple nested domains, where a domain encompassing the UK and a higher resolution nested domain capturing 88% of UK aviation-attributable health impacts [defined as "Southern Great Britain" (SGB)] are used to assess aviation's air quality impacts in the UK. Dispersion modelling is used to capture the impact of sub-grid near airport peaks in $PM_{2.5}$ concentrations. Local dispersion and regional scale results are combined with population density data (for the present-day and a future forecast) to produce estimates of aviation-attributable $PM_{2.5}$ exposure. We apply a concentration-response function to estimate early deaths attributable to aviation in each scenario considered, and to estimate the health benefits (expressed as averted early deaths) of emissions mitigation measures. Uncertainties in emissions are estimated and propagated through to uncertainties in health impacts, and an estimate for uncertainties in atmospheric modelling and the concentration-response function is captured. Where mitigation measures are considered, a paired Monte Carlo approach is used so that the resulting uncertainty distribution for averted early deaths does not "double count" uncertainty common to both the baseline and the mitigation scenarios.

2.1. Airport emissions

We use the methods described by Stettler et al. (2011) [Part I] to calculate emissions from aircraft LTO activity, aircraft APUs and GSE at the top 20 UK major airports, ranked by passenger numbers. The location and name of the 20 UK existing airports are shown in Fig. 1 and Table 1, respectively. Emissions totals for each of the scenarios considered are given in the Supporting Information (SI), available in the online version of this paper. Emissions of CO_2, CO, hydrocarbons (HC), NO, NO_2, HONO, SO_2, sulphate, black carbon (BC) and organic carbon (OC) are estimated. For BC and OC – the emissions of which are particularly uncertain – the method proposed in Part I is used for our analysis, but the sensitivity to an alternative method [FOA3 (Wayson et al., 2009)] is also considered.

Aircraft emissions are spatially distributed according to the corresponding phase of the LTO cycle. Specifically, emissions arising from takeoff are assigned to the runways, emissions from taxiing are assigned to the taxiways and terminal areas, emissions from holding are assigned to taxiways near to the end of runways, and emissions from APUs and GSE are assigned to terminal areas. Emissions from the approach phase are distributed assuming a straight 3 (5.5 at London City Airport) glide slope while emissions from takeoff and climb phases up to 3000 ft above field elevation (AFE) are resolved using Standard Departure Charts available through the NATS (NATS, 2012), assuming high, medium and low climb angles of 9.6 , 6.9 and 4.2 for the initial climb phase and 6.9 , 5.5 and 4 for the climb out phase, respectively.

Other airport or airport-attributable emissions are not considered in this study.

ED_001734_00032593-00002

EPA-HQ-2018-004348

Fig. 1. Locations of the 20 UK airports considered in this study represented by their IATA airport codes and the proposed Thames Hub airport in the Thames Estuary (THA). The symbol (○) represents the airports in London, ( ) is for airports outside London, (*) represents THA.

2.1.1. Mitigation strategies

A number of strategies can be employed by airports, airlines and fuel producers to reduce aircraft fuel consumption and/or emissions of air pollutants. These include the provision of fixed electrical ground power (FEGP) and pre-conditioned air to reduce the use of APUs. Similarly, it would be technically possible to electrify all of the airside support vehicles (EPA, 1999). We evaluate these two strategies by eliminating all direct emissions arising from these two sources. In the baseline case, we assume that there is no provision and/or use of FEGP or pre-conditioned air (i.e. APUs are used) and emissions from GSE are calculated using default equipment assignments, as described in Part I. The consequent emissions arising from increased consumption of grid electricity are not accounted for. [We note that from Yim and Barrett, 2012 it can be inferred that the air quality impact of power consumption on the grid is likely lower than the impact of comparable power consumption resulting in local combustion emissions. This is because grid emissions are concentrated at power stations distant from populations and where emissions are elevated due to the stack height and plume buoyancy.] This means that any air quality benefits associated with APU avoidance and GSE electrification strategies calculated here are upper bounds.

We also evaluate single engine taxiing (SET) as a potential mitigation measure as described by Deonandan and Balakrishnan (2010). This involves using one engine on a twin-engine aircraft (or two engines on a four engine aircraft) for the taxi phases of the LTO cycle, while accounting for a 5 min engine warm up period. Thus, SET is only implemented at airports where the departure taxi time exceeds 5 min. The thrust setting of the engine in use is increased above the baseline range of 4–7% to 10% and the taxi time is unchanged. Our baseline scenario assumes no use of SET, therefore the difference between our baseline and SET scenarios represents an upper bound on the benefit of this strategy.

Desulphurisation of jet fuel has been discussed as a potential strategy to reduce the public health impacts of aviation (Barrett et al., 2012). If implemented globally, the fuel sulphur content (FSC) of aviation fuel could potentially be reduced by >97%. The mean FSC in the UK varied between 360 and 640 ppm over the past two decades and was 500 ppm in 2007 (Rickard, 2008). To evaluate this strategy, we set 500 ppm (with an uncertainty range of 300–700 ppm) as the baseline FSC and 10 ppm for the FSC of desulfurised jet fuels (Barrett et al., 2012).

We note that the emissions reductions of desulphurisation of jet fuel equally apply to biomass-derived alternative jet fuels, which have zero sulphur content. Beyond eliminating SO_x emissions, there is empirical evidence that combustion of drop-in biomass-derived alternative jet fuels can result in a reduction in NO_x emissions of 5–10% and of soot emissions by ~80% (Carter, 2012).

2.1.2. UK aviation traffic forecasts

Forecasts for air travel demand in the UK were obtained from the Department for Transport and include two capacity expansion scenarios: (i) constrained, in which no new runway capacity is built, but activity and emissions can still increase to a limited extent; and (ii) unconstrained, in which capacity is allowed to grow without constraint (DfT, 2011). The DfT provided the number of air traffic movements (ATMs) by aircraft type at each UK airport in each scenario in 2030 as a result of an information request. [The DfT stated that their forecasts on an airport-by-airport and aircraft-by-aircraft basis have not been validated as thoroughly as aggregate forecasts and that predicting ATMs at this resolution is uncertain.]

The DfT's forecasts include the introduction of new and planned aircraft models (e.g. A350, B787), updates to existing aircraft (e.g. A320, B737) and the introduction of proposed aircraft types in 2020 that are intended to represent maximum estimated technological gains. As a result, expected technological improvements in fuel efficiency and emissions are accounted for by fleet turnover. Engine emissions and fuel consumption data contained within the ICAO Emissions Databank (ICAO, 2012) are used where possible and estimates are made for engines not currently certified based on the cleanest current technology. For the next generation of aircraft introduced in 2020, fuel efficiency improvements of 19.5–21.5% relative to the baseline aircraft outlined by the DfT are implemented by reducing the engine fuel flow by these values uniformly across all thrust settings. The consequence of this is that emissions, which are a function of fuel flow multiplied by an emissions index

Table 1
The IATA airport code and name of the existing UK airports and the modelling domains they are included in.

IATA code	Airport name	Included in domains
ABZ	Dyce	UK
BFS	Belfast International/Aldergrove	UK
BHD	George Best Belfast City	UK
BHX	Birmingham International	UK & SGB
BRS	Bristol	UK & SGB
CWL	Cardiff	UK & SGB
EDI	Edinburgh	UK
EMA	East Midlands	UK & SGB
GLA	Glasgow International	UK
LBA	Leeds/Bradford	UK
LCY	London City	UK & SGB
LGW	London Gatwick	UK & SGB
LHR	London Heathrow	UK & SGB
LPL	Liverpool John Lennon	UK & SGB
LTN	London Luton	UK & SGB
MAN	Ringway International	UK & SGB
NCL	Newcastle	UK
PIK	Prestwick	UK
SOU	Southampton	UK & SGB
STN	London Stansted	UK & SGB

ED_001734_00032593-00003

EPA-HQ-2018-004348

are similarly reduced. (NO_x emissions indices also change.) We assume the temporal emissions profile of an average day in 2005 for every day in 2030.

In order to compare an expanded Heathrow with the proposed Thames Hub airport, traffic growth at an unconstrained Heathrow in 2030 is transplanted to the location of the proposed airport. The assumption is that traffic at the new airport quickly grows to that of an expanded Heathrow and the details of the transition period have been omitted in favour of a direct comparison between the locations of the aviation activity.

2.2. Background emissions

The current UK background (i.e. non-airport/aviation) emissions are derived from the 2007 National Atmospheric Emissions Inventory (NAEI) with a spatial resolution of 1 km 1 km. The current background emissions over the rest of Europe are derived from the 2007 European Monitoring and Evaluation Programme (EMEP) inventory with a horizontal resolution of 50 km 50 km for area sources and from the European Pollutant Release and Transfer Register (E-PRTR) for point sources. Plume rise for each point source is estimated according to Briggs (1972). The setup is similar to Yim and Barrett (2012).

The background emissions for the future year are projected according to Wagner et al. (2009) and DECC (2010). We use the projection factor of each sector obtained from Wagner et al. (2009) to project the emissions from year 2007 to year 2020. We then project the emissions to year 2030 (relative to 2020) by referring the growth trend shown in DECC (2010) for all species except ammonia, which is forecast to have a marginal change and is thus kept constant. The projection factors are shown in SI.

2.3. Air quality modelling

2.3.1. Meteorological modelling

The Weather Research and Forecasting Model (WRF) version 3.1 is applied to derive meteorological fields for the air quality simulations. Six-hourly ECMWF reanalysis fields for the year 2005 are used for both present-day and future scenarios. (As such, while changing atmospheric composition is accounted for in the 2030 future year, we make no attempt to capture the effect of climate change on aviation's marginal air quality impacts.) The WRF model is applied in a nested mode at 40.5 km, 13.5 km, and 4.5 km horizontal resolution, with domains shown in Fig. 2. The 40.5 km domain (D1) simulates European meteorology; the 13.5 km (D2) domain simulates meteorology for the UK, and the 4.5 km (D3) domain simulates meteorology for which we assign the non-geopolitical term "Southern Great Britain" (SGB). We will find that SGB accounts for 88% of aviation-attributable early deaths in the UK, 88% of aircraft LTO fuel burn and 82–93% of airport emissions (depending on species), so it is an appropriate area to consider in greater detail.

The details of the WRF validation for the UK (D2) domain are discussed in Yim and Barrett (2012). The WRF performance for the SGB (D3) domain is discussed here. WRF is validated with reference to 74 wind stations and 73 temperature stations in SGB as described further in the SI.

A set of standard statistic measures are calculated (see the SI). The averaged indices of agreement of wind speed and temperature are 0.84 and 0.96, respectively. The averaged annual mean biases are +0.34 m s ^{1} for wind speed and 0.23 K for temperature.

2.3.2. Chemistry-transport modelling

We use the regional chemistry-transport model CMAQ to simulate European air quality at a resolution of 40.5 km, with two nested domains to simulate UK and SGB air quality at a resolution of 13.5 and 4.5 km, respectively. GEOS-Chem is applied for 2005 to provide boundary conditions to the CMAQ outermost domain.

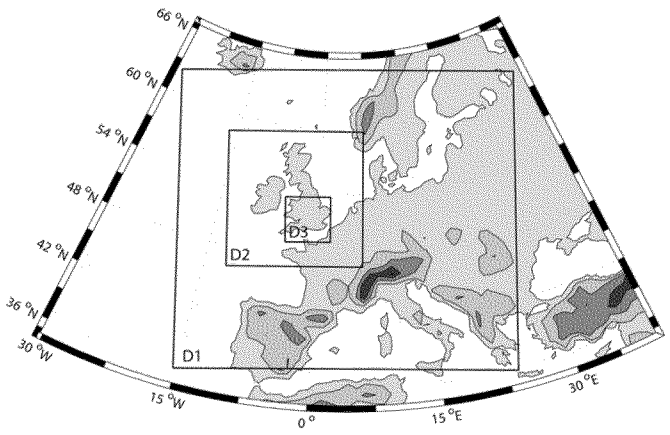


Fig. 2. The domains for the WRF and CMAQ models. The isopleths correspond to terrain elevations from 0 m to 6000 m at an interval of 500 m.

The CMAQ model is validated with UK National Air Quality Archive hourly data from 68 O_3, 88 NO_2 and 48 PM_{10} and 4 $PM_{2.5}$ stations. The CMAQ validation for the UK domain is discussed in Yim and Barrett (2012) and in the SI for the SGB domain, from which nominal correction factors are estimated with uncertainty ranges. In both cases CMAQ underestimates $PM_{2.5}$ concentrations by ~20%, which is accounted for in our treatment of uncertainty in air quality results.

2.3.3. Dispersion modelling

CMAQ models pollutant concentrations at the regional scale, and so does not provide fine-scale variation of concentrations in the proximity of airports. To capture the localised air quality impact of airport emissions, we apply a multi-scale approach. CMAQ is used to simulate regional pollutant concentrations (at a 13.5 km or 4.5 km resolution depending on domain), local-scale dispersion modelling is applied to estimate near-airport PM concentrations at a nominal 100 m resolution, and the results are combined using the Isakov et al. (2007) mass-conserving scheme. These "hybrid" results capture the local peaks in primary PM while also accounting for the formation of secondary PM with increasing distance from airports.

At the local scale, area sources are used to represent runways, taxiways and terminal areas, where the full used area of each surface was used to represent the emissions source. These were defined manually for the 20 UK airports using Google Earth , where a local coordinate system was defined for each airport relative to the CMAQ Lambert conformal grid.

Because long-term dispersion modelling of multiple area sources using tools such as AERMOD is computationally expensive, local scale dispersion modelling is conducted using the rapid approaches described by Barrett and Britter (2008, 2009) and implemented for the US by Lee (2012) as the Rapid Dispersion Code (RDC). RDC is a way of mapping point-source dispersion calculations (the parameterization) to area sources semi-analytically. The process increases the speed of dispersion calculations for complex multi-area source scenarios such as airports by 99.5% while introducing an error in mean concentration of ~5% (Lee, 2012).

AERMOD (Cimorelli et al., 2004), using meteorological data processed by AERMET, is used to provide the parameterization [see Barrett and Britter, 2008, 2009] of dispersion from a point source required by RDC for area source calculations. The upper sounding

ED_001734_00032593-00004

EPA-HQ-2018-004348

and surface meteorological data for 2005 are from the NCAS British Atmospheric Data Centre and UK Meteorological Office, respectively (UKMO, 2006a,b). The airport emissions are consistent with those input to the CMAQ simulations. Calculated local concentrations are sensitive to the chosen surface roughness length, z_0. Di Sabatino et al. (2007) showed that $z_0 = 0.2$ m was representative for Heathrow and this value has been applied for all airports, although uncertainty remains over its value.

2.3.4. Integration of regional and local dispersion scales

We integrate the CMAQ results with the RDC results according to the method developed in Isakov et al. (2007) to capture both regional and local concentration contributions. The hybrid concentration of $PM_{2.5}$ is given by

$$C = C_{RDC} + C_{CMAQ} \quad \overline{C_{RDC}},$$

where $\overline{C_{RDC}}$ is a CMAQ grid cell spatial average (Isakov et al., 2007; Lee, 2012). In this way the scheme neither creates nor destroys mass in the regional CMAQ results, and only serves to move around mass such that concentrations peak near airports, rather than being spatially averaged across the CMAQ grid cells.

2.3.5. Accounting for plume dynamics

Analysis by Barrett (2009) indicates that directly applying passive dispersion models such as AERMOD results in an over-prediction of aircraft-attributable pollutant concentrations because AERMOD does not account for the additional mixing caused by aircraft exhaust plume mixing and buoyancy. Barrett (2009) estimated that accounting for these factors reduce pollutant concentrations in the near-field (only) attributable to aircraft by ~40%. We account for this in our uncertainty method by applying a nominal multiplier to RDC results of 0.6 with an uncertainty range of 0.5–1.0, where 1.0 represents the upper bound in which jet mixing and buoyancy do not serve to reduce pollutant concentrations relative to a passive ground-level source.

2.4. Health impacts

Epidemiological studies show an association between long-term exposure to fine particular matter (i.e. $PM_{2.5}$) and risk of premature mortality, with the likelihood of a causal link estimated at ~90% (Ostro, 2004; Pope and Dockery, 2006; USEPA, 2006; Lewtas, 2007; Pope et al., 2002; Laden et al., 2006). ~80% of monetized health impacts due to air pollution are thought to be captured by assessing long-term $PM_{2.5}$ exposure (USEPA, 2011). Thus, we focus on long-term exposure to $PM_{2.5}$ and the corresponding increase in risk of early death, considering BC, (primary) OC, nitrate, ammonium and sulphate (but not secondary organic) aerosol.

We apply a concentration-response function (CRF) to estimate the increase in early deaths attributable to the aircraft-related emissions and associated $PM_{2.5}$ exposure. The method described in Barrett et al. (2012) is used, in which the CRF reported by a U.S. EPA expert elicitation study – a 1% (uncertainty range: 0.4–1.8%) increase in annual all-cause mortality per $\mu g\ m^{3}$ increase in annual average $PM_{2.5}$ exposure (USEPA, 2011) – is transferred to other countries by assuming $PM_{2.5}$ exposure-related premature mortalities are due to cardiopulmonary diseases and lung cancer. The results are similar to an earlier EU-based study (Cooke et al., 2007).

The $PM_{2.5}$ concentrations for each scenario are attributed to the difference of two simulations (discussed in section 2.5). The National Trip End Model (NTEM) 6.2 population data is used for the calculation of exposure (DfT, 2011b) in the current and future scenarios. The fraction of the British population over 30 years of age for 2005 and 2030 taken from the Office for National Statistics (2009) are 62.9% and 64.9%, respectively. The NTEM 6.2 data has also been corrected for the estimated fraction of the population living in communal residences according to the NTEM Guidance (DfT, 2011b) with the 2020 value used for 2030. Population data in Northern Ireland is from the Gridded Population of the World (GPWv3) at a 2.5′ resolution (GPWv3, 2004). No account has been taken of the impact of airport expansion or construction on population. We estimate the effect of changing population demographics on relative risk of early death by accounting for the aging of the population per the ONS population forecasts, while assuming the baseline mortality rates due to cardiopulmonary diseases and lung cancer remains the same for each age bracket. This implies that our estimates capture the effect of an increasing and aging population, but neglect the potentially changing cardiopulmonary disease and lung cancer mortality rates for a given age group.

2.5. Scenarios

The scenarios considered in this study are summarized in Table 2. Regional health impacts due to current airport emissions for the 20 largest airports in the UK by passenger numbers provide a present-day aviation scenario (1), where the difference (1-A) in Table 2 provides the impact of aviation in the present-day. We also estimate the contribution of London airports (London Heathrow, London Gatwick, London Stansted, London Luton and London City) to regional health impacts in the UK (2). Four scenarios evaluate various mitigation strategies – desulphurisation of jet fuel (3), single engine taxiing (4), electrification of ground support equipment (5) and no use of auxiliary power units (6).

Thereafter, we focus our study on the Southern Great Britain domain. Two scenarios, including all the major airports in SGB, are representative of present-day operations (7) and present-day operations with all aforementioned mitigation strategies employed at all SGB airports (7m).

Three future UK airport scenarios are evaluated for the year 2030: a scenario based on DfT constrained air traffic projections with no additional runways (8) and an unconstrained air traffic projection, including a third runway at London Heathrow (9). We also consider the case where Heathrow traffic and emissions are

Table 2
The list of scenarios assessed in this study.

Scenario	Description	Domain	Year
A	Background (the emissions of UK major airports are removed)	UK	2005
1	Major UK airports	UK	2005
2	Only London airports	UK	2005
3	Ultra-low Sulphur Jet Fuel	UK	2005
4	Single Engine Taxiing	UK	2005
5	Electrifying Ground Support Equipment	UK	2005
6	No Use of Auxiliary Power Units	UK	2005
B	Background (the emissions of UK major airports are removed)	SGB	2005
7	Major airports in Southern Great Britain	SGB	2005
7m	Major airports in Southern Great Britain with all mitigation measures	SGB	2005
C	Future background	SGB	2030
8	No expansion of London Heathrow (constrained growth)	SGB	2030
9	Expansion of London Heathrow (unconstrained growth)	SGB	2030
10	Replacement of Heathrow by a new airport in the Thames Estuary (unconstrained growth)	SGB	2030
9m	Expansion of London Heathrow with all mitigation measures	SGB	2030
10m	A new airport in the Thames Estuary with all mitigation measures	SGB	2030

ED_001734_00032593-00005

EPA-HQ-2018-004348

transplanted to a replacement Thames Estuary hub airport under the DfT unconstrained forecast (10). This scenario is representative of a proposed Thames Estuary hub airport (Forster + Partners et al., 2012). The Thames Estuary hub airport is assumed to be located at 51.456 latitude, 0.689 longitude. The final two scenarios represent the implementation of all mitigation strategies discussed in section 2.1.1 at all UK airports in the unconstrained traffic scenarios, both with a third runway at Heathrow (9m) and the proposed Thames Estuary hub airport (10m).

2.6. Uncertainty assessment

We follow an uncertainty approach continuing from Part I and similar to Yim and Barrett (2012) or Barrett et al. (2012). Uncertainties related to emissions, atmospheric modelling, and the concentration-response function are approximately accounted for using a Monte Carlo approach, in which nominal results are multiplied by random draws from triangular probability distributions (defined by low, nominal, high multipliers). When scenarios are being compared – for example a mitigation measure versus a baseline case – a paired Monte Carlo approach is used so that uncertainty common to both is not "double counted" and the resulting distribution represents the uncertainty in the marginal effect of the mitigation measure. The uncertainty distributions applied are discussed in the SI. The uncertainty in CRF is represented by (0.3, 1, 1.7). The uncertainty factors for air quality model $PM_{2.5}$ concentrations are (0.91, 1.24, 1.46) for CMAQ, (0.5, 1, 1.5) for AERMOD and (0.9, 1, 1.1) for RDC (where this represents the additional uncertainty in using the rapid dispersion approach over AERMOD's 50% uncertainty). The potential decrease in concentrations due to aircraft plume mixing and buoyancy is accounted for by a factor with distribution (0.5, 0.6, 1) applied to local-scale results. [This is not equivalent to reducing airport emissions as the Isakov et al. (2007) method conserves mass – so accounting for plume dynamics mitigates the extent to which RDC causes near-airport peaks that would otherwise be missed by CMAQ.] Each aircraft and associated emissions species has a species-specific uncertainty distribution from Part I. Results for premature mortality calculations are given as a mean with 90% confidence interval, while concentration plots are nominal results from simulations.

It is noted that the differential toxicity of $PM_{2.5}$ species is not considered, which is likely a significant unquantified uncertainty (Levy et al., 2012), nor is the possibility of no causal link between $PM_{2.5}$ exposure and increased risk of early death.

3. Results

3.1. Emissions

Selected emissions results are summarised in Table 3. Detailed emissions results for all scenarios are given in the SI and uncertainty estimates can be found in Part I.

3.2. Air quality

Fig. 3(a) shows the annual average UK aviation-attributable ground level $PM_{2.5}$ concentration in 2005 from CMAQ (scenarios 1-A). The $PM_{2.5}$ peaks are associated with the major UK airports, where the highest peak (0.31 μg m^{-3}) accounts for London Heathrow, while the second peak (0.14 μg m^{-3}) represents London Gatwick. (Note that these peaks are from CMAQ regional scale results – local-scale RDC results are shown graphically in the SI.)

We estimate that UK aviation emissions result in a population-weighted $PM_{2.5}$ exposure of 0.017 μg m^{-3} using 2005 data. In Greater London, the population-weighted $PM_{2.5}$ due to UK aviation emissions is 0.044 μg m^{-3}, of which 93% is attributable to the London airports (scenarios 2-A). Fig. 3 also depicts the annual average ground level black carbon and nitrate concentrations due to the UK airports emissions. BC and nitrate account for 30% and 29% of UK-wide aviation emissions-attributable $PM_{2.5}$ exposure, respectively, resulting in the highest contributions compared to those of other PM species (OC: 16%; sulphate: 12%; ammonium: 13%). In Greater London, the nitrate proportion decreases to 17%, while that of black carbon increases to 39% (OC: 19%; SO_4^{2-} 15%; NH_4^+: 10%). These results highlight the localized impacts of black carbon around the airports.

We find that applying AERMOD and RDC to capture sub-grid variability results in a 25–31% increase in aviation-attributable $PM_{2.5}$ exposure depending on domain and year. This increase is approximately halved when the plume dynamics corrections are accounted for. Fig. 4 shows the average aviation emissions-attributable $PM_{2.5}$ concentration and exposure as a function of distance from each airport, averaged over the 20 major UK airports. Also shown is the population in each 500 m ring as a function of distance, averaged over all airports considered. It can be seen that while the aviation-attributable $PM_{2.5}$ concentration decreases, the increasing population exposed with increasing distance results in a relatively slower decline in airport-related exposure in each ring with distance (although the exposure for any person decreases according to the concentration decay).

We note that the BC and OC emissions methodology developed in Part I results in higher primary PM estimates than FOA3 [described in Part I]. Applying FOA3 emissions (and linearly scaling BC and OC concentrations) to quantify the sensitivity of results to the emissions methodology, we find that aviation-attributable $PM_{2.5}$ exposure decreases by 23%, where sub-grid variability and plume dynamics are accounted for.

Table 3
Airport emissions (in g) for selected scenarios considered. Emissions include aircraft LTO, GSE, and APU activity.

Scenario	Baseline		Baseline		Constrained		Unconstrained	
Domain	UK		SGB		SGB		SGB	
Year	2005		2005		2030		2030	
Fuel burn	7.71	10^{11}	6.77	10^{11}	9.90	10^{11}	1.05	10^{12}
CO_2	2.41	10^{12}	2.12	10^{12}	3.11	10^{12}	3.31	10^{12}
NO_x	1.02	10^{10}	8.94	10^{9}	1.56	10^{10}	1.62	10^{10}
CO	1.17	10^{10}	1.05	10^{10}	9.74	10^{9}	1.08	10^{10}
HC	1.78	10^{9}	1.64	10^{9}	8.61	10^{8}	9.30	10^{8}
SO_2	7.27	10^{8}	6.40	10^{8}	9.35	10^{8}	9.96	10^{8}
SO_4	2.65	10^{7}	2.33	10^{7}	3.40	10^{7}	3.62	10^{7}
BC	2.09	10^{8}	1.81	10^{8}	2.63	10^{8}	2.72	10^{8}
OC	6.46	10^{7}	5.30	10^{7}	7.72	10^{7}	7.94	10^{7}

3.3. Present-day health impacts and mitigation measures

Table 4 summarises results for the present-day baseline health impacts, where results account for plume, local and regional scale contributions. Major UK airport emissions result in 110 (90% CI: 72–160) early deaths per year. Assuming an average loss of 12 life years per air quality related premature mortality (COMEAP, 2010), this is equivalent to ~1300 life years lost. UK airport emissions' impacts on public health are ~45 times smaller than those of UK road transport, and ~37 times smaller than the impact of non-UK EU combustion emissions on UK public health (Yim and Barrett, 2012). Using the same monetization approach of Yim and Barrett (2012), this is equivalent to £45–450 million/year in damage to the UK economy, which – for comparison – represents 0.4–4% of the

ED_001734_00032593-00006

EPA-HQ-2018-004348

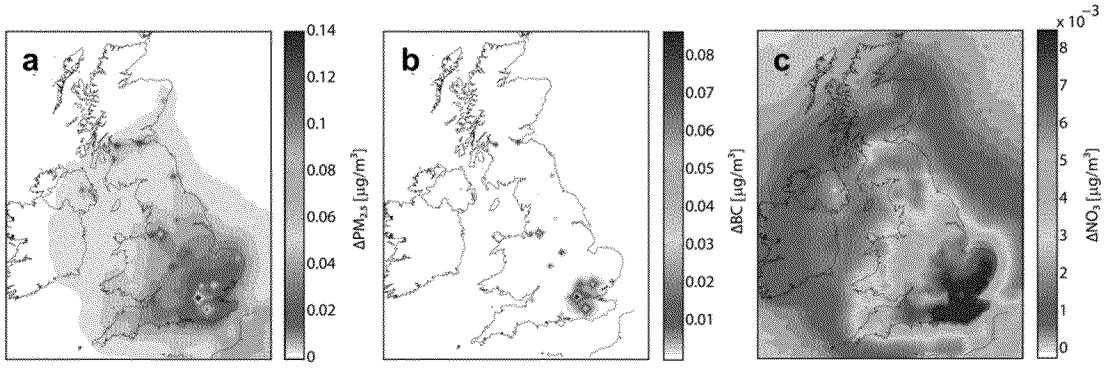


Fig. 3. The annual average ground level $PM_{2.5}$ concentration (μg m ^{3}) due to the emissions from the 20 major UK airports in 2005: (a) total $PM_{2.5}$; (b) BC only; and (c) nitrate only.

estimated £11.4 billion in benefits aviation contributes (Oxford Economic Forecasting, 2006).

The five London airports cause 70% of the UK airport emissions-attributable early deaths, consistent with their accounting for ~70% (62–83% depending on species) of UK airport emissions. 30% of the health impacts of UK airports occur in Greater London.

Approximately 92 early deaths per year are estimated to occur within the higher resolution SGB modelling domain as a whole, equivalent to 84% of the UK-wide health impacts. The estimate for early deaths in Greater London due to UK aviation emissions is 21% higher with the SGB domain, likely due to the higher resolution of CMAQ. Approximately one third of aviation-attributable early deaths occur in Greater London, and in particular aircraft emissions result in ~31 early deaths per year within 20 miles (32 km) of Heathrow.

Table 5 shows the estimated reduction in aviation-attributable early deaths per year for each of the mitigation measures considered. For the SGB domain we estimate that the mitigation measures combined could avert 57% of the health impacts of UK aviation. In the UK as a whole the figure is 65% and in Greater London we estimate a reduction potential of 50%. We note that for the SET, APU and GSE measures, the results represent the maximum mitigation potential. This is because the baseline scenario assumes that SET is not used, APUs are routinely used, and in the mitigation scenario for electrification of GSE the impact of increased grid electricity usage is not accounted for. In the case of desulphurising jet fuel, the baseline average FSC considered is uncertain (range: 300–700 ppm), while the ultra-low sulphur FSC is fixed at 10 ppm, consistent with ULS diesel in the EU.

To approximate the potential health impacts reduction that would be associated with widespread use of biomass-derived alternative jet fuels, we recall that 30% of aviation-attributable population exposure to $PM_{2.5}$ in 2005 is BC using the method of Part I, and that all SO_x and ~80% of BC emissions may be averted. This implies that widespread use of biomass-derived alternative jet fuels would avert ~51 early deaths per year, where the effect of the potential reduction in NO_x is not accounted for and the figure results from adding the reduction associated with desulphurising jet fuel to a linearly scaled reduction in aviation-attributable BC. Alternatively scaling results to an 80% reduction in BC emissions estimated by the FOA3 methodology, ~26 early deaths per year would be averted.

3.4. Future scenarios

Future scenarios are assessed in the SGB domain only, so are expected to capture >80% of UK-wide impacts (inferring from the present-day analysis result). Our baseline for comparison is the DfT constrained growth scenario, for which we estimate that aviation emissions will result in 250 (95% CI: 200–390) early deaths per year in 2030, of which ~96 are in Greater London. This is an increase of 170% for the SGB domain relative to 2005. Factors contributing to this include a 27% increase in baseline cardiopulmonary and lung cancer mortality rates due to an aging population, a 59% increase air passengers (even in the constrained scenario), and a 17% increase in population. As 1.27 1.59 1.17 = 2.36, this implies a residual of +15%. If instead of the increase in air passengers, the increase in fuel burn (+46%) or NO_x (+74%) were to be used, the residual would be 25% or 5%, respectively. We suggest this residual is due to the changing background atmosphere, where non-aviation emissions decrease in general – except ammonia – which will lead to greater free ammonia for secondary ammoniated

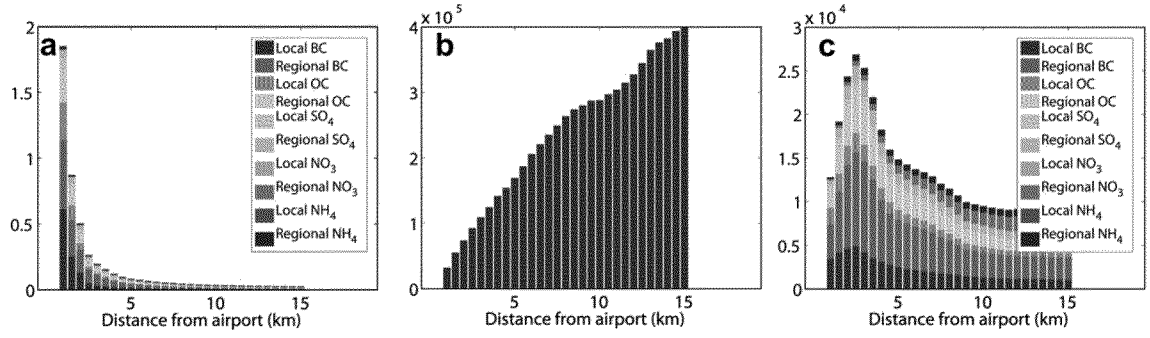


Fig. 4. (a) The mean $PM_{2.5}$ concentration (μg m ^{3}) attributable to aviation emissions in 2005 as a function of distance from all airports, (b) the average population in each 500 m ring at increasing distances from UK airports, and (c) the population exposure (people-μg m ^{3}) in each 500 m ring at increasing distances from UK airports. If population density and $PM_{2.5}$ concentrations were axisymmetric about all UK airports the schematic multiplication (a) (b) = (c) would be exact. Components from RDC (local) and CMAQ (regional) models are shown.

ED_001734_00032593-00007

EPA-HQ-2018-004348

Table 4
Central estimates for early deaths per year in the UK and Greater London due to airport emissions in 2005, with 90% confidence intervals.

Emissions included	Domain	UK early deaths	Greater London early deaths
Major UK airports	UK	110 (72,160)	33 (20,47)
London airports	UK	77 (46,110)	24 (16,35)
Major airports in SGB	SGB	92 (69,140)	40 (30,61)

sulphate and nitrate PM formation due to aircraft NO_x and SO_x emissions.

Table 6 shows our estimated changes in early deaths in SGB in 2030 relative to two baseline scenarios: (i) constrained growth and (ii) unconstrained growth with additional capacity at LHR. In these scenarios we do not account for any change in the spatial distribution of population due to the replacement of Heathrow by a new Thames Estuary hub airport.

We find that applying mitigation measures to all airports would reduce airport emissions-attributable early deaths in 2030 by ~110 relative to a baseline of constrained growth (or ~120 relative to unconstrained growth), which represents a 44% (or 48%) reduction in health impacts.

Comparing an unconstrained growth scenario where a Thames Estuary hub airport has replaced Heathrow to a constrained Heathrow scenario, we find that the Thames hub scenario results in 24% fewer premature mortalities in the SGB domain (due to all SGB airport emissions). This is consistent with: (i) its greater distance from the Greater London population centre, and (ii) its being downwind of London much of the time instead of upwind (given the prevailing south-westerly winds). Using the same constrained Heathrow baseline, a Thames hub scenario with all airports applying mitigation measures would result in 56% fewer early deaths in the SGB domain. In this case the number of premature mortalities in 2030 due to UK aviation would increase by ~20% instead of ~170% as would be the case by neither expanding capacity nor mitigating emissions.

3.5. Hub-specific airport impact

We note that under the expansion scenarios, emissions at all airports change. For example, relative to the 2030 constrained scenario, both an expanded Heathrow and a Thames hub results in a UK-wide increase in fuel burn of 6%. At LHR or THA the increase is 34% (relative to a constrained LHR), while at the remaining London airports fuel burn is estimated to decrease by 12% because additional flights use the hub airport. We have therefore not focused on detailed scenarios related to individual airports, because such results would not represent consistent UK aviation scenarios. However, estimates for the hub-specific health impacts are provided. In particular, we estimate (see SI) that a Thames hub would result in airport-specific health impacts in 2030 that are 60–70% lower than expansion of London Heathrow, and 55–63% lower than an unexpanded Heathrow.

Table 5
Estimated number of averted early deaths per year due to each mitigation measure considered (and all together) with 90% confidence intervals. 2005 Data is used.

Mitigation measure	Domain	UK early deaths averted	Greater London early deaths averted
Ultra-low sulphur jet fuel	UK	18 (11,28)	5 (3,8)
Single engine taxiing	UK	12 (7,18)	3 (2,5)
Electrification of GSE	UK	31 (19,49)	7 (4,11)
No APU use	UK	11 (7,16)	2 (2,4)
All of above	SGB	52 (38,82)	20 (14,30)

Table 6
Estimates for changes in the number of early deaths per year in the SGB domain due to airport emissions in 2030, with 90% confidence intervals. The baseline used for the paired Monte Carlo calculations is indicated.

2030 Scenario	ΔSGB early deaths (baseline: 2030 with constraints)	ΔSGB early deaths (baseline: 2030 expanded Heathrow)
Expansion of London Heathrow	+11 (8,20)	0
Replacement of Heathrow by a new Thames Estuary airport	60 (44, 94)	66 (51, 94)
Expansion of London Heathrow with all mitigation measures	110 (81, 170)	120 (91, 190)
A new Thames Estuary airport with all mitigation measures	140 (110, 230)	160 (110, 240)

4. Conclusions

UK airport emissions cause ~110 early deaths per year in the UK today. Due to changing population demographics, increasing air passenger demand, and a forecast cleaner atmosphere, this is projected to rise to ~250 early deaths per year by 2030 under a constrained growth scenario (i.e. no airport expansion or new builds).

Near-term mitigation measures – including desulphurisation of jet fuel, electrification of ground support equipment, widespread use of single engine taxiing, and provision and use of fixed ground electrical power, have the potential to offset more than half of the health impacts of airport emissions, although likely benefits relative to current practice may be lower. However, longer-term widespread use of biomass-derived alternative jet fuels could further increase the mitigation potential.

If the UK chooses to expand capacity by building a new runway at Heathrow we estimate a 4% increase in health impacts of UK aviation relative to the constrained 2030 baseline. Alternatively, if Heathrow is replaced by a Thames Estuary hub airport, health impacts are projected to decrease by a quarter relative to the constrained 2030 baseline. This is primarily because of the position of the proposed airport. The health impact of emissions at the Thames Estuary hub airport in isolation is estimated to be 60–70% lower than the equivalent emissions at an expanded Heathrow.

Expansion of Heathrow with all aforementioned mitigation measures are employed could reduce health impacts in 2030 by 48%, while a Thames Estuary hub airport with all mitigation measures employed could reduce health impacts by 56%. In both cases the baseline for comparison is the constrained (Heathrow without expansion), unmitigated 2030 scenario.

We note that non-aviation (ground access, local heat and power, etc) emissions have not been accounted for in this analysis. In the Thames hub vs. Heathrow expansion comparison, such emissions may be higher or lower (for example, if an efficient rail link were created). Additionally, lifecycle emissions associated with construction, and the potential health benefits of reduced road traffic around Heathrow have not been accounted for.

Because aviation emissions are included in the EU Emissions Trading Scheme, which has a fixed number of emissions permits for all included sectors, both expansion options considered are CO_2-neutral in terms of direct aviation CO_2 emissions. However, high altitude aviation non-CO_2 emissions are estimated to result in a different – and likely greater – climate impact relative to the same emissions at ground level (e.g. Dorbian et al., 2011). This implies that while unconstrained aviation growth options are theoretically CO_2-neutral as far as aircraft emissions are concerned, they are not climate-neutral. To illustrate, if we take the (Dorbian et al., 2011) 3% discount rate net present value-based marginal damage ratio for aviation's total climate impacts of 1.8 relative to

ED_001734_00032593-00008

EPA-HQ-2018-004348

CO_2 (where the uncertainty range is 0.6–2.5 for this discount rate choice), we would infer that the net effective climate impacts would be 80% of the increase in aviation CO_2 emissions (with an uncertainty range of −40% to +150%), assuming the ETS does not introduce a non-unity multiplier for aviation CO_2 emissions.

Acknowledgements

The authors express their thanks to the UK Department for Transport for supplying detailed future air traffic forecasts from UK DfT (2009). Funding was from MIT and EPSRC.

Appendix A. Supplementary material

Supplementary material related to this article can be found at http://dx.doi.org/10.1016/j.atmosenv.2012.10.017.

References

Barrett, S.R.H., 2009. The air quality impacts of aviation. PhD thesis, University of Cambridge. (Extended version of cited work also submitted: Barrett, S.R.H., Britter, R.E., Waitz, I.A., 2012. The impact of aircraft plume dynamics on airport local air quality.).

Barrett, S.R.H., Britter, R.E., 2008. Development of algorithms and approximations for rapid operational air quality modelling. Atmospheric Environment 42, 8105–8111.

Barrett, S.R.H., Britter, R.E., 2009. Algorithms and analytical solutions for rapidly approximating long-term dispersion from line and area sources. Atmospheric Environment 43 (20), 3249–3258.

Barrett, S.R.H., Britter, R.E., Waitz, I.A., 2010. Global mortality attributable to aircraft cruise emissions. Environmental Science and Technology 44, 7736–7742.

Barrett, S.R.H., Yim, S.H.L., Gilmore, C.K., Murray, L.T., Tai, A.P.K., Kuhn, S.R., Jacob, D.J., Yantosca, R.M., Byun, D., Ngan, F., Li, X.S., Ashok, A., Koo, J., Levy, J., Dessens, O., Balasubramanian, S., Fleming, G.G., Wollersheim, C., Malina, R., Pearlson, M.N., Stratton, R.W., Arunachalam, S., Binkowski, F.S., Hileman, J.I., Waitz, I.A., 2012. Public health, climate and economic impacts of desulfurizing aviation fuel. Environmental Science and Technology 46 (8), 4275–4282.

Briggs, G.A., 1972. Discussion on chimney plumes in neutral and stable surroundings. Atmospheric Environment 6, 507–510.

Carslaw, D.C., Beevers, S.D., Ropkins, K., Bell, M.C., 2006. Detecting and quantifying aircraft and other on-airport contributions to ambient nitorgen oxides in the vicinity of a large international airport. Atmospheric Environment 48 (28), 5424–5434.

Carslaw, D.C., Williams, M.L., Barratt, B., 2012. A short-term intervention study – impact of airport closure due to the eruption of Eyjafjallajökull on near-field air quality. Atmospheric Environment 54, 328–336.

Carter, N., 2012. Environmental and economic assessment of microalgae-derived jet fuel. Master of Science thesis, Massachusetts Institute of Technology, June 2012.

CERC, 2007. Air Quality Studies for Heathrow: Base Case, Segregated Mode, Mixed Mode and Third Runway Scenarios Modelled Using ADMS-Airport. Final report prepared for the Department of Transport, 15 November 2007.

Cimorelli, A.J., Perry, S.G., Venkatram, A., Weil, J.C., Paine, R.J., Wilson, R.B., Lee, R.F., Petersand, W.D., Brode, R.W., Paumier, J.O., 2004. AERMOD: Description of Model Formulation (EPA-454/R-03-004). Tech. rep. US Environmental Protection Agency, Office of Air Quality Planning and Standards, Emissions Monitoring and Analysis Division.

COMEAP, 2010. The Mortality Effects of Long-term Exposure to Particulate Air Pollution in the United Kingdom (A report by the Committee on the Medical Effects of Air Pollutants).

Cooke, R.M., Wilson, A.M., Tuomisto, J.T., Morales, O., Tainio, M., Evans, J.S., 2007. A probabilistic characterization of the relationship between fine particulate matter and mortality: elicitation of European experts. Environmental Science and Technology 41 (18), 6598–6605.

DECC, 2010. Updated Energy and Emissions Projections. Department of Energy & Climate Change. Available at: http://www.decc.gov.uk/assets/decc/statistics/projections/67-updated-emissions-projections-june-2010.pdf (accessed 03.09.12).

Deonandan, I., Balakrishnan, H., 2010. Evaluation of strategies for reducing taxi-out emissions at airports. In: Proceedings of the AIAA Aviation Technology, Integration, and Operations (ATIO) Conference, September 2010, pp. 1–14. Retrieved from: http://www.mit.edu/~hamsa/pubs/DeonandanBalakrishnanATIO2010.pdf .

DfT, 2011. UK Aviation Forecasts. Department for Transport. Available at: http://assets.dft.gov.uk/publications/uk-aviation-forecasts-2011/uk-aviation-forecasts.pdf (accessed 03.09.12).

DfT, 2011b. NTEM planning data version 6.2 Guidance note. Transportation. Retrieved from: https://www.dft.gov.uk/tempro/ files/NTEM62_Guidance.pdf (accessed 03.09.12).

Di Sabatino, S., Solazzo, E., Britter, R., 2007. The sustainable development of Heathrow airport: model intercomparison study. In: Proceedings of the 11th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes, pp. 362–366.

Dorbian, C.S., Wolfe, P.J., Waitz, I.A., 2011. Estimating the climate and air quality benefits of aviation fuel and emissions reductions. Atmospheric Environment 45 (16), 2750–2759.

EPA, 1999. Technical support for development of airport ground support equipment emission reductions (EPA420-R-99-007). Retrieved from: http://www.epa.gov/oms/stateresources/policy/transp/airports/r99007.pdf.

Forster + Partners, Halcrow, Volterra, 2012. Thames Hub – an integrated vision for Britain. http://www.halcrow.com/thames-hub/pdf/thames_hub_vision.pdf (accessed 03.09.12).

GPWv3, 2004. Center for International Earth Science Information Network (CIESIN), Centro Internacional de Agricultura Tropical (CIAT). Version 3. Gridded Population of the World (GPW), Columbia University.

Greater London Authority, 2011. A new airport for London, Part 1 – the Case for New Capacity, Mayor of London, Greater London Authority. Available at: http://www.london.gov.uk/sites/default/ files/AnewairportforLondon.pdf (accessed 03.09.12).

Hsu, H.H., Adamkiewicz, G., Houseman, E.A., Vallarino, J., Melly, S.J., Wayson, R.L., Spengler, J.D., Levy, J.I., 2012. The relationship between aviation activities and ultrafine particulate matter concentrations near a mid-sized airport. Atmospheric Environment 50, 328–337.

ICAO, 2012. ICAO aircraft engine emissions databank. http://easa.europa.eu/environment/edb/aircraft-engine-emissions.php (accessed October 2012).

Isakov, V., Irwin, J.S., Ching, J., 2007. Using CMAQ for exposure modeling and characterizing the subgrid variability for exposure estimates. Journal of Applied Meteorology and Climatology 46, 1354–1371.

Laden, F., Schwartz, J., Speizer, F.E., Dockery, D.W., 2006. Reduction in fine particulate air pollution and mortality: extended follow-up of the Harvard Six Cities study. American Journal of Respiratory Critical Care Medicine 173, 667–672.

Lee, G., 2012. Development of techniques for rapidly assessing the local air quality impacts of airports, SM thesis, The Massachusetts Institute of Technology.

Levy, J.I., Diez, D., Dou, Y., Barr, C.D., Dominici, F., 2012. A meta-analysis and multisite time-series analysis of the differential toxicity of major fine particulate matter constituents. American Journal of Epidemiology 175 (11), 1091–1099.

Lewtas, J., 2007. Air pollution combustion emissions: characterization of causative agents and mechanisms associated with cancer, reproductive, and cardiovascular effects. Mutation Research 636, 95–133.

NATS, 2012. Aeronautical Information Service – Aerodromes published in the UK Aviation Information Publication. Available at: http://www.nats-uk.eadit.com/public/index.php%3Foption=com_content&task=blogcategory&id=6&Itemid=13.html. UK Aeronautical Information Service, NATS Ltd, Middlesex, UK (accessed 03.09.12).

Office for National Statistics, 2009. Report: a demographic portrait of Northern Ireland population. Trends 135, 91–97. Available at: http://www.nisra.gov.uk/archive/demography/publications/Pop_Trends_NI_Article.pdf (accessed 03.09.12).

Ostro, B., 2004. Outdoor air pollution: assessing the environmental burden of disease at national and local levels. In: Environmental Burden of Disease Series, vol. 5. World Health Organization, Geneva.

Oxford Economic Forecasting, 2006. The Economic Contribution of the Aviation Industry in the UK.

Pope III, C.A., Dockery, D.W., 2006. Health effects of fine particulate air pollution: lines that connect. Journal of Air and Waste Management Association 56, 709–742.

Pope III, C.A., Burnett, R.T., Thun, M.J., Calle, E.E., Krewski, D., Ito, K., Thurston, G.D., 2002. Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. Journal of American Medical Association 287 (9), 1132–1141.

Ratliff, G., Sequeira, C., Waitz, I., Ohsfeldt, M., Thrasher, T., Graham, G., Thompson, T., Graham, M., Thompson, T., 2009. Aircraft Impacts on Local and Regional Air Quality in the United States. PARTNER report (Report No. PARTNER-COE-2009-002).

Rickard, G., 2008. QINETIQ/08/01656 The Quality of Aviation Fuel Available in the United Kingdom Annual Survey 2007. QinetiQ Ltd.

Stettler, M.E.J., Eastham, S., Barrett, S.R.H., 2011. Air quality and public health impacts of UK airports. Part I: Emissions. Atmospheric Environment 45 (31), 5415–5424.

UKMO, 2006a. UK Meteorological Office. UK High Resolution Radiosonde Data. NCAS British Atmospheric Data Centre. Available at: http://badc.nerc.ac.uk/view/badc.nerc.ac.uk__ATOM__dataent_ABER (accessed 03.09.12).

UKMO, 2006b. UK Meteorological Office. MIDAS Land Surface Stations Data (1853-current). NCAS British Atmospheric Data Centre. Available at: http://badc.nerc.ac.uk/view/badc.nerc.ac.uk__ATOM__dataent_ukmo-midas (accessed 03.09.12).

USEPA, 2006. Expanded Expert Judgment Assessment of the Concentration-response Relationship Between $PM_{2.5}$ Exposure and Mortality. EPA.

USEPA, 2011. The benefits and costs of the clean air act: 1990 to 2020. Final Report of U.S. Environmental Protection Agency Office of Air and Radiation, pp. 5–10.

Wagner, A., Wiley, T., Murrells, T.P., Passant, N.R., Thistlethwaite, G., Li, Y., Norris, J., Coleman, P.J., Walker, C., Stewart, R.A., Jackson, J., Pierce, M., 2009. UK Emission Projections of Air Quality Pollutants to 2020 (A report of the National Atmospheric Emissions Inventory).

Wayson, R.L., Fleming, G.G., Iovinelli, R., 2009. Methodology to estimate particulate matter emissions from certified commercial aircraft engines. Journal of the Air & Waste Management Association 59, 91–100.

Westerdahla, D., Fruina, S.A., Fineb, P.L., Sioutas, C., 2008. The Los Angeles International Airport as a source of ultrafine particles and other pollutants to nearby communities. Atmospheric Environment 42, 3143–3155.

Yim, S.H.L., Barrett, S.R.H., 2012. Public health impacts of combustion sources in United Kingdom. Environmental Science and Technology 46 (8), 4291–4296.

ED_001734_00032593-00009

EPA-HQ-2018-004348

Atmos. Chem. Phys. Discuss., 15, 34035–34062, 2015
www.atmos-chem-phys-discuss.net/15/34035/2015/
doi:10.5194/acpd-15-34035-2015
© Author(s) 2015. CC Attribution 3.0 License.

Atmospheric Chemistry and Physics Discussions

This discussion paper is/has been under review for the journal Atmospheric Chemistry and Physics (ACP). Please refer to the corresponding final paper in ACP if available.

The global impact of the transport sectors on atmospheric aerosol in 2030 – Part 2: Aviation

M. Righi, J. Hendricks, and R. Sausen

Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Physik der Atmosphäre, Oberpfaffenhofen, Germany

Received: 13 October 2015 – Accepted: 19 November 2015 – Published: 2 December 2015

Correspondence to: M. Righi (mattia.righi@dlr.de)

Published by Copernicus Publications on behalf of the European Geosciences Union.

ED_001734_00032598-00001

Abstract

We use the EMAC (ECHAM/MESSy Atmospheric Chemistry) global climate-chemistry model coupled to the aerosol module MADE (Modal Aerosol Dynamics model for Europe, adapted for global applications) to simulate the impact of aviation emissions on global atmospheric aerosol and climate in 2030. Emissions of short-lived gas and aerosol species follow the four Representative Concentration Pathways (RCPs) designed in support of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. We compare our findings with the results of a previous study with the same model configuration focusing on year 2000 emissions. We also characterize the aviation results in the context of the other transport sectors presented in a companion paper. In spite of a relevant increase in aviation traffic volume and resulting emissions of aerosol (black carbon) and aerosol precursor species (nitrogen oxides and sulfur dioxide), the aviation effect on particle mass concentration in 2030 remains quite negligible (on the order of a few ng m ^{3}), about one order of magnitude less than the increase in concentration due to other emission sources. Due to the relatively small size of the aviation-induced aerosol, however, the increase in particle number concentration is significant in all scenarios (about 1000 cm ^{3}), mostly affecting the northern mid-latitudes at typical flight altitudes (7–12 km). This largely contributes to the overall change in particle number concentration between 2000 and 2030, which results also in significant climate effects due to aerosol-cloud interactions. Aviation is the only transport sector for which a larger impact on the Earth's radiation budget is simulated in the future: The aviation-induced RF in 2030 is more than doubled with respect to the year 2000 value of 15 mW m ^{2}, with a maximum value of 63 mW m ^{2} simulated for RCP2.6.

ACPD
15, 34035–34062, 2015

1 Introduction

Civil aviation is the fastest growing transport mode. Lee et al. (2009) reported a growth of air traffic (in terms of revenue-per-kilometer) of 38 % between 2000 and 2007, while several future scenarios (Kahn Ribeiro et al., 2007) project an increase of CO_2 emissions from aviation of about a factor of 2 between 2010 and 2030, with an even faster increase up to 2050. Although this sector accounts for a small fraction of the global CO_2 emissions from fossil fuels (2.6 % in the year 2004, Lee et al., 2010), it has a substantial impact on climate due to a wide range of non-CO_2 effects including ozone formation and methane destruction via NO_x emissions, direct and indirect aerosol effects from sulfate and black carbon (BC), the formation of contrail and contrail-cirrus clouds as well as the perturbation of natural cirrus clouds due to BC (see Sausen et al., 2005; Lee et al., 2010, and references therein). In addition to impacts on the climate, emissions of particulate matter from aircraft and related activities at and in the vicinity of airports can have detrimental effects on air quality and related impacts on human health (Herndon et al., 2004; Schürmann et al., 2007; Herndon et al., 2008). The study by Barrett et al. (2010) has also found significant impacts on air quality from aircraft emissions at cruise level, but these results have been questioned by Lee et al. (2013a).

In this work, we analyse the aviation impact on aerosol and climate for different future scenarios. We focus on the year 2030 in the four Representative Concentration Pathways (RCPs, Moss et al., 2010; van Vuuren et al., 2011a). These scenarios were developed in support of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5). The results presented here complement those of Righi et al. (2015, hereafter R15), focusing on land transport and shipping. These two papers together represent a follow-up study of Righi et al. (2013, hereafter R13). In R13, we considered year 2000 emissions and performed several sets of model simulations to estimate transport impacts on atmospheric aerosol, to quantify the uncertainty in the effects on particle number concentrations related to the assumed particle size

ACPD
15, 34035–34062, 2015

distribution of emitted particles, and to explore the non-linearities in the aerosol response to the perturbations induced by transport emissions. Concerning aviation, the R13 study revealed that aircraft emissions perturb the aerosol distribution in the upper troposphere, particularly at northern mid-latitudes, and have significant impacts also near the surface, mainly due to activities nearby airports. The aviation-induced impact on the Earth's radiation budget was found to be quite uncertain, strongly dependent on the assumed size distribution of particles emitted by aircraft. R13 estimated a radiative forcing in the range of 70 to 2.4 mW m ^{2}. The by far largest part of this effect was attributed to low clouds, lying much below the typical emission altitude, in line with the results by Gettelman and Chen (2013) and, more recently, Kapadia et al. (2015).

The numerical experiments in this work have been conducted using the EMAC-MADE global aerosol model (see R13 and references therein), which is able to track both aerosol mass and number perturbations, and to simulate the aerosol-cloud and aerosol-radiation interactions, hence allowing the estimation of aerosol radiative forcing effects. In addition to the global effects, we also analyse specific regions, where aviation emissions are expected to change significantly compared to 2000, as a consequence of changes in the transport patterns. Since we focus on the relative contribution of aviation to global aerosol and climate, changes in the background concentrations due to the effect of the anthropogenic emissions from other sectors are shown as well. Finally, we note that in the present study only the changes in the emissions of short-lived species (aerosol and precursor gases) are considered, whereas the investigation of the impact of a changing climate on aerosol distribution is not accounted for (we refer to Pye et al., 2009; Kloster et al., 2009; Megaritis et al., 2013, for a discussion on this topic). For this reason, we drive the model using year 2000 conditions for long-lived species (CO_2 and methane) and radiatively active gases (other than water vapour), and use meteorological data for the period 1996–2005 to nudge the model dynamics. The analysis in this paper focuses on the same period.

The future aviation impacts were investigated by Unger et al. (2013), who considered RCP4.5 for the background combined with several aviation emission scenarios.

ACPD
15, 34035–34062, 2015

They found that cooling effects induced by short-lived compounds can neutralize or even overcome the CO_2 warming, depending on the time horizon under consideration. That study, however, did not take into account the RF due to aerosol-cloud interactions, which we found to be significant for year 2000 emissions, when considering low-level clouds, and potentially much larger than the CO_2 forcing (R13). Olivié et al. (2012), found a positive climate impact of non-CO_2 compounds from aviation using the previous IPCC SRES A1B scenario (Nakicenovic et al., 2000) up to 2100. Their model accounts for both direct and indirect effects of aerosols, but the indirect effect is limited to the sulfate component, which may lead to an underestimation of the total indirect effect. Our study, therefore, represents a step forward since it includes a more complete representation of the aerosol indirect effect, including the recently-reported aviation effect on low clouds, in the framework of the most recent RCP scenarios. Including the four RCPs in our experiments also allows us to provide a more complete analysis of the future development of aviation impacts on aerosol and climate.

This paper is organized as follows: A brief overview of the EMAC-MADE model system and its setup, including the considered emissions is provided in Sect. 2. The impact of aviation on the atmospheric aerosol distribution and aerosol burdens is discussed in Sect. 3, while Sect. 4 presents the corresponding aerosol-induced climate impacts. The main conclusions are summarized in Sect. 5.

2 Model setup, emission inventories and model simulations

The simulations of this work are performed with the ECHAM MESSy Atmospheric Chemistry (EMAC) model, coupled with the Modular Aerosol Dynamics submodel for Europe (MADE), adapted for global applications. We refer to R13 and R15 for a more detailed description of the model system and its configuration, here we only summarize its main features. MADE describes the aerosol population by means of three log-normal aerosol modes (Aitken, accumulation, and coarse) and eight aerosol species: Black carbon (BC), particulate organic matter (POM), nitrate (NO_3), ammonium (NH_4),

ACPD
15, 34035–34062, 2015

sulfate (SO_4), mineral dust, sea-salt and aerosol water. To reduce the computational burden, the chemistry setup is based on a simplified mechanism, including basic tropospheric background chemistry (NO_x-HO_x-CH_4-CO-O_3 chemistry) and the sulfur cycle. The model is able to simulate the competition for ammonium between the sulfate and nitrate formation processes, which is particularly important in the upper troposphere, as we will show in Sect. 3. All model experiments are performed with a T42L19 resolution (corresponding to 2.8° 2.8° in the horizontal) and 19 vertical layer up to 10 hPa, and covering a period of 10 years. The model dynamics (temperature, winds, and logarithm of surface pressure) is nudged using the data from the European Centre for Medium-range Weather Forecast (ECMWF). This minimizes the dynamical differences between the different experiments and allows to extract a significant signal even with a relatively limited amount of simulated years.

The model's ability to reproduce the vertical aerosol distribution was evaluated by Aquila et al. (2011), using observational data from several aircraft campaigns over the globe. They concluded that the aerosol representation in the UTLS (Upper-Troposphere Lower-Stratosphere) by EMAC-MADE is reasonably good.

We have applied the emission datasets developed by Lamarque et al. (2010) in support of the IPCC and the four Representative Concentration Pathways for the future projection in 2030 (RCP; Moss et al., 2010; van Vuuren et al., 2011a). As extensively discussed in R15, the RCPs are defined based on the projected value of the global anthropogenic radiative forcing in 2100 and includes four projections with increasing climate impact: RCP2.6, RCP4.5, RCP6.0, and RCP8.5. The RCP are climate-policy scenarios, but are quite limited in terms of air-quality projections, as they do not cover the full range of air pollution mitigation policies currently available (Chuwah et al., 2013). As pointed out by R15 and several other studies (e.g., Takemura, 2012), they often show an opposite behaviour between long-lived and short-lived species.

The aerosol submodel MADE used for this study simulates both aerosol mass and number, and therefore requires number emissions to be provided as input. These have been calculated from mass emissions under specific assumptions on the size distri-

ACPD
15, 34035–34062, 2015

bution of emitted particles. In R13, we analysed several sets of parameters to test the effect of such assumptions on the simulated impacts of transport on aerosol distributions and climate. To reduce the computational burden, in the present study we have performed experiments assuming only one set of parameters to describe the size distribution of emitted particles. Namely, we have used the parameters as for the reference case in R13. Compared to the other cases assumed in R13, this is a middle-of-the-road choice, based on measured values by Petzold et al. (1999) in the engine exhaust of a B737-300 aircraft, and combined with an assumption for fuel sulfur content ($0.8\,g(SO_2)\,kg_{fuel}^{1}$) suggested in the assessment by Lee et al. (2010).

All the RCPs project a steady increase in aviation emissions of short-lived compounds between 2000 and 2030. This is significantly different from the other two transport sectors discussed in R15, for which a decrease in emissions of aerosol and aerosol precursors was found in most regions for all scenarios: This is a consequence of air pollution control measures (land transport) and sulfate reduction policies (shipping), which lead to emission reductions despite the steady growth in traffic volumes of these two sectors. For large commercial aircraft, on the contrary, no significant changes in technology are foreseen for aircraft engines in the near future, as no viable alternative to jet engines has been identified (Sims et al., 2014). Therefore the growing emissions are essentially a direct consequence of increasing air traffic volumes. The development and the implementation of new technologies in the aviation sector is more difficult than for road traffic and shipping, given the much higher safety standard required by aircraft, the relatively long life-time of the commercial fleet (about three decades), and the necessity to keep costs low (Kahn Ribeiro et al., 2007). Current efforts to minimise the climate impact of aviation are focusing on the improvements of fuel efficiency, modification of aircraft routes (Grewe et al., 2014a) and introduction of low-sulfur fuels (Unger, 2011; Bock, 2014).

As there are relevant regional differences in the distribution of air traffic, we have analysed the emission changes between 2000 and 2030 on the global scale and in three different regions of intense air traffic: The flight routes connecting the USA and

ACPD
15, 34035–34062, 2015

Global impact of aviation on aerosol and climate in 2030

M. Righi et al.

Europe (the so-called North Atlantic flight corridor), the routes between Europe and Asia, and between Asia and the USA (Fig. 1). The relative changes between 2030 and 2000 in the emissions of aviation-relevant compounds are depicted in Fig. 2. We shall recall here that the CMIP5 inventories and the RCPs do not include SO_2 emissions from aviation and that these were calculated by scaling the BC emissions with the ratio of the emission factors of the two species at each altitude level (see R13 for details). For this reason, their relative changes between 2000 and 2030 are similar in Fig. 2. The largest increases are projected for the flight connections between Europe and Asia (lower-left panel of Fig. 2), mostly due to the fast-growing economies of South East Asia, which drives an increase in air traffic volumes. To a lesser extent, this also applies to the Asia-USA connections (lower-right panel). Aviation emissions in RCP4.5 (Thomson et al., 2011) and RCP8.5 (Riahi et al., 2011) were both based on the QUANTIFY inventories (Lee et al., 2010). In RCP6.0 (Masui et al., 2011) the spatial distribution for the year 2000 (Lamarque et al., 2010) was simply scaled with global total emissions, with the consequence that the relative changes are identical in the different regions. The very high increase in BC emissions in RCP2.6 (van Vuuren et al., 2011b) is due to the fact that in this scenario the emissions were calculated for total transport and then split among the three sectors (road, shipping and aviation): This split was based on the time-dependent shares of each sector for each species, again according to QUANTIFY. The aviation share for BC in QUANTIFY is characterized by a large increase between 2000 and 2030 (about an order of magnitude for all scenarios, not shown), which explains the large increase of BC emissions in RCP2.6 given in Fig. 2.

To estimate the effects of aviation on atmospheric aerosol and on climate, we have performed two model simulations for each RCP (thus a total of 8 simulations): A reference experiment (REF) including all emission sources and a sensitivity simulation (NOAIRC) with aviation emissions completely switched off. This allows to estimate the aviation impact as:

$$\Delta_{RCP}^{AIRC} = REF_{RCP} \quad NOAIRC_{RCP}. \qquad (1)$$

ACPD
15, 34035–34062, 2015

This approach could have some limitations due to non-linearities in the response of the system to the emission perturbation. For the aviation sector, however, R13 found that the impact of the non-linearities is small. The aviation effects calculated for the year 2030 are related to the effects in the year 2000, as simulated by R13, in terms of the changes D in aviation-induced surface-level concentrations between 2000 and 2030 for the different scenarios. In analogy to R15, this is given by the difference:

$$D_{\mathrm{RCP}}^{\mathrm{AIRC}} = \Delta_{\mathrm{RCP}}^{\mathrm{AIRC}} \quad \Delta_{2000}^{\mathrm{AIRC}}. \tag{2}$$

To provide a more complete view on the changes in aviation-induced aerosols, we relate this quantity to the total changes in concentration (i.e., from all sources):

$$D_{\mathrm{RCP}}^{\mathrm{ALL}} = \mathrm{REF}_{\mathrm{RCP}} \quad \mathrm{REF}_{2000}, \tag{3}$$

and to the changes in the concentrations induced by other (non-aviation) sources:

$$D_{\mathrm{RCP}}^{\mathrm{OTHER}} = \mathrm{NOAIRC}_{\mathrm{RCP}} \quad \mathrm{NOAIRC}_{2000}. \tag{4}$$

Note that, of course, $D_{\mathrm{RCP}}^{\mathrm{ALL}} = D_{\mathrm{RCP}}^{\mathrm{AIRC}} + D_{\mathrm{RCP}}^{\mathrm{OTHER}}$.

3 Aviation impacts on aerosol in 2030

The aviation impact on BC, SO_4, NO_3 and particle number concentrations in fine mode (i.e., $\lesssim 1\,\mu m$, sum of the Aitken and accumulation mode) are plotted in Figs. 3–6, respectively. We consider zonally averaged fields from the surface to the UTLS. As a reference for comparison, the first row depicts the year 2000 results from R13 showing the concentrations induced by all sources (left), by aviation only (middle) and by other (non-aviation) sources (right). R13 showed that the aviation impact on particle mass concentration is quite negligible, being around 0.1 ng m ^{3} for BC, 2–5 ng m ^{3} for SO_4, and 2–3 ng m ^{3} for NO_3. The relevance of these impacts, however, depends also on the

ACPD
15, 34035–34062, 2015

simulated background aerosol concentrations in the UTLS, which for BC is known to be biased high in most global models (Schwarz et al., 2013) and, to a lesser extent, in EMAC-MADE (Aquila et al., 2011). The aviation impact is much larger on particle number concentration, in particular in the northern mid-latitudes between 200 and 300 hPa, contributing about 30–40 % of total concentration in this region. This is due to the relatively small size of particle emitted by aviation (around 25 nm in our simulations).

The other rows of Figs. 3–6 show the changes between 2000 and 2030 in the concentrations induced by all sources (left), by aviation only (middle) and by other (non-aviation) sources (right). For BC (Fig. 3), SO_4 (Fig. 4) and NO_3 (Fig. 5), the contribution of the aviation sector to the mass concentration changes remains small, as it is clear from the comparison of the left (all sources) and the right (non-aviation sources) columns. The only noticeable feature is the increase in aviation-induced BC concentration for RCP2.6 (Fig. 3, second row). This contributes to increase the overall BC concentration in the tropopause region of the Northern Hemisphere (left panel), which would be otherwise characterized by a decrease (right panel). In the other scenarios, the pattern of aviation-induced BC is similar but the perturbations are clearly smaller than in RCP2.6. In these scenarios, changes are relevant only in the upper-troposphere. RCP2.6 is the only scenario showing a significantly increasing impact of aviation on BC concentration close to surface, with mean values of 0.1–0.3 ng m^{3} around 30 °N. This is more than a factor of 3 larger than the year 2000 impact, and is even more important given that the impact of other sources is getting smaller over the same time period. This could be an issue for air-pollution control in the vicinity of major airports. However, due to the reasons discussed in Sect. 2, it should be questioned whether the assumptions of high aviation emission shares in RCP2.6 are realistic. Another interesting aspect is the negative value for aerosol nitrate in Fig. 5. This is a typical effect of the NH_3-limited environment in the UTLS (Unger et al., 2013, R13), and is due to the competition between nitrate and sulfate for the available ammonium.

The increase in mean aviation-induced particle number concentration (Fig. 6), on the other hand, is quite strong in all scenarios, with values of the order of 1000 cm^{3} in the

ACPD
15, 34035–34062, 2015

northern mid-latitudes UTLS. In this domain, the aviation emissions significantly contribute to the overall changes in particle number concentration between 2000 and 2030, leading to a large increase (1000–3000 cm ^{3}), in particular for RCP2.6 and RCP8.5.

To further explore the aviation effects, Fig. 7 presents the contribution of the aviation sector to the UTLS burden of different species in various regions. The largest increase in the relative contribution to the burden is found again for RCP2.6, as expected from the emission changes (Fig. 2). The impact of aviation on the number burden is far larger than for the mass and is projected to grow for all scenarios in 2030, in particular for RCP2.6, showing a more than doubled relative contribution compared to 2000, for both size modes. The highest values, around 55–75 %, are simulated for the North Atlantic flight corridor (USA-Europe routes, top-right panel) for the particles in the Aitken mode. As discussed in R13, the simulated impact of aviation on aerosol number concentration in the upper troposphere are not very sensitive to the assumed size distribution of emitted particles, but rather to the sulfur content of aviation fuels. The large increase simulated for 2030 scenarios has to be considered therefore as an upper limit, since much smaller impacts on particle number burden can be expected if low-sulfur fuels are considered for the future. It is also interesting to note that the largest burdens are not found in the routes to and from Asia, where the emissions were larger, but for the USA-Europe route. This could be due to the relatively clean background in this region, due the lower emission from other sectors being transported upwards, an effect similar to the relatively low impact of land transport in Asia reported by R13.

The large changes in particle number concentration induced by aviation emissions have also a large impact on climate, as we discuss in the next section.

4 Aviation impacts on Earth's radiation budget

To quantify the aviation-induced aerosol radiative forcing we follow the method outlined by Lohmann and Feichter (2005) and Schulz et al. (2006) and consider the changes in the radiative fluxes at the top of the atmosphere. We include both the longwave

ACPD
15, 34035–34062, 2015

and the shortwave radiation in this calculation and analyse all-sky and clear-sky fluxes separately. The clear-sky flux is determined online by the model by neglecting clouds in the radiative flux calculations. Comparing the all-sky and the clear-sky effects, an estimate of the aviation-induced cloud radiative forcing can be inferred.

The results for the year 2000 (R13, reference case) and for the four RCPs in 2030 are presented in Fig. 8. In R13, we conducted several sensitivity simulations to quantify the uncertainties in the RF related to the assumption on the size distribution of emitted particles. As mentioned in R15 and in Sect. 2, this analysis is not repeated here in order to reduce the computational burden. Only the reference case of R13 is simulated for the RCP scenarios in 2030. Nevertheless, we estimated the RF uncertainty for the 2030 results by simply rescaling them according to the uncertainty range calculated for 2000. These ranges are shown as open boxes in Fig. 8. This rescaling assumes that the same uncertainty can be applied to 2000 and 2030. On the one hand, this is reasonable since no fundamental changes in the aviation engine technology are expected in this time period. On the other hand, however, there are some limitations. The upper limit of this estimate was found to be non-significant in R13 therefore even the sign of the RF in this case is uncertain, while the lower limit could be overestimated by this rescaling. Non-linearities in the system response to such large emission perturbation might reduce the actual lower limit of the RF estimate for 2030 presented here. Addressing these issues will require additional experiments and shall be the focus of future analyses.

Given the results of R15 for land transport and shipping, aviation is the only transport sector for which an increasing impact of aerosol on the radiation budget is simulated. RCP2.6 is the scenario with the largest increase, shifting the all-sky forcing from $-15\,\mathrm{mW\,m^{-2}}$ in 2000 to $-63\,\mathrm{mW\,m^{-2}}$ in 2030, while values between -30 and $-40\,\mathrm{mW\,m^{-2}}$ are calculated for the other scenarios. The total forcing is mostly driven by cloud effects and the large increase with respect to 2000 can be explained by the large increase in aviation sulfate emissions (Fig. 2). Considering the uncertainties associated with the size distribution, extremely large values can be estimated, up to $-285\,\mathrm{mW\,m^{-2}}$ for RCP2.6, if the NUC (i.e., nucleation) size distribution of R13 is assumed, charac-

ACPD
15, 34035–34062, 2015

terized by a large number of sulfate particles emitted in the nucleation mode. Some of these particles can eventually grow and act as cloud condensation nuclei which affect climate by altering the cloud microphysical structure. Note that, according to the results of R13, the bulk of the RF simulated here is due to perturbation of liquid clouds at lower levels, below the typical emission altitude. Two possible mechanism can explain this effect: (i) emissions during climb and approach, or (ii) downward transport of particles from flight levels, particularly due to downwelling of air masses in the subtropical jet regions. Figure 6 (middle column) seems to support the latter mechanism, as also found by Gettelman and Chen (2013) using a different model.

The future impacts of aviation emissions on climate have been simulated also by Unger et al. (2013), using RCP4.5 for background emissions and considering three different technology scenarios for aviation in 2050. However, their study only considered the direct aerosol effect (sulfate, nitrate and black carbon), reporting a range [65; 20] mW m ^{2}.

5 Conclusions

Using the EMAC global climate-chemistry model coupled to the aerosol module MADE, we quantified the impact of aviation on atmospheric aerosol and climate in the year 2030 under the four RCPs. In terms of both aerosol load and climate impacts, we found all scenarios to project an increasing impact of aviation in the future, with RCP2.6 being the most extreme one. Aviation-induced concentration of black carbon and aerosol sulfate will increase in the UTLS and close to the surface, but their overall impact on the atmospheric composition will still be small compared to the other anthropogenic sources. We simulated a strong impact of the aviation sector on particle number concentration in the upper-troposphere mid-latitudes. This is significantly larger than for the year 2000, and counteracts the decrease in particle number concentration due to other sources, leading to an overall increase in this region. The aerosol-driven climate impact of aviation in 2030 results in a global cooling effect, albeit with large uncertain-

ACPD
15, 34035–34062, 2015

ties depending on the assumptions on emitted particle size distribution and fuel sulfur content, which even affect the sign of the resulting RF. Compared to the estimates for the year 2000, aviation-induced aerosol radiative forcing is about two (RCP6.0) to four times (RCP2.6) larger.

Together with Righi et al. (2013) and Righi et al. (2015), this paper closes a series of three studies on the global impact of land transport, shipping and aviation on atmospheric aerosol and climate in the year 2000 and in the RCP scenarios in 2030. The present study reveals that aviation is the only transport sector for which an increasing impact is simulated in the future. This is essentially due to continuously growing traffic volumes without the implementation of significant technological improvements to reduce the emissions, as it is happening for the other sectors (e.g., emission control on vehicles engines and fuel regulations in shipping). In this set of studies, we also found that transport-induced aerosol particles can efficiently perturb low-level warm clouds, resulting in a strong cooling effect on the Earth's radiation budget, often comparable or stronger than the warming effect of other compounds, like CO_2 and ozone. Future policies addressing the aviation sector should therefore focus on reducing its climate impact. Recent studies suggested a promising approach, based on optimised aircraft routes to reduce climate impacts (Grewe et al., 2014a, b). The focus so far has been on CO_2 and nitrogen oxides, but it shall be extended to include aerosol effects on clouds, especially warm clouds as the results of our study suggest. Another possibility to reduced the aviation impact is the replacement of conventional (fossil) fuel by alternative fuels and biofuels. This will change the amount of emissions, with potential effects on contrail formation and evolution, as well as indirect cloud effects. In light of the results presented in this work, the role of sulfur content of aviation fuels will be of particular relevance. Hence, detailed knowledge on the combustion process, emissions, and related climate impact of biofuels is required.

The estimate of the global impact of the transport sectors using global aerosol-climate models is still affected by several uncertainties. Some of them have been addressed in our series of papers: We showed, for example, that the parameters describ-

ACPD
15, 34035–34062, 2015

ing the size distribution of emitted particles can be critical and can significantly influence the resulting estimates, especially concerning transport-induced aerosol number concentrations and, as a direct consequence, aerosol-cloud effects and RF calculations. The parameterisation of sub-grid scale processes is a general issue in global models, due to their coarse spatial resolution. In an extensive parametric study, Lee et al. (2013b) have shown that the sub-grid production of a few per cent mass of sulfate particles in plumes is much more important for the uncertainty on cloud condensation nuclei calculation than the SO_2 emissions themselves. This is consistent with our findings for the aviation sector, where a much larger climate impact is simulated when an extra nucleation mode for sulfate particles is considered. We also showed that sulfur content of aviation fuels can play a relevant role in the resulting climate impacts. We estimated that using basic assumptions and two extreme cases, but in the future it will be important to achieve better constraints, also including geographically-dependent sulfur emission factors, since the aviation fuel type often depends on the departure airport.

Finally, we recall that the model version applied for these studies considers a simplified representation of aerosol effects on ice clouds. Only homogeneous freezing of supercooled liquid aerosol is considered, but heterogeneous nucleation processes, such as soot-induced ice formation, are neglected. In the future, we shall improve this aspect of the model, including heterogeneous nucleation via various processes. This will also require an improved representation of aerosol in the UTLS, which is essential for a correct representation of the aerosol concentration and hence a more precise estimate of the impact of aviation emissions.

Acknowledgements. This study has been conducted in the framework of the DLR projects VEU and WeCare, and of the EU-FP7 project REACT4C. The aerosol model MADE was originally developed by the University of Cologne, Germany (RIU/EURAD project). We are grateful to the whole MESSy team for the development of EMAC and in particular to Patrick Jöckel for his help with the model setup. We thank Klaus-Dirk Gottschaldt for his valuable comments on the manuscript draft.

The article processing charges for this open-access publication were covered by a Research Centre of the Helmholtz Association.

References

Aquila, V., Hendricks, J., Lauer, A., Riemer, N., Vogel, H., Baumgardner, D., Minikin, A., Petzold, A., Schwarz, J. P., Spackman, J. R., Weinzierl, B., Righi, M., and Dall'Amico, M.: MADE-in: a new aerosol microphysics submodel for global simulation of insoluble particles and their mixing state, Geosci. Model Dev., 4, 325–355, doi:10.5194/gmd-4-325-2011, 2011. 34040, 34044

Barrett, S. R. H., Britter, R. E., and Waitz, I. A.: Global mortality attributable to aircraft cruise emissions., Environ. Sci. Technol., 44, 7736–7742, doi:10.1021/es101325r, 2010. 34037

Bock, L.: Modellierung von Kondensstreifenzirren: Mikrophysikalische und optische Eigenschaften, PhD thesis, LMU München, Faculty of Physics, Munich, Germany, 2014. 34041

Chuwah, C., van Noije, T., van Vuuren, D. P., Hazeleger, W., Strunk, A., Deetman, S., Beltran, A. M., and van Vliet, J.: Implications of alternative assumptions regarding future air pollution control in scenarios similar to the Representative Concentration Pathways, Atmos. Environ., 79, 787–801, doi:10.1016/j.atmosenv.2013.07.008, 2013. 34040

Gettelman, A. and Chen, C.: The climate impact of aviation aerosols, Geophys. Res. Lett., 40, 2785–2789, doi:10.1002/grl.50520, 2013. 34038, 34047

Grewe, V., Champougny, T., Matthes, S., Frömming, C., Brinkop, S., Søvde, O. A., Irvine, E. A., and Halscheidt, L.: Reduction of the air traffic's contribution to climate change: a REACT4C case study, Atmos. Environ., 94, 616–625, 2014a. 34041, 34048

Grewe, V., Frömming, C., Matthes, S., Brinkop, S., Ponater, M., Dietmüller, S., Jöckel, P., Garny, H., Tsati, E., Dahlmann, K., Søvde, O. A., Fuglestvedt, J., Berntsen, T. K., Shine, K. P., Irvine, E. A., Champougny, T., and Hullah, P.: Aircraft routing with minimal climate impact: the REACT4C climate cost function modelling approach (V1.0), Geosci. Model Dev., 7, 175–201, doi:10.5194/gmd-7-175-2014, 2014b. 34048

Herndon, S. C., Shorter, J. H., Zahniser, M. S., Nelson, D. D., Jayne, J., Brown, R. C., Miake-Lye, R. C., Waitz, I., Silva, P., Lanni, T., Demerjian, K., and Kolb, C. E.: NO and NO_2 emission ratios measured from in-use commercial aircraft during taxi and takeoff, Environ. Sci. Technol., 38, 6078–6084, doi:10.1021/es049701c, 2004. 34037

Herndon, S. C., Jayne, J. T., Lobo, P., Onasch, T. B., Fleming, G., Hagen, D. E., Whitefield, P. D., and Miake-Lye, R. C.: Commercial aircraft engine emissions characterization of in-use aircraft at Hartsfield-Jackson Atlanta International Airport, Environ. Sci. Technol., 42, 1877–1883, doi:10.1021/es072029+, 2008. 34037

Kahn Ribeiro, S., Kobayashi, S., Beuthe, M., Gasca, J., Greene, D., Lee, D., Muromachi, Y., Newton, P., Plotkin, S., Sperling, D., Wit, R., , and Zhou, P.: Transport and its infrastructure, in: Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, IPCC, edited by: Metz, B., Davidson, O., Bosch, P., Dave, R., and Meyer, L., Cambridge University Press, Cambridge, UK and New York, NY, USA, 323–385, 2007. 34037, 34041

Kapadia, Z. Z., Spracklen, D. V., Arnold, S. R., Borman, D. J., Mann, G. W., Pringle, K. J., Monks, S. A., Reddington, C. L., Benduhn, F., Rap, A., Scott, C. E., Butt, E. W., and Yoshioka, M.: Impacts of aviation fuel sulfur content on climate and human health, Atmos. Chem. Phys. Discuss., 15, 18921–18961, doi:10.5194/acpd-15-18921-2015, 2015. 34038

Kloster, S., Dentener, F., Feichter, J., Raes, F., Lohmann, U., Roeckner, E., and Fischer-Bruns, I.: A GCM study of future climate response to aerosol pollution reductions, Clim. Dynam., 34, 1177–1194, doi:10.1007/s00382-009-0573-0, 2009. 34038

Lamarque, J.-F., Bond, T. C., Eyring, V., Granier, C., Heil, A., Klimont, Z., Lee, D., Liousse, C., Mieville, A., Owen, B., Schultz, M. G., Shindell, D., Smith, S. J., Stehfest, E., Van Aardenne, J., Cooper, O. R., Kainuma, M., Mahowald, N., McConnell, J. R., Naik, V., Riahi, K., and van Vuuren, D. P.: Historical (1850–2000) gridded anthropogenic and biomass burning emissions of reactive gases and aerosols: methodology and application, Atmos. Chem. Phys., 10, 7017–7039, doi:10.5194/acp-10-7017-2010, 2010. 34040, 34042

Lee, D. S., Fahey, D. W., Forster, P. M., Newton, P. J., Wit, R. C. N., Lim, L. L., Owen, B., and Sausen, R.: Aviation and global climate change in the 21st century, Atmos. Environ., 43, 3520–3537, doi:10.1016/j.atmosenv.2009.04.024, 2009. 34037

Lee, D. S., Fahey, D. W., Forster, P. M., Newton, P. J., Wit, R. C. N., Lim, L. L., Owen, B., and Sausen, R.: Transport impacts on atmosphere and climate: Aviation, Atmos. Environ., 44, 4678–4734, doi:10.1016/j.atmosenv.2009.06.005, 2010. 34037, 34041, 34042

Lee, H., Olsen, S. C., Wuebbles, D. J., and Youn, D.: Impacts of aircraft emissions on the air quality near the ground, Atmos. Chem. Phys., 13, 5505–5522, doi:10.5194/acp-13-5505-2013, 2013a. 34037

Lee, L. A., Pringle, K. J., Reddington, C. L., Mann, G. W., Stier, P., Spracklen, D. V., Pierce, J. R., and Carslaw, K. S.: The magnitude and causes of uncertainty in global model simulations of cloud condensation nuclei, Atmos. Chem. Phys., 13, 8879–8914, doi:10.5194/acp-13-8879-2013, 2013b. 34049

Lohmann, U. and Feichter, J.: Global indirect aerosol effects: a review, Atmos. Chem. Phys., 5, 715–737, doi:10.5194/acp-5-715-2005, 2005. 34045

Masui, T., Matsumoto, K., Hijioka, Y., Kinoshita, T., Nozawa, T., Ishiwatari, S., Kato, E., Shukla, P., Yamagata, Y., and Kainuma, M.: An emission pathway for stabilization at 6 W m ^{2} radiative forcing, Climatic Change, 109, 59–76, doi:10.1007/s10584-011-0150-5, 2011. 34042

Megaritis, A. G., Fountoukis, C., Charalampidis, P. E., Pilinis, C., and Pandis, S. N.: Response of fine particulate matter concentrations to changes of emissions and temperature in Europe, Atmos. Chem. Phys., 13, 3423–3443, doi:10.5194/acp-13-3423-2013, 2013. 34038

Moss, R. H., Edmonds, J. A., Hibbard, K. A., Manning, M. R., Rose, S. K., van Vuuren, D. P., Carter, T. R., Emori, S., Kainuma, M., Kram, T., Meehl, G. A., Mitchell, J. F. B., Nakicenovic, N., Riahi, K., Smith, S. J., Stouffer, R. J., Thomson, A. M., Weyant, J. P., and Wilbanks, T. J.: The next generation of scenarios for climate change research and assessment, Nature, 463, 747–56, doi:10.1038/nature08823, 2010. 34037, 34040

Nakicenovic, N., Alcamo, J., Davis, G., de Vries, B., Fenhann, J., Gaffin, S., Gregory, K., Grübler, A., Jung, T. Y., Kram, T., Lebre La Rovere, E., Michaelis, L., Mori, S., Morita, T., Pepper, W., Pitcher, H., Price, L., Riahi, K., Roehrl, A., Rogner, H.-H., Sankovski, A., Schlesinger, M., Shukla, P., Smith, S., Swart, R., van Rooijen, S., Victor, N., and Dadi, Z.: Special Report on Emissions Scenarios: A Special Report of Working Group III of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK, 2000. 34039

Olivié, D. J. L., Cariolle, D., Teyssèdre, H., Salas, D., Voldoire, A., Clark, H., Saint-Martin, D., Michou, M., Karcher, F., Balkanski, Y., Gauss, M., Dessens, O., Koffi, B., and Sausen, R.: Modeling the climate impact of road transport, maritime shipping and aviation over the period 1860–2100 with an AOGCM, Atmos. Chem. Phys., 12, 1449–1480, doi:10.5194/acp-12-1449-2012, 2012. 34039

Petzold, A., Döpelheuer, A., Brock, C. A., and Schröder, F.: In situ observations and model calculations of black carbon emission by aircraft at cruise altitude, J. Geophys. Res., 104, 22171–22181, doi:10.1029/1999JD900460, 1999. 34041

Pye, H. O. T., Liao, H., Wu, S., Mickley, L. J., Jacob, D. J., Henze, D. K., and Seinfeld, J. H.: Effect of changes in climate and emissions on future sulfate-nitrate-ammonium aerosol levels in the United States, J. Geophys. Res., 114, D01205, doi:10.1029/2008JD010701, 2009. 34038

Riahi, K., Rao, S., Krey, V., Cho, C., Chirkov, V., Fischer, G., Kindermann, G., Nakicenovic, N., and Rafaj, P.: RCP 8.5 – a scenario of comparatively high greenhouse gas emissions, Climatic Change, 109, 33–57, doi:10.1007/s10584-011-0149-y, 2011. 34042

Righi, M., Hendricks, J., and Sausen, R.: The global impact of the transport sectors on atmospheric aerosol: simulations for year 2000 emissions, Atmos. Chem. Phys., 13, 9939–9970, doi:10.5194/acp-13-9939-2013, 2013. 34037, 34048

Righi, M., Hendricks, J., and Sausen, R.: The global impact of the transport sectors on atmospheric aerosol in 2030 – Part 1: Land transport and shipping, Atmos. Chem. Phys., 15, 633–651, doi:10.5194/acp-15-633-2015, 2015. 34037, 34048

Sausen, R., Isaksen, I., Grewe, V., Hauglustaine, D., Lee, D. S., Myhre, G., Köhler, M. O., Pitari, G., Schumann, U., Stordal, F., and Zerefos, C.: Aviation radiative forcing in 2000: an update on IPCC (1999), Meteorol. Z., 14, 555–561, doi:10.1127/0941-2948/2005/0049, 2005. 34037

Schulz, M., Textor, C., Kinne, S., Balkanski, Y., Bauer, S., Berntsen, T., Berglen, T., Boucher, O., Dentener, F., Guibert, S., Isaksen, I. S. A., Iversen, T., Koch, D., Kirkevå g,A., Liu, X., Montanaro, V., Myhre, G., Penner, J. E., Pitari, G., Reddy, S., Seland, Ø., Stier, P., and Takemura, T.: Radiative forcing by aerosols as derived from the AeroCom present-day and preindustrial simulations, Atmos. Chem. Phys., 6, 5225–5246, doi:10.5194/acp-6-5225-2006, 2006. 34045

Schürmann, G., Schäfer, K., Jahn, C., Hoffmann, H., Bauerfeind, M., Fleuti, E., and Rappenglück, B.: The impact of NO_x, CO and VOC emissions on the air quality of Zurich airport, Atmos. Environ., 41, 103–118, doi:10.1016/j.atmosenv.2006.07.030, 2007. 34037

Schwarz, J. P., Samset, B. H., Perring, A. E., Spackman, J. R., Gao, R. S., Stier, P., Schulz, M., Moore, F. L., Ray, E. A., and Fahey, D. W.: Global-scale seasonally resolved black carbon vertical profiles over the Pacific, Geophys. Res. Lett., 40, 5542–5547, doi:10.1002/2013GL057775, 2013. 34044

Sims, R., Schaeffer, R., Creutzig, F., Cruz-Nú ñez, X., D'Agosto, M., Dimitriu, D., Figueroa Meza, M. J., Fulton, L., Kobayashi, S., Lah, O., McKinnon, A., Newman, P., Ouyang, M., Schauer, J. J., Sperling, D., and Tiwari, G.: Transport, in: Climate Change 2014: Mitigation. Contribution of Working Group III to the Fifth Assessment Report of the Intergov-

ernmental Panel on Climate Change, IPCC, edited by: Metz, B., Davidson, O., Bosch, P., Dave, R., and Meyer, L., Cambridge University Press, Cambridge, UK and New York, NY, USA, 1–117, 2014. 34041

Takemura, T.: Distributions and climate effects of atmospheric aerosols from the preindustrial era to 2100 along Representative Concentration Pathways (RCPs) simulated using the global aerosol model SPRINTARS, Atmos. Chem. Phys., 12, 11555–11572, doi:10.5194/acp-12-11555-2012, 2012. 34040

Thomson, A. M., Calvin, K. V., Smith, S. J., Kyle, G. P., Volke, A., Patel, P., Delgado-Arias, S., Bond-Lamberty, B., Wise, M. A., Clarke, L. E., and Edmonds, J. A.: RCP4.5: a pathway for stabilization of radiative forcing by 2100, Climatic Change, 109, 77–94, doi:10.1007/s10584-011-0151-4, 2011. 34042

Unger, N.: Global climate impact of civil aviation for standard and desulfurized jet fuel, Geophys. Res. Lett., 38, 1–6, doi:10.1029/2011GL049289, 2011. 34041

Unger, N., Zhao, Y., and Dang, H.: Mid-21st century chemical forcing of climate by the civil aviation sector, Geophys. Res. Lett., 40, 641–645, doi:10.1002/grl.50161, 2013. 34038, 34044, 34047

van Vuuren, D. P., Edmonds, J., Kainuma, M., Riahi, K., Thomson, A., Hibbard, K., Hurtt, G. C., Kram, T., Krey, V., Lamarque, J.-F., Masui, T., Meinshausen, M., Nakicenovic, N., Smith, S. J., and Rose, S. K.: The representative concentration pathways: an overview, Climatic Change, 109, 5–31, doi:10.1007/s10584-011-0148-z, 2011a. 34037, 34040

van Vuuren, D. P., Stehfest, E., Elzen, M., Kram, T., Vliet, J., Deetman, S., Isaac, M., Klein Goldewijk, K., Hof, A., Mendoza Beltran, A., Oostenrijk, R., and Ruijven, B.: RCP2.6: exploring the possibility to keep global mean temperature increase below 2°C, Climatic Change, 109, 95–116, doi:10.1007/s10584-011-0152-3, 2011b. 34042

ACPD
15, 34035–34062, 2015

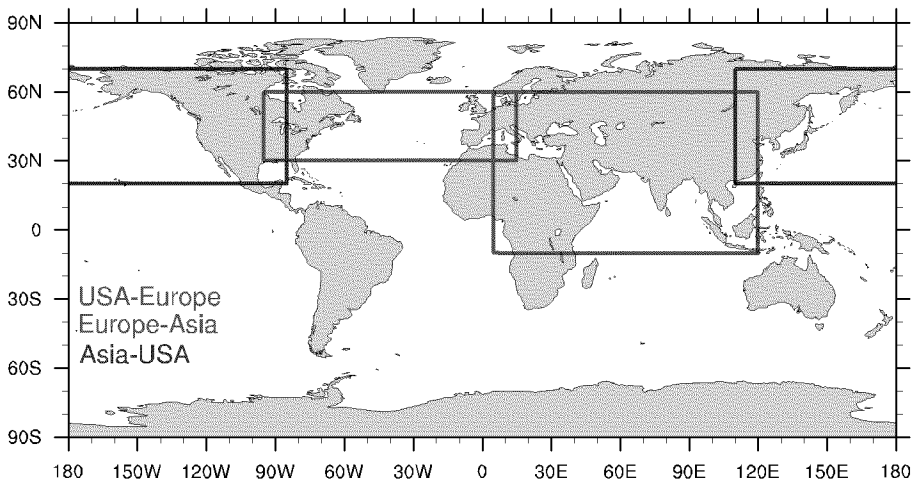


Figure 1. The regions selected for the analysis of the aviation impacts.

ACPD
15, 34035–34062, 2015

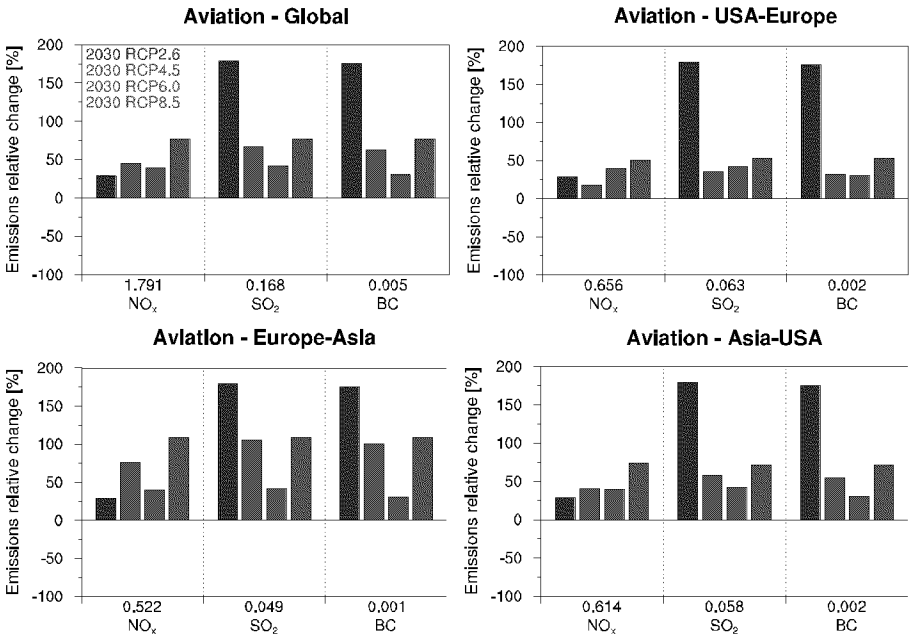


Figure 2. Relative changes in the emissions from aviation in the year 2030 with respect to 2000, for the four RCP scenarios. The changes are calculated globally (top left) and for the regions defined in Fig. 1. Total emissions for the year 2000 are indicated at the bottom of each panel, in units of Tg(species) a ^{1} for SO_2 and BC, and Tg(NO) a ^{1} for NO_x.

ACPD
15, 34035–34062, 2015

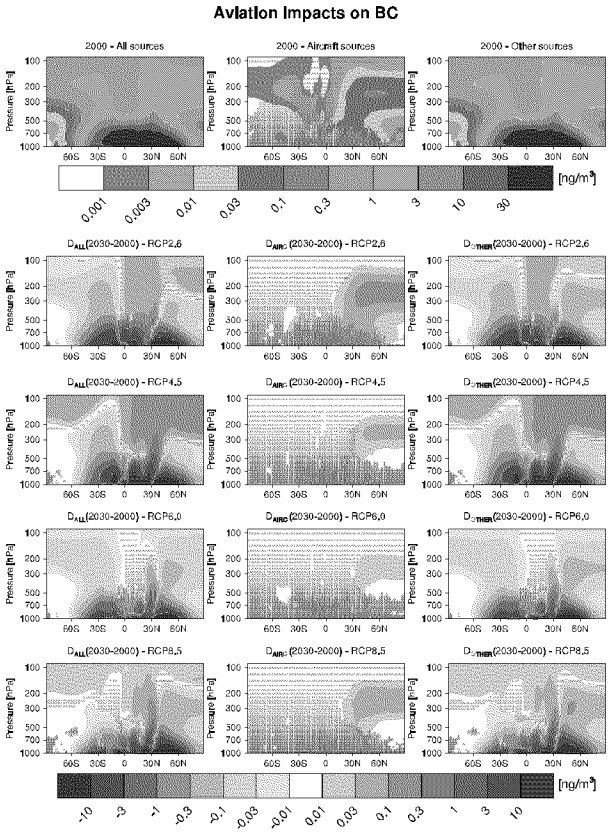


Figure 3. Annual average zonal mean concentrations of BC. The first row shows the results for year 2000 emissions: Total concentration (REF_{2000}, left), the concentration induced by aviation (Δ^{AIRC}_{2000}, middle) and the concentration induced by other sources ($NOAIRC_{2000}$, right). The lower four rows show the changes in these quantities between 2000 and 2030 for the four RCPs, as given in Eqs. (2)–(4). Grid points where the difference is not statistically significant according to a univariate t test (5 % error probability) are hatched.

ACPD
15, 34035–34062, 2015

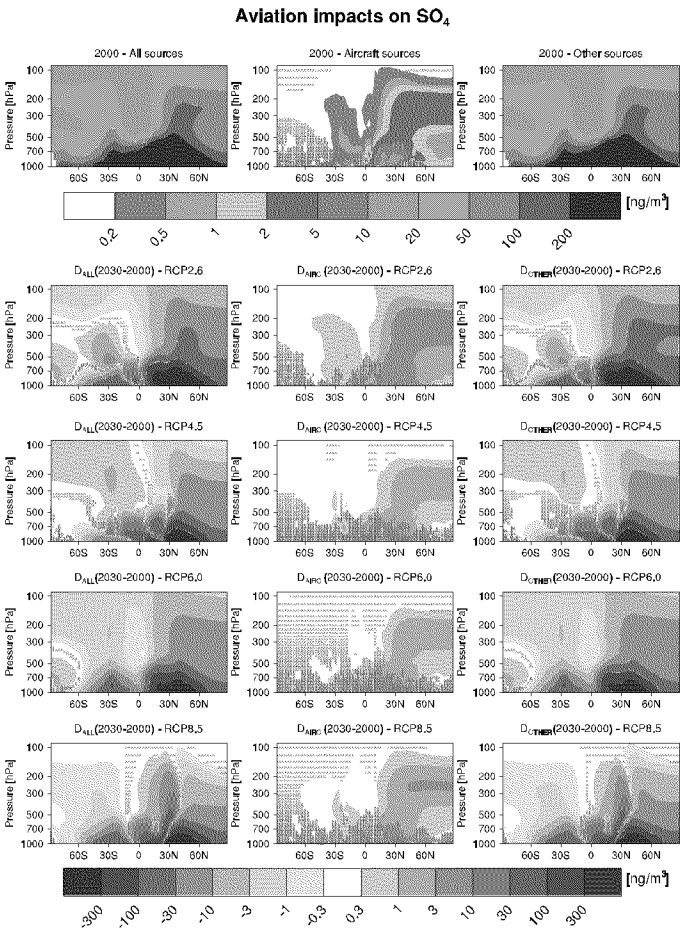


Figure 4. As in Fig. 3, but for aerosol sulfate concentration.

ACPD
15, 34035–34062, 2015

Global impact of aviation on aerosol and climate in 2030

M. Righi et al.

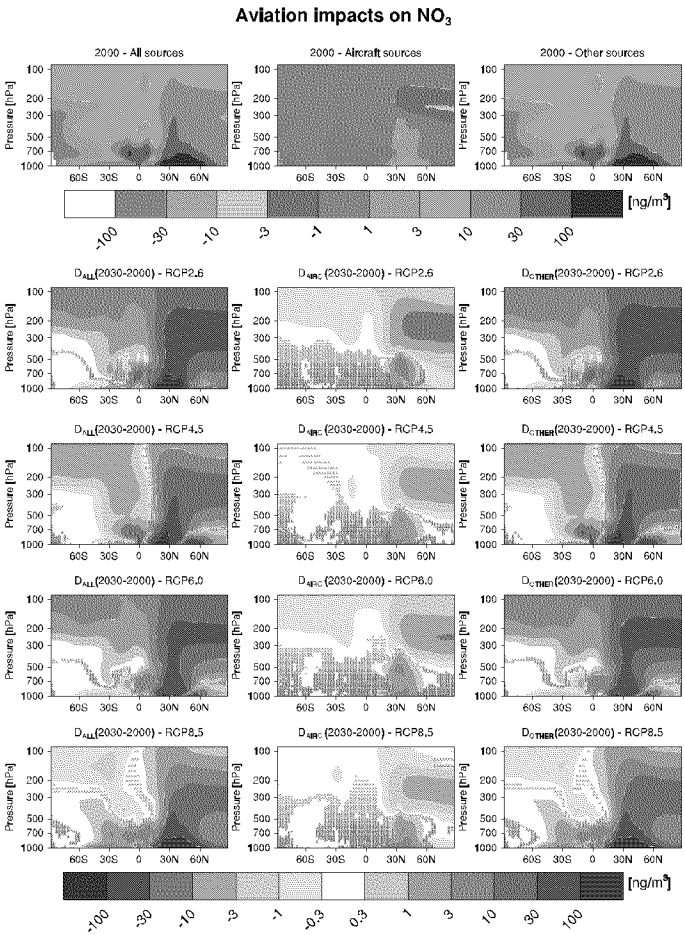


Figure 5. As in Fig. 3, but for aerosol nitrate concentration.

ACPD
15, 34035–34062, 2015

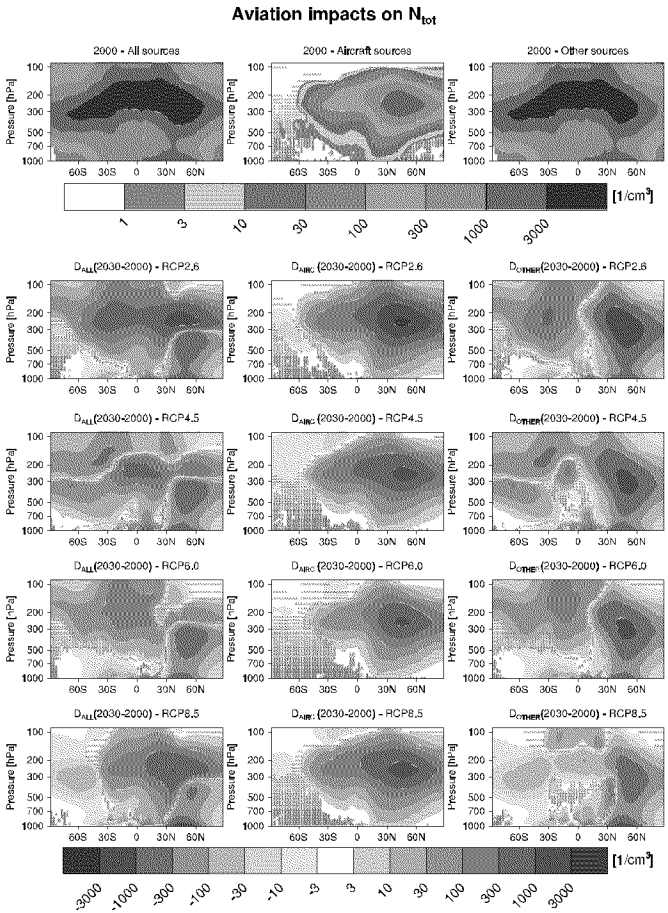


Figure 6. As in Fig. 3, but for fine particle ($\lesssim$1 µm, sum of the Aitken and accumulation mode particles) number concentrations.

ACPD
15, 34035–34062, 2015

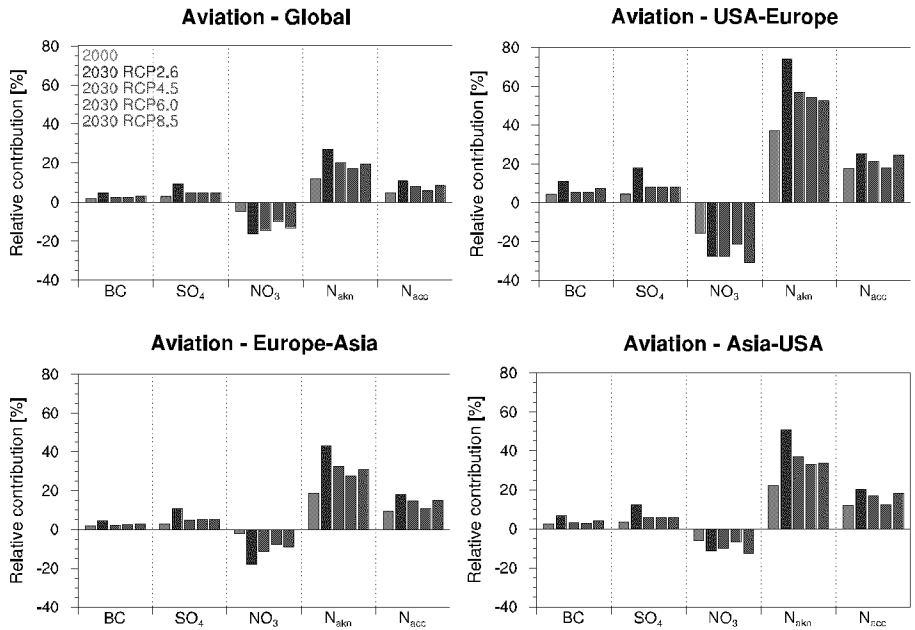


Figure 7. Relative contributions of aviation to the average mass and number burdens of selected aerosol species and different particle size modes (Aitken and accumulation mode), respectively. Results are shown for the year 2000 and for the four RCP scenarios in 2030. The values are integrated in model layers 7 to 9 (~ 8–13 km) globally and in three different regions (defined in Fig. 1).

ACPD
15, 34035–34062, 2015

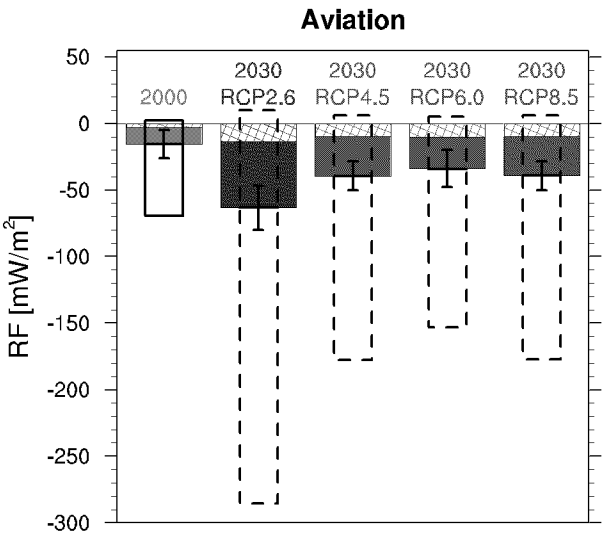


Figure 8. Global mean all-sky RF resulting from aviation emissions in the year 2000 (gray bar) and for the four RCP scenarios in 2030 (colored bars). The hatched part of each bar is the corresponding clear-sky forcing, calculated neglecting the radiative effects of clouds. The whiskers represent the 95 % confidence interval with respect to the interannual variability. The boxes correspond to the uncertainty range derived from the assumption on the size distribution of emitted particles and fuel sulfur content, as calculated by R13 for the year 2000 (solid) and rescaled here to the 2030 values (dashed).

ACPD
15, 34035–34062, 2015

Air Quality and Public Health Impacts of UK Airports– Part II: Impacts and Policy Assessment (Supporting Information)

Steve H. L. Yim[1], Marc E. J. Stettler[2], Steven R. H. Barrett[1*]

[1] Laboratory for Aviation and the Environment,Department of Aeronauticsand Astronautics, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139, United States

[2] Energy Efficient Cities Initiative,Department of Engineering, University of Cambridge, Trumpington Street, Cambridge CB2 1PZ, United Kingdom

[*] Corresponding author (Email:sbarrett@mit.edu)

Emissions by Scenario

Table 1. Aviation emissions by airport and source in the UK and Southern Great Britainin 2005 (scenario numbers 1 and 7 as referred to the main paper, respectively).

Airport	Fuel burn (g)	CO2 (g)	NOx (g)	NO (g)	NO2 (g)	HONO (g)	CO (g)	HC (g)	SO2 (g)	SO4 (g)	BC (g)	OC (g)
LHR	3.63E+11	1.13E+12	4.87E+09	4.07E+09	7.25E+08	7.40E+07	6.25E+09	1.11E+09	3.45E+08	1.26E+07	9.14E+07	2.30E+07
LGW	1.04E+11	3.27E+11	1.33E+09	1.10E+09	2.07E+08	2.10E+07	1.61E+09	2.21E+08	9.88E+07	3.61E+06	2.47E+07	7.62E+06
MAN	5.13E+10	1.61E+11	7.31E+08	6.29E+08	9.09E+07	1.07E+07	6.05E+08	7.63E+07	4.79E+07	1.74E+06	1.62E+07	5.45E+06
STN	6.73E+10	2.11E+11	8.50E+08	7.05E+08	1.30E+08	1.39E+07	9.37E+08	1.08E+08	6.36E+07	2.31E+06	1.97E+07	5.52E+06
BHX	2.29E+10	7.16E+10	2.88E+08	2.45E+08	3.73E+07	4.40E+06	3.06E+08	4.05E+07	2.12E+07	7.69E+05	7.59E+06	2.80E+06
LTN	2.08E+10	6.52E+10	2.68E+08	2.30E+08	3.30E+07	4.11E+06	2.34E+08	2.21E+07	1.95E+07	7.08E+05	6.06E+06	2.08E+06
NCL	1.11E+10	3.48E+10	1.41E+08	1.21E+08	1.78E+07	2.16E+06	1.33E+08	1.39E+07	1.03E+07	3.74E+05	3.19E+06	1.31E+06
BFS	1.18E+10	3.70E+10	1.36E+08	1.15E+08	1.84E+07	2.17E+06	1.76E+08	1.53E+07	1.11E+07	4.03E+05	3.30E+06	1.17E+06
LPL	1.03E+10	3.23E+10	1.32E+08	1.13E+08	1.72E+07	2.09E+06	1.20E+08	1.16E+07	9.56E+06	3.47E+05	3.04E+06	1.21E+06
LCY	7.77E+09	2.44E+10	9.79E+07	8.37E+07	1.27E+07	1.56E+06	9.32E+07	1.34E+07	6.96E+06	2.53E+05	2.81E+06	1.49E+06
EMA	1.08E+10	3.38E+10	1.36E+08	1.15E+08	1.81E+07	2.24E+06	1.43E+08	1.45E+07	1.01E+07	3.67E+05	3.76E+06	1.08E+06
ABZ	7.49E+09	2.35E+10	1.06E+08	9.07E+07	1.29E+07	1.57E+06	7.57E+07	1.10E+07	6.76E+06	2.45E+05	2.38E+06	1.28E+06
LBA	6.60E+09	2.07E+10	7.93E+07	6.79E+07	1.01E+07	1.22E+06	9.20E+07	1.06E+07	6.08E+06	2.21E+05	1.97E+06	8.69E+05
PIK	8.12E+09	2.55E+10	1.20E+08	1.03E+08	1.48E+07	1.80E+06	7.51E+07	9.50E+06	7.67E+06	2.79E+05	2.66E+06	6.73E+05
BHD	5.34E+09	1.68E+10	7.93E+07	6.76E+07	1.03E+07	1.23E+06	5.80E+07	8.61E+06	4.81E+06	1.75E+05	1.69E+06	9.11E+05
SOU	4.82E+09	1.51E+10	6.36E+07	5.35E+07	8.80E+06	1.02E+06	7.57E+07	9.00E+06	4.27E+06	1.55E+05	1.90E+06	1.02E+06

CWL	3.32E+09	1.04E+10	3.92E+07	3.32E+07	5.23E+06	6.07E+05	4.45E+07	4.41E+06	3.05E+06	1.11E+05	9.06E+05	4.55E+05
GLA	1.97E+10	6.19E+10	2.62E+08	2.23E+08	3.31E+07	3.95E+06	2.39E+08	2.71E+07	1.83E+07	6.63E+05	5.89E+06	2.40E+06
EDI	2.41E+10	7.56E+10	3.09E+08	2.64E+08	3.98E+07	4.77E+06	3.01E+08	3.52E+07	2.23E+07	8.10E+05	7.02E+06	2.95E+06
BRS	1.07E+10	3.35E+10	1.34E+08	1.15E+08	1.66E+07	2.04E+06	1.17E+08	1.30E+07	9.89E+06	3.59E+05	3.28E+06	1.31E+06
Source												
UK												
Aircraft	6.47E+11	2.02E+12	8.19E+09	6.74E+09	1.28E+09	1.38E+08	1.04E+10	1.57E+09	6.26E+08	2.28E+07	1.46E+08	2.00E+07
APU	1.03E+11	3.23E+11	7.16E+08	6.58E+08	5.31E+07	5.37E+06	9.50E+08	7.29E+07	1.00E+08	3.62E+06	1.38E+07	9.31E+05
GSE	2.02E+10	6.42E+10	1.17E+09	1.05E+09	1.05E+08	1.17E+07	3.11E+08	1.24E+08	9.86E+03	3.74E+02	4.26E+07	4.26E+07
TOTAL	7.72E+11	2.42E+12	1.02E+10	8.56E+09	1.46E+09	1.56E+08	1.17E+10	1.77E+09	7.27E+08	2.65E+07	2.11E+08	6.42E+07
Southern Great Britain												
Aircraft	5.70E+11	1.78E+12	7.30E+09	6.00E+09	1.16E+09	1.23E+08	9.43E+09	1.48E+09	5.52E+08	2.02E+07	1.31E+08	1.76E+07
APU	8.93E+10	2.81E+11	6.34E+08	5.83E+08	4.70E+07	4.76E+06	7.99E+08	6.19E+07	8.71E+07	3.15E+06	1.12E+07	7.52E+05
GSE	1.61E+10	5.11E+10	9.27E+08	8.35E+08	8.35E+07	9.27E+06	2.46E+08	9.82E+07	7.62E+03	2.89E+02	3.37E+07	3.37E+07
TOTAL	6.78E+11	2.12E+12	8.96E+09	7.50E+09	1.30E+09	1.38E+08	1.05E+10	1.65E+09	6.40E+08	2.34E+07	1.82E+08	5.27E+07

Table 2. Aviation emissions by airport and source in 2005 with ultra-low sulphur jet fuel (scenario number 3 as referred to the main paper).

Airport	Fuel burn (g)	CO2 (g)	NOx (g)	NO (g)	NO2 (g)	HONO (g)	CO (g)	HC (g)	SO2 (g)	SO4 (g)	BC (g)	OC (g)
LHR	3.63E+11	1.13E+12	4.87E+09	4.07E+09	7.25E+08	7.40E+07	6.25E+09	1.11E+09	6.94E+06	2.54E+05	9.14E+07	2.30E+07
LGW	1.04E+11	3.27E+11	1.33E+09	1.10E+09	2.07E+08	2.10E+07	1.61E+09	2.21E+08	1.99E+06	7.28E+04	2.47E+07	7.62E+06
MAN	5.13E+10	1.61E+11	7.31E+08	6.29E+08	9.09E+07	1.07E+07	6.05E+08	7.63E+07	9.64E+05	3.53E+04	1.62E+07	5.45E+06
STN	6.73E+10	2.11E+11	8.50E+08	7.05E+08	1.30E+08	1.39E+07	9.37E+08	1.08E+08	1.28E+06	4.67E+04	1.97E+07	5.52E+06
BHX	2.29E+10	7.16E+10	2.88E+08	2.45E+08	3.73E+07	4.40E+06	3.06E+08	4.05E+07	4.25E+05	1.56E+04	7.59E+06	2.80E+06
LTN	2.08E+10	6.52E+10	2.68E+08	2.30E+08	3.30E+07	4.11E+06	2.34E+08	2.21E+07	3.91E+05	1.44E+04	6.06E+06	2.08E+06
NCL	1.11E+10	3.48E+10	1.41E+08	1.21E+08	1.78E+07	2.16E+06	1.33E+08	1.39E+07	2.07E+05	7.58E+03	3.19E+06	1.31E+06
BFS	1.18E+10	3.70E+10	1.36E+08	1.15E+08	1.84E+07	2.17E+06	1.76E+08	1.53E+07	2.23E+05	8.15E+03	3.30E+06	1.17E+06
LPL	1.03E+10	3.23E+10	1.32E+08	1.13E+08	1.72E+07	2.09E+06	1.20E+08	1.16E+07	1.92E+05	7.03E+03	3.04E+06	1.21E+06
LCY	7.77E+09	2.44E+10	9.79E+07	8.37E+07	1.27E+07	1.56E+06	9.32E+07	1.34E+07	1.39E+05	5.13E+03	2.81E+06	1.49E+06
EMA	1.08E+10	3.38E+10	1.36E+08	1.15E+08	1.81E+07	2.24E+06	1.43E+08	1.45E+07	2.03E+05	7.43E+03	3.76E+06	1.08E+06
ABZ	7.49E+09	2.35E+10	1.06E+08	9.07E+07	1.29E+07	1.57E+06	7.57E+07	1.10E+07	1.36E+05	4.97E+03	2.38E+06	1.28E+06

LBA	6.60E+09	2.07E+10	7.93E+07	6.79E+07	1.01E+07	1.22E+06	9.20E+07	1.06E+07	1.22E+05	4.47E+03	1.97E+06	8.69E+05
PIK	8.12E+09	2.55E+10	1.20E+08	1.03E+08	1.48E+07	1.80E+06	7.51E+07	9.50E+06	1.54E+05	5.67E+03	2.66E+06	6.73E+05
BHD	5.34E+09	1.68E+10	7.93E+07	6.76E+07	1.03E+07	1.23E+06	5.80E+07	8.61E+06	9.66E+04	3.54E+03	1.69E+06	9.11E+05
SOU	4.82E+09	1.51E+10	6.36E+07	5.35E+07	8.80E+06	1.02E+06	7.57E+07	9.00E+06	8.58E+04	3.13E+03	1.90E+06	1.02E+06
CWL	3.32E+09	1.04E+10	3.92E+07	3.32E+07	5.23E+06	6.07E+05	4.45E+07	4.41E+06	6.13E+04	2.24E+03	9.06E+05	4.55E+05
GLA	1.97E+10	6.19E+10	2.62E+08	2.23E+08	3.31E+07	3.95E+06	2.39E+08	2.71E+07	3.67E+05	1.34E+04	5.89E+06	2.40E+06
EDI	2.41E+10	7.56E+10	3.09E+08	2.64E+08	3.98E+07	4.77E+06	3.01E+08	3.52E+07	4.48E+05	1.64E+04	7.02E+06	2.95E+06
BRS	1.07E+10	3.35E+10	1.34E+08	1.15E+08	1.66E+07	2.04E+06	1.17E+08	1.30E+07	1.99E+05	7.27E+03	3.28E+06	1.31E+06
Source												
Aircraft	6.47E+11	2.02E+12	8.19E+09	6.74E+09	1.28E+09	1.38E+08	1.04E+10	1.57E+09	1.26E+07	4.62E+05	1.46E+08	2.00E+07
APU	1.03E+11	3.23E+11	7.16E+08	6.58E+08	5.31E+07	5.37E+06	9.50E+08	7.29E+07	2.00E+06	7.38E+04	1.38E+07	9.31E+05
GSE	2.02E+10	6.42E+10	1.17E+09	1.05E+09	1.05E+08	1.17E+07	3.11E+08	1.24E+08	9.86E+03	3.74E+02	4.26E+07	4.26E+07
TOTAL	7.72E+11	2.42E+12	1.02E+10	8.56E+09	1.46E+09	1.56E+08	1.17E+10	1.77E+09	1.46E+07	5.35E+05	2.11E+08	6.42E+07

Table 3. Aviation emissions by airport and source in 2005 with Single Engine Taxiing(scenario number 4 as referred to the main paper).

Airport	**Fuel burn (g)**	**CO2 (g)**	**NOx (g)**	**NO (g)**	**NO2 (g)**	**HONO (g)**	**CO (g)**	**HC (g)**	**SO2 (g)**	**SO4 (g)**	**BC (g)**	**OC (g)**
LHR	3.14E+11	9.85E+11	4.71E+09	4.05E+09	5.86E+08	6.64E+07	4.06E+09	7.13E+08	2.99E+08	1.09E+07	8.52E+07	2.17E+07
LGW	9.13E+10	2.86E+11	1.28E+09	1.09E+09	1.67E+08	1.89E+07	1.10E+09	1.52E+08	8.63E+07	3.14E+06	2.35E+07	7.30E+06
MAN	4.87E+10	1.53E+11	7.21E+08	6.27E+08	8.33E+07	1.03E+07	5.02E+08	6.42E+07	4.54E+07	1.65E+06	1.58E+07	5.39E+06
STN	6.03E+10	1.89E+11	8.25E+08	7.01E+08	1.08E+08	1.28E+07	6.64E+08	7.87E+07	5.69E+07	2.07E+06	1.88E+07	5.37E+06
BHX	2.29E+10	7.16E+10	2.88E+08	2.45E+08	3.73E+07	4.40E+06	3.06E+08	4.05E+07	2.12E+07	7.69E+05	7.59E+06	2.80E+06
LTN	2.08E+10	6.52E+10	2.68E+08	2.30E+08	3.30E+07	4.11E+06	2.34E+08	2.21E+07	1.95E+07	7.08E+05	6.06E+06	2.08E+06
NCL	1.11E+10	3.48E+10	1.41E+08	1.21E+08	1.78E+07	2.16E+06	1.33E+08	1.39E+07	1.03E+07	3.74E+05	3.19E+06	1.31E+06
BFS	1.18E+10	3.70E+10	1.36E+08	1.15E+08	1.84E+07	2.17E+06	1.76E+08	1.53E+07	1.11E+07	4.03E+05	3.30E+06	1.17E+06
LPL	1.03E+10	3.23E+10	1.32E+08	1.13E+08	1.72E+07	2.09E+06	1.20E+08	1.16E+07	9.56E+06	3.47E+05	3.04E+06	1.21E+06
LCY	7.77E+09	2.44E+10	9.79E+07	8.37E+07	1.27E+07	1.56E+06	9.32E+07	1.34E+07	6.96E+06	2.53E+05	2.81E+06	1.49E+06
EMA	1.08E+10	3.38E+10	1.36E+08	1.15E+08	1.81E+07	2.24E+06	1.43E+08	1.45E+07	1.01E+07	3.67E+05	3.76E+06	1.08E+06
ABZ	7.49E+09	2.35E+10	1.06E+08	9.07E+07	1.29E+07	1.57E+06	7.57E+07	1.10E+07	6.76E+06	2.45E+05	2.38E+06	1.28E+06
LBA	6.60E+09	2.07E+10	7.93E+07	6.79E+07	1.01E+07	1.22E+06	9.20E+07	1.06E+07	6.08E+06	2.21E+05	1.97E+06	8.69E+05
PIK	8.12E+09	2.55E+10	1.20E+08	1.03E+08	1.48E+07	1.80E+06	7.51E+07	9.50E+06	7.67E+06	2.79E+05	2.66E+06	6.73E+05

BHD	5.34E+09	1.68E+10	7.93E+07	6.76E+07	1.03E+07	1.23E+06	5.80E+07	8.61E+06	4.81E+06	1.75E+05	1.69E+06	9.11E+05
SOU	4.82E+09	1.51E+10	6.36E+07	5.35E+07	8.80E+06	1.02E+06	7.57E+07	9.00E+06	4.27E+06	1.55E+05	1.90E+06	1.02E+06
CWL	3.32E+09	1.04E+10	3.92E+07	3.32E+07	5.23E+06	6.07E+05	4.45E+07	4.41E+06	3.05E+06	1.11E+05	9.06E+05	4.55E+05
GLA	1.97E+10	6.19E+10	2.62E+08	2.23E+08	3.31E+07	3.95E+06	2.39E+08	2.71E+07	1.83E+07	6.63E+05	5.89E+06	2.40E+06
EDI	2.41E+10	7.56E+10	3.09E+08	2.64E+08	3.98E+07	4.77E+06	3.01E+08	3.52E+07	2.23E+07	8.10E+05	7.02E+06	2.95E+06
BRS	1.07E+10	3.35E+10	1.34E+08	1.15E+08	1.66E+07	2.04E+06	1.17E+08	1.30E+07	9.89E+06	3.59E+05	3.28E+06	1.31E+06
Source												
Aircraft	5.76E+11	1.80E+12	7.94E+09	6.71E+09	1.08E+09	1.27E+08	7.30E+09	1.06E+09	5.58E+08	2.03E+07	1.37E+08	1.84E+07
APU	1.03E+11	3.23E+11	7.16E+08	6.58E+08	5.31E+07	5.37E+06	9.50E+08	7.29E+07	1.00E+08	3.62E+06	1.38E+07	9.31E+05
GSE	2.02E+10	6.42E+10	1.17E+09	1.05E+09	1.05E+08	1.17E+07	3.11E+08	1.24E+08	9.86E+03	3.74E+02	4.26E+07	4.26E+07
TOTAL	7.00E+11	2.19E+12	9.95E+09	8.53E+09	1.25E+09	1.46E+08	8.64E+09	1.27E+09	6.59E+08	2.40E+07	2.02E+08	6.26E+07

Table 4. Aviation emissions by airport and source in 2005 with Electrifying Ground Support Equipment (scenario number 5 as referred to the main paper).

Airport	**Fuel burn (g)**	**CO2 (g)**	**NOx (g)**	**NO (g)**	**NO2 (g)**	**HONO (g)**	**CO (g)**	**HC (g)**	**SO2 (g)**	**SO4 (g)**	**BC (g)**	**OC (g)**
LHR	3.56E+11	1.11E+12	4.50E+09	3.73E+09	6.86E+08	7.01E+07	6.14E+09	1.07E+09	3.45E+08	1.26E+07	7.69E+07	9.80E+06
LGW	1.02E+11	3.19E+11	1.19E+09	9.70E+08	1.93E+08	1.96E+07	1.57E+09	2.07E+08	9.88E+07	3.61E+06	1.94E+07	2.80E+06
MAN	4.94E+10	1.55E+11	6.14E+08	5.24E+08	8.03E+07	9.48E+06	5.74E+08	6.39E+07	4.79E+07	1.74E+06	1.17E+07	1.46E+06
STN	6.55E+10	2.05E+11	7.42E+08	6.08E+08	1.19E+08	1.28E+07	9.08E+08	9.67E+07	6.36E+07	2.31E+06	1.55E+07	1.87E+06
BHX	2.18E+10	6.82E+10	2.25E+08	1.89E+08	3.14E+07	3.72E+06	2.90E+08	3.40E+07	2.12E+07	7.69E+05	5.15E+06	6.45E+05
LTN	2.00E+10	6.28E+10	2.24E+08	1.91E+08	2.91E+07	3.66E+06	2.22E+08	1.73E+07	1.95E+07	7.08E+05	4.37E+06	5.83E+05
NCL	1.06E+10	3.33E+10	1.12E+08	9.44E+07	1.51E+07	1.85E+06	1.25E+08	1.07E+07	1.03E+07	3.74E+05	2.08E+06	3.11E+05
BFS	1.14E+10	3.57E+10	1.11E+08	9.34E+07	1.61E+07	1.91E+06	1.69E+08	1.27E+07	1.11E+07	4.03E+05	2.35E+06	3.28E+05
LPL	9.84E+09	3.09E+10	1.05E+08	8.86E+07	1.47E+07	1.81E+06	1.13E+08	8.69E+06	9.56E+06	3.47E+05	2.02E+06	2.88E+05
LCY	7.14E+09	2.24E+10	6.20E+07	5.13E+07	9.27E+06	1.17E+06	8.28E+07	9.23E+06	6.96E+06	2.53E+05	1.45E+06	2.19E+05
EMA	1.04E+10	3.26E+10	1.13E+08	9.46E+07	1.61E+07	2.00E+06	1.37E+08	1.21E+07	1.01E+07	3.67E+05	2.86E+06	2.98E+05
ABZ	6.95E+09	2.18E+10	7.46E+07	6.35E+07	9.92E+06	1.25E+06	6.70E+07	7.44E+06	6.76E+06	2.45E+05	1.23E+06	2.06E+05
LBA	6.26E+09	1.96E+10	5.92E+07	4.99E+07	8.24E+06	1.00E+06	8.65E+07	8.43E+06	6.08E+06	2.21E+05	1.22E+06	1.84E+05
PIK	7.90E+09	2.48E+10	1.07E+08	9.16E+07	1.36E+07	1.66E+06	7.15E+07	8.07E+06	7.67E+06	2.79E+05	2.17E+06	2.34E+05
BHD	4.95E+09	1.55E+10	5.74E+07	4.81E+07	8.18E+06	9.99E+05	5.20E+07	6.22E+06	4.81E+06	1.75E+05	8.88E+05	1.53E+05
SOU	4.39E+09	1.37E+10	3.85E+07	3.12E+07	6.45E+06	7.52E+05	6.87E+07	6.13E+06	4.27E+06	1.55E+05	9.75E+05	1.34E+05

CWL	3.14E+09	9.84E+09	2.85E+07	2.39E+07	4.23E+06	4.95E+05	4.16E+07	3.27E+06	3.05E+06	1.11E+05	5.15E+05	9.09E+04
GLA	1.88E+10	5.90E+10	2.07E+08	1.75E+08	2.81E+07	3.37E+06	2.26E+08	2.10E+07	1.83E+07	6.63E+05	3.85E+06	5.54E+05
EDI	2.30E+10	7.21E+10	2.43E+08	2.04E+08	3.36E+07	4.05E+06	2.83E+08	2.79E+07	2.23E+07	8.10E+05	4.51E+06	6.73E+05
BRS	1.02E+10	3.19E+10	1.04E+08	8.87E+07	1.38E+07	1.72E+06	1.09E+08	9.77E+06	9.89E+06	3.59E+05	2.16E+06	2.99E+05
Source												
Aircraft	6.47E+11	2.02E+12	8.19E+09	6.74E+09	1.28E+09	1.38E+08	1.04E+10	1.57E+09	6.26E+08	2.28E+07	1.46E+08	2.00E+07
APU	1.03E+11	3.23E+11	7.16E+08	6.58E+08	5.31E+07	5.37E+06	9.50E+08	7.29E+07	1.00E+08	3.62E+06	1.38E+07	9.31E+05
GSE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	7.50E+11	2.35E+12	8.91E+09	7.40E+09	1.34E+09	1.43E+08	1.13E+10	1.65E+09	7.27E+08	2.65E+07	1.62E+08	2.11E+07

Table 5. Aviation emissions by airport and source in 2005 with No Use of Auxiliary Power Unit (scenario number 6 as referred to the main paper).

Airport	**Fuel burn (g)**	**CO2 (g)**	**NOx (g)**	**NO (g)**	**NO2 (g)**	**HONO (g)**	**CO (g)**	**HC (g)**	**SO2 (g)**	**SO4 (g)**	**BC (g)**	**OC (g)**
LHR	3.16E+11	9.87E+11	4.52E+09	3.76E+09	6.97E+08	7.12E+07	5.85E+09	1.08E+09	2.99E+08	1.09E+07	8.65E+07	2.26E+07
LGW	8.88E+10	2.78E+11	1.21E+09	9.90E+08	1.98E+08	2.02E+07	1.46E+09	2.12E+08	8.34E+07	3.05E+06	2.21E+07	7.42E+06
MAN	4.50E+10	1.41E+11	6.90E+08	5.90E+08	8.77E+07	1.04E+07	5.37E+08	7.14E+07	4.17E+07	1.51E+06	1.49E+07	5.35E+06
STN	5.97E+10	1.87E+11	7.99E+08	6.59E+08	1.26E+08	1.35E+07	8.83E+08	1.05E+08	5.61E+07	2.05E+06	1.84E+07	5.43E+06
BHX	1.97E+10	6.18E+10	2.69E+08	2.28E+08	3.60E+07	4.25E+06	2.71E+08	3.82E+07	1.81E+07	6.56E+05	6.91E+06	2.75E+06
LTN	1.78E+10	5.58E+10	2.48E+08	2.12E+08	3.16E+07	3.96E+06	2.08E+08	2.04E+07	1.65E+07	5.99E+05	5.49E+06	2.04E+06
NCL	9.54E+09	2.99E+10	1.31E+08	1.12E+08	1.71E+07	2.08E+06	1.18E+08	1.28E+07	8.75E+06	3.17E+05	2.89E+06	1.28E+06
BFS	1.01E+10	3.18E+10	1.26E+08	1.06E+08	1.76E+07	2.09E+06	1.57E+08	1.42E+07	9.42E+06	3.42E+05	3.02E+06	1.15E+06
LPL	8.77E+09	2.75E+10	1.23E+08	1.04E+08	1.66E+07	2.02E+06	1.03E+08	1.02E+07	8.05E+06	2.92E+05	2.71E+06	1.18E+06
LCY	6.42E+09	2.02E+10	9.15E+07	7.80E+07	1.22E+07	1.51E+06	6.81E+07	1.12E+07	5.64E+06	2.05E+05	2.33E+06	1.46E+06
EMA	9.43E+09	2.96E+10	1.28E+08	1.08E+08	1.76E+07	2.18E+06	1.26E+08	1.35E+07	8.75E+06	3.18E+05	3.51E+06	1.06E+06
ABZ	6.32E+09	1.99E+10	9.82E+07	8.43E+07	1.23E+07	1.52E+06	6.19E+07	9.78E+06	5.61E+06	2.03E+05	2.08E+06	1.25E+06
LBA	5.64E+09	1.77E+10	7.41E+07	6.32E+07	9.75E+06	1.18E+06	7.79E+07	9.74E+06	5.13E+06	1.86E+05	1.77E+06	8.51E+05
PIK	7.12E+09	2.24E+10	1.14E+08	9.78E+07	1.44E+07	1.75E+06	6.78E+07	8.94E+06	6.70E+06	2.43E+05	2.50E+06	6.59E+05
BHD	4.62E+09	1.45E+10	7.48E+07	6.37E+07	9.96E+06	1.20E+06	4.56E+07	7.24E+06	4.10E+06	1.48E+05	1.42E+06	8.89E+05
SOU	4.06E+09	1.27E+10	6.00E+07	5.03E+07	8.54E+06	9.92E+05	5.81E+07	7.54E+06	3.51E+06	1.27E+05	1.61E+06	9.98E+05
CWL	2.77E+09	8.69E+09	3.64E+07	3.07E+07	5.02E+06	5.85E+05	3.77E+07	4.00E+06	2.51E+06	9.09E+04	7.73E+05	4.44E+05
GLA	1.69E+10	5.32E+10	2.44E+08	2.07E+08	3.18E+07	3.81E+06	2.06E+08	2.45E+07	1.55E+07	5.63E+05	5.28E+06	2.35E+06

EDI	2.06E+10	6.46E+10	2.88E+08	2.44E+08	3.83E+07	4.59E+06	2.58E+08	3.23E+07	1.88E+07	6.85E+05	6.23E+06	2.89E+06
BRS	9.05E+09	2.84E+10	1.24E+08	1.06E+08	1.58E+07	1.96E+06	1.05E+08	1.21E+07	8.29E+06	3.00E+05	2.95E+06	1.29E+06
Source												
Aircraft	6.47E+11	2.02E+12	8.19E+09	6.74E+09	1.28E+09	1.38E+08	1.04E+10	1.57E+09	6.26E+08	2.28E+07	1.46E+08	2.00E+07
APU	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GSE	2.02E+10	6.42E+10	1.17E+09	1.05E+09	1.05E+08	1.17E+07	3.11E+08	1.24E+08	9.86E+03	3.74E+02	4.26E+07	4.26E+07
TOTAL	6.69E+11	2.09E+12	9.48E+09	7.90E+09	1.41E+09	1.51E+08	1.07E+10	1.70E+09	6.26E+08	2.29E+07	1.94E+08	6.29E+07

Table 6. Aviation emissions by airportand source in Southern Great Britain in 2005 with all the mitigation strategies(scenario number 7m as referred to the main paper).

Airport	**Fuel burn (g)**	**CO2 (g)**	**NOx (g)**	**NO (g)**	**NO2 (g)**	**HONO (g)**	**CO (g)**	**HC (g)**	**SO2 (g)**	**SO4 (g)**	**BC (g)**	**OC (g)**
LHR	2.61E+11	8.18E+11	3.99E+09	3.39E+09	5.25E+08	5.99E+07	3.57E+09	6.38E+08	5.09E+06	1.86E+05	6.65E+07	8.37E+06
LGW	7.32E+10	2.29E+11	1.02E+09	8.52E+08	1.45E+08	1.65E+07	9.14E+08	1.27E+08	1.43E+06	5.21E+04	1.55E+07	2.31E+06
MAN	4.03E+10	1.27E+11	5.63E+08	4.83E+08	6.93E+07	8.75E+06	4.01E+08	4.62E+07	7.87E+05	2.89E+04	1.00E+07	1.31E+06
STN	5.09E+10	1.60E+11	6.65E+08	5.58E+08	9.43E+07	1.13E+07	5.83E+08	6.35E+07	9.92E+05	3.63E+04	1.34E+07	1.61E+06
BHX	1.86E+10	5.84E+10	2.05E+08	1.72E+08	3.00E+07	3.57E+06	2.54E+08	3.17E+07	3.64E+05	1.33E+04	4.44E+06	5.91E+05
LTN	1.70E+10	5.34E+10	2.04E+08	1.73E+08	2.76E+07	3.51E+06	1.95E+08	1.57E+07	3.32E+05	1.22E+04	3.84E+06	5.47E+05
LPL	8.31E+09	2.61E+10	9.59E+07	7.99E+07	1.40E+07	1.73E+06	9.58E+07	7.39E+06	1.62E+05	5.94E+03	1.68E+06	2.64E+05
LCY	5.80E+09	1.82E+10	5.55E+07	4.56E+07	8.80E+06	1.12E+06	5.76E+07	6.94E+06	1.13E+05	4.17E+03	9.53E+05	1.84E+05
EMA	9.04E+09	2.83E+10	1.05E+08	8.73E+07	1.55E+07	1.94E+06	1.20E+08	1.12E+07	1.77E+05	6.46E+03	2.65E+06	2.82E+05
SOU	3.61E+09	1.13E+10	3.49E+07	2.79E+07	6.18E+06	7.26E+05	5.08E+07	4.70E+06	7.05E+04	2.58E+03	6.69E+05	1.13E+05
CWL	2.58E+09	8.09E+09	2.57E+07	2.12E+07	4.02E+06	4.73E+05	3.49E+07	2.86E+06	5.04E+04	1.85E+03	3.76E+05	8.15E+04
BRS	8.53E+09	2.68E+10	9.37E+07	7.91E+07	1.30E+07	1.64E+06	9.68E+07	8.94E+06	1.67E+05	6.10E+03	1.79E+06	2.73E+05
Source												
Aircraft	4.99E+11	1.56E+12	7.05E+09	5.97E+09	9.52E+08	1.11E+08	6.38E+09	9.64E+08	9.73E+06	3.56E+05	1.22E+08	1.59E+07
APU	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GSE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	4.99E+11	1.56E+12	7.05E+09	5.96E+09	9.55E+08	1.11E+08	6.39E+09	9.62E+08	9.73E+06	3.56E+05	1.22E+08	1.59E+07

Table 7. Aviation emissions by airport and source in Southern Great Britain in 2030 with runway capacity constraints (scenario number 8 as referred to the main paper).

Airport	Fuel burn (g)	CO2 (g)	NOx (g)	NO (g)	NO2 (g)	HONO (g)	CO (g)	HC (g)	SO2 (g)	SO4 (g)	BC (g)	OC (g)
LHR	4.39E+11	1.38E+12	7.03E+09	5.90E+09	1.02E+09	1.03E+08	4.72E+09	3.47E+08	4.18E+08	1.52E+07	1.10E+08	2.64E+07
LGW	1.32E+11	4.13E+11	1.85E+09	1.55E+09	2.74E+08	2.80E+07	1.50E+09	1.34E+08	1.24E+08	4.53E+06	3.22E+07	9.70E+06
MAN	9.88E+10	3.11E+11	1.68E+09	1.46E+09	1.97E+08	2.35E+07	8.13E+08	8.57E+07	9.29E+07	3.37E+06	2.94E+07	9.33E+06
STN	1.01E+11	3.17E+11	1.51E+09	1.28E+09	2.03E+08	2.23E+07	1.00E+09	9.90E+07	9.51E+07	3.46E+06	2.47E+07	8.43E+06
BHX	7.70E+10	2.42E+11	1.32E+09	1.15E+09	1.51E+08	1.83E+07	6.12E+08	6.44E+07	7.25E+07	2.63E+06	2.40E+07	7.19E+06
LTN	4.18E+10	1.31E+11	7.01E+08	6.15E+08	7.71E+07	9.73E+06	2.97E+08	3.39E+07	3.93E+07	1.42E+06	1.13E+07	4.08E+06
LPL	1.49E+10	4.70E+10	2.44E+08	2.13E+08	2.73E+07	3.43E+06	1.14E+08	1.29E+07	1.40E+07	5.09E+05	4.13E+06	1.53E+06
LCY	2.49E+10	7.84E+10	3.41E+08	2.97E+08	3.82E+07	5.00E+06	1.96E+08	2.53E+07	2.30E+07	8.33E+05	8.75E+06	3.45E+06
EMA	1.13E+10	3.56E+10	1.65E+08	1.42E+08	2.00E+07	2.41E+06	9.96E+07	1.11E+07	1.06E+07	3.85E+05	3.25E+06	1.21E+06
SOU	2.09E+10	6.56E+10	2.79E+08	2.41E+08	3.32E+07	4.16E+06	1.86E+08	2.31E+07	1.92E+07	6.98E+05	7.09E+06	2.78E+06
CWL	4.47E+09	1.40E+10	5.85E+07	5.01E+07	7.33E+06	8.84E+05	4.18E+07	5.26E+06	4.11E+06	1.49E+05	1.55E+06	5.83E+05
BRS	2.36E+10	7.44E+10	3.87E+08	3.39E+08	4.24E+07	5.38E+06	1.59E+08	1.91E+07	2.21E+07	8.01E+05	6.85E+06	2.52E+06
Source												
Aircraft	8.04E+11	2.52E+12	1.31E+10	1.09E+10	1.88E+09	2.03E+08	7.74E+09	5.67E+08	7.78E+08	2.84E+07	1.89E+08	2.50E+07
APU	1.59E+11	5.00E+11	1.03E+09	9.48E+08	7.66E+07	7.74E+06	1.57E+09	1.36E+08	1.55E+08	5.61E+06	1.55E+07	1.05E+06
GSE	2.39E+10	7.58E+10	1.37E+09	1.23E+09	1.23E+08	1.37E+07	3.63E+08	1.45E+08	1.10E+08	4.16E+04	4.98E+07	4.98E+07
TOTAL	9.89E+11	3.11E+12	1.56E+10	1.33E+10	2.09E+09	2.26E+08	9.77E+09	8.59E+08	9.33E+08	3.41E+07	2.64E+08	7.66E+07

Table 8. Aviation emissions by airport and source in Southern Great Britain in 2030 without runway capacity constraints (scenario number 9 as referred to the main paper).

Airport	Fuel burn (g)	CO2 (g)	NOx (g)	NO (g)	NO2 (g)	HONO (g)	CO (g)	HC (g)	SO2 (g)	SO4 (g)	BC (g)	OC (g)
LHR	5.89E+11	1.85E+12	9.23E+09	7.73E+09	1.35E+09	1.36E+08	6.46E+09	4.88E+08	5.60E+08	2.04E+07	1.45E+08	3.63E+07
LGW	1.39E+11	4.38E+11	1.93E+09	1.62E+09	2.83E+08	2.91E+07	1.57E+09	1.42E+08	1.32E+08	4.80E+06	3.36E+07	1.04E+07
MAN	9.90E+10	3.11E+11	1.70E+09	1.48E+09	1.99E+08	2.36E+07	8.06E+08	8.50E+07	9.31E+07	3.38E+06	2.93E+07	9.30E+06
STN	6.92E+10	2.17E+11	9.97E+08	8.45E+08	1.35E+08	1.49E+07	7.06E+08	6.87E+07	6.52E+07	2.37E+06	1.68E+07	5.90E+06
BHX	4.10E+10	1.29E+11	6.12E+08	5.30E+08	7.29E+07	8.91E+06	3.55E+08	4.07E+07	3.83E+07	1.39E+06	1.20E+07	4.41E+06
LTN	2.95E+10	9.27E+10	4.81E+08	4.20E+08	5.34E+07	6.72E+06	2.21E+08	2.52E+07	2.77E+07	1.00E+06	8.08E+06	2.94E+06
LPL	1.35E+10	4.26E+10	2.20E+08	1.92E+08	2.46E+07	3.09E+06	1.05E+08	1.18E+07	1.27E+07	4.61E+05	3.76E+06	1.39E+06
LCY	2.51E+10	7.90E+10	3.42E+08	2.99E+08	3.84E+07	5.02E+06	1.97E+08	2.55E+07	2.31E+07	8.38E+05	8.86E+06	3.49E+06

EMA	1.11E+10	3.50E+10	1.67E+08	1.44E+08	2.00E+07	2.41E+06	9.54E+07	1.07E+07	1.04E+07	3.79E+05	3.18E+06	1.16E+06
SOU	9.51E+09	2.99E+10	1.24E+08	1.07E+08	1.49E+07	1.86E+06	8.32E+07	1.07E+07	8.75E+06	3.17E+05	3.39E+06	1.33E+06
CWL	3.94E+09	1.24E+10	5.25E+07	4.50E+07	6.54E+06	7.91E+05	3.68E+07	4.56E+06	3.63E+06	1.32E+05	1.32E+06	4.97E+05
BRS	2.24E+10	7.06E+10	3.73E+08	3.27E+08	4.05E+07	5.16E+06	1.46E+08	1.75E+07	2.10E+07	7.62E+05	6.37E+06	2.33E+06
Source												
Aircraft	8.53E+11	2.68E+12	1.36E+10	1.14E+10	2.02E+09	2.14E+08	8.57E+09	6.17E+08	8.26E+08	3.01E+07	1.97E+08	2.64E+07
APU	1.73E+11	5.43E+11	1.09E+09	9.98E+08	8.06E+07	8.14E+06	1.77E+09	1.54E+08	1.68E+08	6.09E+06	1.60E+07	1.08E+06
GSE	2.43E+10	7.69E+10	1.39E+09	1.25E+09	1.25E+08	1.39E+07	3.68E+08	1.47E+08	1.11E+08	4.20E+04	5.05E+02	5.05E+07
TOTAL	1.05E+12	3.31E+12	1.62E+10	1.38E+10	2.24E+09	2.38E+08	1.08E+10	9.31E+08	9.96E+08	3.64E+07	2.73E+08	7.89E+07

Table 9. Aviation emissions by airportand source in Southern Great Britainin 2030 with the replacement of Heathrow by a new airport in the Thames Estuary (THA) (scenario number 10 as referred to the main paper).

Airport	**Fuel burn (g)**	**CO2 (g)**	**NOx (g)**	**NO (g)**	**NO2 (g)**	**HONO (g)**	**CO (g)**	**HC (g)**	**SO2 (g)**	**SO4 (g)**	**BC (g)**	**OC (g)**
THA	5.89E+11	1.85E+12	9.23E+09	7.73E+09	1.35E+09	1.36E+08	6.46E+09	4.88E+08	5.60E+08	2.04E+07	1.45E+08	3.63E+07
LGW	1.39E+11	4.38E+11	1.93E+09	1.62E+09	2.83E+08	2.91E+07	1.57E+09	1.42E+08	1.32E+08	4.80E+06	3.36E+07	1.04E+07
MAN	9.90E+10	3.11E+11	1.70E+09	1.48E+09	1.99E+08	2.36E+07	8.06E+08	8.50E+07	9.31E+07	3.38E+06	2.93E+07	9.30E+06
STN	6.92E+10	2.17E+11	9.97E+08	8.45E+08	1.35E+08	1.49E+07	7.06E+08	6.87E+07	6.52E+07	2.37E+06	1.68E+07	5.90E+06
BHX	4.10E+10	1.29E+11	6.12E+08	5.30E+08	7.29E+07	8.91E+06	3.55E+08	4.07E+07	3.83E+07	1.39E+06	1.20E+07	4.41E+06
LTN	2.95E+10	9.27E+10	4.81E+08	4.20E+08	5.34E+07	6.72E+06	2.21E+08	2.52E+07	2.77E+07	1.00E+06	8.08E+06	2.94E+06
LPL	1.35E+10	4.26E+10	2.20E+08	1.92E+08	2.46E+07	3.09E+06	1.05E+08	1.18E+07	1.27E+07	4.61E+05	3.76E+06	1.39E+06
LCY	2.51E+10	7.90E+10	3.42E+08	2.99E+08	3.84E+07	5.02E+06	1.97E+08	2.55E+07	2.31E+07	8.38E+05	8.86E+06	3.49E+06
EMA	1.11E+10	3.50E+10	1.67E+08	1.44E+08	2.00E+07	2.41E+06	9.54E+07	1.07E+07	1.04E+07	3.79E+05	3.18E+06	1.16E+06
SOU	9.51E+09	2.99E+10	1.24E+08	1.07E+08	1.49E+07	1.86E+06	8.32E+07	1.07E+07	8.75E+06	3.17E+05	3.39E+06	1.33E+06
CWL	3.94E+09	1.24E+10	5.25E+07	4.50E+07	6.54E+06	7.91E+05	3.68E+07	4.56E+06	3.63E+06	1.32E+05	1.32E+06	4.97E+05
BRS	2.24E+10	7.06E+10	3.73E+08	3.27E+08	4.05E+07	5.16E+06	1.46E+08	1.75E+07	2.10E+07	7.62E+05	6.37E+06	2.33E+06
Source												
Aircraft	8.53E+11	2.68E+12	1.36E+10	1.14E+10	2.02E+09	2.14E+08	8.57E+09	6.17E+08	8.26E+08	3.01E+07	1.97E+08	2.64E+07
APU	1.73E+11	5.43E+11	1.09E+09	9.98E+08	8.06E+07	8.14E+06	1.77E+09	1.54E+08	1.68E+08	6.09E+06	1.60E+07	1.08E+06
GSE	2.43E+10	7.69E+10	1.39E+09	1.25E+09	1.25E+08	1.39E+07	3.68E+08	1.47E+08	1.11E+08	4.20E+04	5.05E+02	5.05E+07
TOTAL	1.05E+12	3.31E+12	1.62E+10	1.38E+10	2.24E+09	2.38E+08	1.08E+10	9.31E+08	9.96E+08	3.64E+07	2.73E+08	7.89E+07

Table 10. Aviation emissions by airportand source in Southern Great Britain in 2030 without runway capacity constraints but applying all the mitigation strategies(scenario number 9m as referred to the main paper).

Airport	Fuel burn (g)	CO2 (g)	NOx (g)	NO (g)	NO2 (g)	HONO (g)	CO (g)	HC (g)	SO2 (g)	SO4 (g)	BC (g)	OC (g)
LHR	3.99E+11	1.25E+12	7.75E+09	6.62E+09	9.94E+08	1.11E+08	3.16E+09	2.04E+08	7.77E+06	2.83E+05	1.03E+08	1.28E+07
LGW	9.36E+10	2.94E+11	1.49E+09	1.26E+09	2.00E+08	2.29E+07	8.48E+08	6.88E+07	1.82E+06	6.66E+04	2.01E+07	2.94E+06
MAN	7.71E+10	2.43E+11	1.40E+09	1.21E+09	1.59E+08	2.01E+07	5.02E+08	4.43E+07	1.51E+06	5.53E+04	1.93E+07	2.53E+06
STN	5.15E+10	1.62E+11	7.85E+08	6.71E+08	9.98E+07	1.21E+07	4.29E+08	3.62E+07	1.00E+06	3.68E+04	1.00E+07	1.62E+06
BHX	3.33E+10	1.05E+11	4.72E+08	4.02E+08	6.07E+07	7.53E+06	2.84E+08	2.74E+07	6.51E+05	2.39E+04	7.18E+06	1.06E+06
LTN	2.39E+10	7.54E+10	3.85E+08	3.33E+08	4.53E+07	5.84E+06	1.71E+08	1.60E+07	4.67E+05	1.71E+04	4.99E+06	7.76E+05
LPL	1.10E+10	3.45E+10	1.75E+08	1.51E+08	2.08E+07	2.65E+06	7.93E+07	7.37E+06	2.14E+05	7.87E+03	2.27E+06	3.54E+05
LCY	1.95E+10	6.15E+10	2.29E+08	1.97E+08	2.87E+07	3.91E+06	1.39E+08	1.37E+07	3.81E+05	1.40E+04	4.76E+06	6.40E+05
EMA	9.11E+09	2.86E+10	1.29E+08	1.10E+08	1.68E+07	2.05E+06	7.79E+07	7.26E+06	1.78E+05	6.53E+03	1.93E+06	2.89E+05
SOU	7.43E+09	2.34E+10	8.20E+07	6.94E+07	1.12E+07	1.44E+06	6.25E+07	6.22E+06	1.45E+05	5.33E+03	1.84E+06	2.41E+05
CWL	3.14E+09	9.85E+09	3.66E+07	3.08E+07	5.14E+06	6.33E+05	2.93E+07	3.00E+06	6.12E+04	2.25E+03	7.51E+05	1.00E+05
BRS	1.82E+10	5.72E+10	2.97E+08	2.57E+08	3.41E+07	4.43E+06	1.13E+08	1.05E+07	3.55E+05	1.30E+04	3.89E+06	5.90E+05
Source												
Aircraft	7.47E+11	2.35E+12	1.32E+10	1.13E+10	1.68E+09	1.95E+08	5.90E+09	4.45E+08	1.46E+07	5.32E+05	1.80E+08	2.39E+07
APU	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GSE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	7.47E+11	2.35E+12	1.32E+10	1.13E+10	1.68E+09	1.95E+08	5.89E+09	4.46E+08	1.46E+07	5.32E+05	1.80E+08	2.39E+07

Table 11. Aviation emissions by airportand source in Southern Great Britain in 2030 with the replacement of Heathrow by a new airport in Thames Estuary(THA) and applying all the mitigation strategies (scenario number 10m as referred to the main paper).

Airport	Fuel burn (g)	CO2 (g)	NOx (g)	NO (g)	NO2 (g)	HONO (g)	CO (g)	HC (g)	SO2 (g)	SO4 (g)	BC (g)	OC (g)
THA	3.99E+11	1.25E+12	7.75E+09	6.62E+09	9.94E+08	1.11E+08	3.16E+09	2.04E+08	7.77E+06	2.83E+05	1.03E+08	1.28E+07
LGW	9.36E+10	2.94E+11	1.49E+09	1.26E+09	2.00E+08	2.29E+07	8.48E+08	6.88E+07	1.82E+06	6.66E+04	2.01E+07	2.94E+06
MAN	7.71E+10	2.43E+11	1.40E+09	1.21E+09	1.59E+08	2.01E+07	5.02E+08	4.43E+07	1.51E+06	5.53E+04	1.93E+07	2.53E+06
STN	5.15E+10	1.62E+11	7.85E+08	6.71E+08	9.98E+07	1.21E+07	4.29E+08	3.62E+07	1.00E+06	3.68E+04	1.00E+07	1.62E+06
BHX	3.33E+10	1.05E+11	4.72E+08	4.02E+08	6.07E+07	7.53E+06	2.84E+08	2.74E+07	6.51E+05	2.39E+04	7.18E+06	1.06E+06
LTN	2.39E+10	7.54E+	3.85E+	3.33E+	4.53E+	5.84E+0	1.71E+	1.60E+	4.67E+	1.71E+	4.99E+	7.76E+

		10	08	08	07	6	08	07	05	04	06	05
LPL	1.10E+10	3.45E+10	1.75E+08	1.51E+08	2.08E+07	2.65E+06	7.93E+07	7.37E+06	2.14E+05	7.87E+03	2.27E+06	3.54E+05
LCY	1.95E+10	6.15E+10	2.29E+08	1.97E+08	2.87E+07	3.91E+06	1.39E+08	1.37E+07	3.81E+05	1.40E+04	4.76E+06	6.40E+05
EMA	9.11E+09	2.86E+10	1.29E+08	1.10E+08	1.68E+07	2.05E+06	7.79E+07	7.26E+06	1.78E+05	6.53E+03	1.93E+06	2.89E+05
SOU	7.43E+09	2.34E+10	8.20E+07	6.94E+07	1.12E+07	1.44E+06	6.25E+07	6.22E+06	1.45E+05	5.33E+03	1.84E+06	2.41E+05
CWL	3.14E+09	9.85E+09	3.66E+07	3.08E+07	5.14E+06	6.33E+05	2.93E+07	3.00E+06	6.12E+04	2.25E+03	7.51E+05	1.00E+05
BRS	1.82E+10	5.72E+10	2.97E+08	2.57E+08	3.41E+07	4.43E+06	1.13E+08	1.05E+07	3.55E+05	1.30E+04	3.89E+06	5.90E+05
Source												
Aircraft	7.47E+11	2.35E+12	1.32E+10	1.13E+10	1.68E+09	1.95E+08	5.90E+09	4.45E+08	1.46E+07	5.32E+05	1.80E+08	2.39E+07
APU	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GSE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	7.47E+11	2.35E+12	1.32E+10	1.13E+10	1.68E+09	1.95E+08	5.89E+09	4.46E+08	1.46E+07	5.32E+05	1.80E+08	2.39E+07

Projection of future background emissions

For the future year scenarios, weuse CMAQ to simulate air quality in2030. Since a background emissions inventory in 2030 is not available, we apply different projection factors for each sector to a year 2020 emissions inventory obtained from the National Atmospheric Emissions Inventory(Wagner 2009). The factors are estimated based on the ratio of the green house gas emissions for each sector between in year 2020 and in year 2025shown in the report of Department of Energy and Climate Change (DECC, 2010), on the assumption that for marginal changes in emissions, most major emissions track greenhouse gases approximately on a per sector basis The same projection factors are applied to project the emissions in year 2025 out to 2030. The projectiorn factors for each sector are shown in Table 12

Tabel 12. The projection factors for each sector applied to project emissions in 2020 to 2030.

	Projection factors from 2020 to 2030
Energy supply	0.76
Business	1.02
Industrial Processes	0.89
Transport	0.98
Residential	1.10
Waste Management	1.00

Evaluation of WRF

Figure 1. Locations of observational wind (x) and temperature stations (O).

Table 13. Statistical parameters of the validations of WRF: [1] is in m/s; [2] is in K.

	Wind	Temperature
Model mean	5.06[1]	283.22[2]
Model SD	2.64[1]	5.76[2]
Observed mean	4.72[1]	283.44[2]
Observed SD	2.56[1]	5.74[2]
Index of agreement	0.91	0.97
Correlation	0.88	0.95
Annual mean bias (%)	7.24	-0.08
Root-mean-square error	1.40[1]	1.90[2]
Mean bias	0.34[1]	-0.23[2]
Mean normalized bias (%)	19.08	-0.08
Normalized mean bias (%)	9.83	-0.08
Mean fractional bias (%)	8.70	-0.08
Mean error	1.04[1]	1.46[2]
Normalized mean gross error (%)	23.92	0.51

Mean normalized gross error (%)	33.22	0.51
Mean fractional error (%)	25.75	0.51
Data availability (%)	94.62	98.60

Evaluation of CMAQ

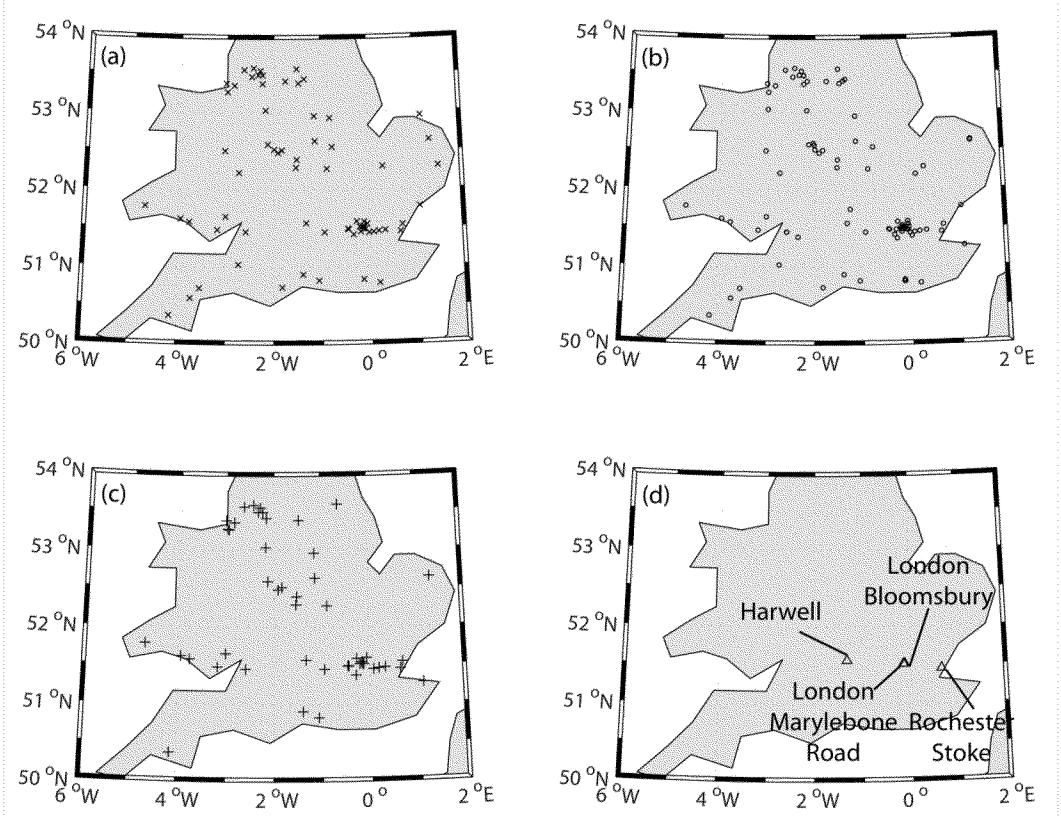


Figure 2. Model validation with measurement at (a) 68 O$_3$, at (b) 88 NO_2, at (c) 48 PM_{10} and at (d) 4 $PM_{2.5}$ stations.

Table 14. Averaged statistic parameters (USEPA, 2007) of the validations of CMAQ. [1] is in ppb; [2] is in $\mu g/m^3$

	O_3	NO_2	PM_{10}
Model mean	30.34[1]	7.39[1]	25.57[2]
Model SD	8.42[1]	5.38[1]	29.87[2]
Observed mean	21.87[1]	18.15[1]	23.29[2]
Observed SD	12.00[1]	10.65[1]	13.59[2]
Index of agreement	0.64	0.55	0.45
Correlation	0.55	0.43	0.33
Annual mean bias (%)	38.70	-59.26	9.78
Root-mean-square error	13.63[1]	14.87[1]	30.71[2]

Mean bias	8.47[1]	-10.75[1]	2.26[2]
Mean normalized bias (%)	187.42	-42.74	39.35
Normalized mean bias (%)	44.43	-56.40	14.84
Mean fractional bias (%)	45.14	-82.21	-21.47
Mean error	10.95[1]	11.84[1]	18.83[2]
Normalized mean gross error (%)	55.42	64.88	83.16
Mean normalized gross error (%)	194.98	66.75	102.62
Mean fractional error(%)	54.52	94.35	72.61
Data availability (%)	90.50	85.95	89.43

Table 15. Averaged statistic parameters (USEPA, 2007) of the validations of modelled $PM_{2.5}$.

	Harwell	**Rochester Stoke**	**London Bloomsbury**	**London Marylebone Road**
Model mean (µg/m^3)	9.18	9.30	8.81	8.72
Model SD (µg/m^3)	5.27	6.63	6.86	10.26
Observed mean (µg/m^3)	10.53	10.84	12.83	19.23
Observed SD (µg/m^3)	10.64	8.72	8.40	8.31
Index of agreement	0.61	0.72	0.73	0.57
Correlation	0.52	0.57	0.63	0.44
Annual mean bias (%)	-12.78	-14.19	-31.31	-54.65
Root-mean-square error (µg/m^3)	9.18	7.50	7.82	14.50
Mean bias (µg/m^3)	-1.35	-1.54	-4.02	-10.51
Mean normalized bias (%)	-18.40	-11.82	-32.71	-51.83
Normalized mean bias (%)	-12.78	-14.19	-31.31	-54.65
Mean fractional bias (%)	-51.13	-34.15	-55.78	-84.53
Mean error (µg/m^3)	6.46	5.30	6.23	11.60
Normalized mean gross error (%)	61.39	48.93	48.55	60.34
Mean normalized gross error (%)	64.43	52.88	51.47	59.24
Mean fractional error (%)	76.57	58.76	68.43	89.85
Data availability (%)	97.43	97.31	93.54	96.67

For the validation of CMAQ over SGB, Figure 2 shows the locations of the observational stations. The statistic measures are estimated. Table 14 shows the average of statistic measures over all O_3, NO_2 and PM_{10}. The CMAQ over-estimates the annual mean O_3 and PM_{10} by 39% and 10%, respectively, while the model under-estimates the annual mean NO_2 by 60% (in part due to the regional resolution of CMAQ, which does not capture the peaks at monitoring stations).

Table 15 shows the validation results of $PM_{2.5}$ at four available stations. The results show that the CMAQ in general under estimates the $PM_{2.5}$ by 14% at rural regions. For urban regions, our model tends to have a lower bias, especially at the kerb side as expected, since the CMAQ is not supposed to capture the local concentration variations.

Concentration results from regional air quality modeling

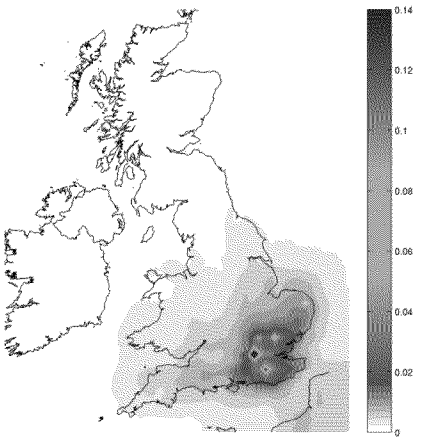


Figure 3. The annual $PM_{2.5}$ concentration due to all London airports in 2005 ($\mu g/m^3$).

Concentration-response function (CRF)

A concentration-response function (CRF) is derived based on a US EPA CRF [as described in the main paper and in Barrett et al. (2012)] for application to the UK, which is equivalent to a approximate 1% increase in all-cause mortality in the US per 1 $\mu g/m^3$ increase in annual average concentrations of $PM_{2.5}$, based on a Weibull distribution fit to major cohort studies in the US (Laden et al., 2002; Pope et al., 2006). The US EPA CRF Specifically, for a population particular grid cell,

$$\Delta(\text{premature mortalities}) = \sum_{k=1}^{2} \beta^* (B^{CP} + \gamma B^{LC}) \times f_k \times P_k \times \Delta\chi$$

where; β^* is 0.0242 and γ is 1.556, see Barrett et al., (2012); $\Delta\chi$ represents the concentration difference between two scenarions

We note that all the early deaths estimated in this study are related to the two diseases: (1) cardiopulmonary dieases and (2) lung cancer. B^{CP} and B^{LC} represent the baseline disease specific baseline per capita mortality rate in UK obtained from the WHO Global Burden of Disease (GBD)(WHO, 2008).

f_k represents the fractions of population (1) between 30 and 59 years of age and (2) above 60 years of age; P is population; The projected population is obtained from UK National Statistics. In the calculation of premature deaths in 2030, the UK population aging is considered.

Uncertainty estimation

The uncertainty in CRF is represented by a (low, nominal, high) =(0.3, 1, 1.7) triangular distribution, consistent with the EPA CRF uncertainty range of 0.4-1.8% per $\mu g/m^3$. (Note that these figures have been calculated without rounding at intermediate stages.) The uncertainties distribution for $PM_{2.5}$ from CMAQ is taken as (0.91, 1.24, 1.46). This is based on noting that our evaluation using $PM_{2.5}$ monitoring stations resulted in an average bias of -19%, (a correction factor of 1.24) a greatest bias of -32% (factor 1.46), and while the least bias is -13% we broaden the uncertainty distribution to account for the +10% bias (factor

0.9) in mean PM_{10} monitoring stations. The uncertainty distributionfor AERMOD was taken to be (0.5, 1, 1.5)[i.e. an assumed uncertainty of ±50%, which is typical for dispersion models, e.gCimorelli et al. (2004)], and for RDC was (0.9, 1, 1.1) per Lee (2012) and Barrett and Britter (2009) In our calculation, the uncertainty due to the influence of plume dynamics is also included, which is (0.5, 0.6, 1)based on Barrett et al. (2009). We note that our estimation does not include the ~10% probability of no causal link between $PM_{2.5}$ exposure and early deaths quantitatively.

2005 Aircraft-Engine Assignments

Table 16. Aircraft-Engine assigments for all aircrafttypes current in 2005with number of engines and APU model.

EQUIPMENT CODE	ENGINE	NUM	APU
100	TAY650-15	2	APU GTCP 36-150[RR]
141	ALF502R-5	4	APU GTCP 36-100
142	ALF502R-5	4	APU GTCP 36-100
143	ALF502R-5	4	APU GTCP 36-150[]
146	ALF502R-5	4	APU GTCP 36-100
14F	ALF502R-5	4	APU GTCP 36-100
310	CF6-80C2A2	2	APU GTCP331-200ER (143 HP)
312	CF6-80C2A2	2	APU GTCP331-200ER (143 HP)
313	CF6-80C2A2	2	APU GTCP331-200ER (143 HP)
318	CFM56-5B6/P	2	APU GTCP 36-300 (80HP)
319	CFM56-5A5	2	APU GTCP 36-300 (80HP)
320	CFM56-5A1	2	APU GTCP 36-300 (80HP)
321	CFM56-5B3/P	2	APU GTCP 36-300 (80HP)
32S	V2527-A5	2	APU GTCP 36-300 (80HP)
330	TRENT-772	2	APU GTCP 331-350
332	TRENT-772	2	APU GTCP 331-350
333	PW4168	2	APU GTCP 331-350
340	CFM56-5C2	4	APU GTCP 331-350
342	CFM56-5C2	4	APU GTCP 331-350
343	CFM56-5C4	4	APU GTCP 331-350
345	TRENT 553-61	4	APU GTCP 331-350
346	TRENT 556-61	4	APU GTCP 331-350
707	JT3D-3B	4	APU GTC 85
70F	JT3D-3B	4	APU GTC 85
717	BR700-715A1-30	2	APU GTC 85
721	JT8D-7B	3	APU GTCP85-129 (200 HP)
722	JT8D-15	3	APU GTCP85-129 (200 HP)
727	JT8D-15	3	APU GTCP85-129 (200 HP)
72A	JT8D-15	3	APU GTCP85-129 (200 HP)
72F	JT8D-15	3	APU GTCP85-129 (200 HP)
72M	JT8D-15	3	APU GTCP85-129 (200 HP)
72S	JT8D-15	3	APU GTCP85-129 (200 HP)

732	JT8D-15	2	APU GTCP85-129 (200 HP)
733	CFM56-3-B1	2	APU GTCP85-129 (200 HP)
734	CFM56-3B-2	2	APU GTCP85-129 (200 HP)
735	CFM56-3-B1	2	APU GTCP85-129 (200 HP)
736	CFM56-7B20	2	APU 131-9
737	CFM56-7B22	2	APU GTCP85-129 (200 HP)
738	CFM56-7B26	2	APU 131-9
739	CFM56-7B26	2	APU 131-9
73A	CFM56-3B-2	2	APU GTCP85-129 (200 HP)
73C	CFM56-3B-2	2	APU GTCP85-129 (200 HP)
73F	CFM56-3B-2	2	APU GTCP85-129 (200 HP)
73G	CFM56-3B-2	2	APU 131-9
73H	CFM56-3B-2	2	APU 131-9
73M	CFM56-3B-2	2	APU 131-9
73S	CFM56-3B-2	2	APU 131-9
73W	CFM56-3B-2	2	APU 131-9
73X	CFM56-3B-2	2	APU GTCP85-129 (200 HP)
73Y	CFM56-3-B1	2	APU GTCP85-129 (200 HP)
741	JT9D-7A	4	APU GTCP 660 (300 HP)
742	CF6-50E2	4	APU GTCP 660 (300 HP)
743	JT9D-7R4G2	4	APU GTCP 660 (300 HP)
744	CF6-80C2B1F revised	4	APU PW901A
747	CF6-80C2B1F revised	4	APU PW901A
74D	CF6-50E2	4	APU GTCP 660 (300 HP)
74E	CF6-50E2	4	APU PW901A
74F	RB211-524H-T	4	APU GTCP 660 (300 HP)
74L	JT9D-7F	4	APU GTCP 660 (300 HP)
74M	CF6-80C2B1F revised	4	APU GTCP 660 (300 HP)
74R	CF6-45A2	4	APU GTCP 660 (300 HP)
74X	CF6-50E2	4	APU GTCP 660 (300 HP)
74Y	RB211-524H-T	4	APU PW901A
752	PW2037	2	APU GTCP331-200ER (143 HP)
753	RB211-535E4B	2	APU GTCP331-200ER (143 HP)
757	RB211-535E4	2	APU GTCP331-200ER (143 HP)
75F	RB211-535E4	2	APU GTCP331-200ER (143 HP)
762	CF6-80A (A1)	2	APU GTCP331-200ER (143 HP)
763	PW4060	2	APU GTCP331-200ER (143 HP)
764	CF6-80C2B8F	2	APU GTCP331-200ER (143 HP)
767	PW4060	2	APU GTCP331-200ER (143 HP)
76F	PW4060	2	APU GTCP331-200ER (143 HP)
772	GE90-90B	2	APU GTCP331-500 (143 HP)
773	GE90-90B	2	APU GTCP331-500 (143 HP)
777	Trent 892	2	APU GTCP331-500 (143 HP)

77W	GE90-90B	2	APU GTCP331-500 (143 HP)
A40	PW127-A	2	None
AB3	PW4158	2	APU GTCP331-200ER (143 HP)
AB4	CF6-50C2	2	APU TSCP700-4B (142 HP)
AB6	CF6-80C2A5 (revised)	2	APU GTCP331-200ER (143 HP)
ABF	PW4158	2	APU TSCP700-4B (142 HP)
ABX	PW4158	2	APU TSCP700-4B (142 HP)
ABY	PW4158	2	APU TSCP700-4B (142 HP)
ACD	TPE331-10	2	None
AN4	PW127-C/F/J	2	None
AN6	PW127-C/F/J	2	None
ANF	PW127-C/F/J	4	None
AR1	LF507 SERIES	4	APU GTCP 36-150[RR]
AR7	LF507 SERIES	4	APU GTCP 36-150[RR]
AR8	LF507 SERIES	4	APU GTCP 36-150[RR]
ARJ	LF507 SERIES	4	APU GTCP 36-150[RR]
AT4	PW121	2	APU GTCP 36-150[]
AT5	PW127E	2	APU GTCP 36-150[]
AT7	PW127-C/F/J	2	APU GTCP 36-150[]
ATP	PW126A	2	APU GTCP30-54
ATR	PW121	2	APU GTCP 36-150[]
B11	SPEY MK555 original	2	APU GTCP85-129 (200 HP)
BE1	PT6A-67D	2	None
BE9	PT6A-20	2	None
BEC	PT6A-20	2	None
BEH	PT6A-67D	2	None
BES	PT6A-67D	2	None
BET	PT6A-67D	2	None
BNI	IO-360-B	2	None
BNT	IO-360-B	3	None
CNA	PT6A-27	1	None
CNC	PT6A-27	1	None
CR1	CF34-3B	2	APU GTCP 36-150[RR]
CR2	CF34-3B	2	APU GTCP 36-150[RR]
CR7	CF34-8C1	2	APU GTCP 85 (200 HP)
CR9	CF34-8C1	2	APU GTCP 85 (200 HP)
CRA	CF34-3B	2	APU GTCP 36-150[RR]
CRJ	CF34-3A1	2	APU GTCP 36-150[RR]
CS2	TPE331-10	2	None
CS5	CT7-5	2	None
CV5	501D22A	2	APU GTCP30-54
CVF	501D22A	2	APU GTCP30-54
CVR	501D22A	2	APU GTCP30-54

CWC	R-1820	2	None
D10	CF6-50C2	3	APU TSCP700-4B (142 HP)
D11	CF6-50C2	3	APU TSCP700-4B (142 HP)
D1C	CF6-50C2	3	APU TSCP700-4B (142 HP)
D1F	CF6-50C2	3	APU TSCP700-4B (142 HP)
D28	TPE331-8	2	None
D38	PW119-B	2	APU GTCP 36-150[]
D3F	R-1820	2	None
D6F	R-1820	4	None
D8F	JT3D-3B	4	APU GTCP85-129 (200 HP)
D8Y	JT3D-3B	4	APU GTCP85-129 (200 HP)
D92	JT8D-11	2	APU GTCP85-129 (200 HP)
D93	JT8D-9A	2	APU GTCP85-129 (200 HP)
D95	JT8D-17	2	APU GTCP85-129 (200 HP)
D9F	JT8D-17	2	APU GTCP85-129 (200 HP)
D9S	JT8D-17	2	APU GTCP85-129 (200 HP)
DC3	R-1820	2	None
DC8	JT3D-3B	4	APU GTCP85-129 (200 HP)
DC9	JT8D-7B	2	APU GTCP85-129 (200 HP)
DF2	PW308C	2	APU GTCP 36-150[]
DH1	PW120A	2	APU GTCP30-54
DH2	PT6A-20	2	APU GTCP30-54
DH3	PT6A-20	2	APU GTCP30-54
DH4	PW127-C/F/J	2	APU GTCP30-54
DH7	PT6A-50	4	None
DH8	PW120A	2	APU GTCP30-54
DHL	PT6A-20	1	None
DHP	PT6A-20	1	None
DHT	PT6A-27	2	None
E70	CF34-8E5	2	APU GTCP 36-150[]
E75	CF34-8E5	2	APU GTCP 36-150[]
E90	CF34-10E5	2	APU GTCP 36-150[]
EM2	PW118	2	None
EMB	PT6A-34	2	None
EMJ	CF34-8E5	2	APU GTCP 36-150[]
ER3	AE3007A3 (Type 3)	2	APU GTCP 36-150[]
ER4	AE3007A	2	APU GTCP 36-150[]
ERD	AE3007A	2	APU GTCP 36-150[]
ERJ	AE3007A	2	APU GTCP 36-150[]
F24	TAY650-15	2	APU GTCP 36-4A
F27	PW125-B	2	None
F28	TAY650-15	2	APU GTCP 36-4A
F50	PW125-B	2	APU GTCP30-54

F70	TAY620-15	2	APU GTCP 36-4A
FK7	PW125-B	2	None
FRJ	PW306B	2	APU GTCP 36-150[]
GRG	PT6A-27	2	None
GRM	PT6A-34	2	None
GRS	PW121	2	None
HS7	PT6A-27	2	None
I14	PW127-A	2	None
IL6	D-30KU	4	APU GTCP85-129 (200 HP)
IL7	D-30KP-2	4	APU GTCP85-129 (200 HP)
IL8	501D22A	4	None
IL9	PS-90A	4	APU TSCP700-4B (142 HP)
ILW	NK-86	4	APU TSCP700-4B (142 HP)
J31	TPE331-12	2	None
J32	TPE331-12	2	None
J41	TPE331-14	2	None
JST	TPE331-10	2	None
L10	RB211-22B	3	APU ST-6
L11	RB211-22B	3	APU ST-6
L15	RB211-22B	3	APU ST-6
L1F	RB211-22B	3	APU ST-6
L4T	PT6A-34	2	None
LOH	RB211-22B	3	APU ST-6
LRJ	TFE731-2	2	None
M11	CF6-80C2D1F	3	APU TSCP700-4B (142 HP)
M1F	CF6-80C2D1F	3	APU TSCP700-4B (142 HP)
M1M	CF6-80C2D1F	3	APU TSCP700-4B (142 HP)
M80	JT8D-217C	2	APU GTCP85-129 (200 HP)
M81	JT8D-217C	2	APU GTCP85-129 (200 HP)
M82	JT8D-217C	2	APU GTCP85-129 (200 HP)
M83	JT8D-219	2	APU GTCP85-129 (200 HP)
M87	JT8D-217C	2	APU GTCP85-129 (200 HP)
M88	JT8D-219	2	APU GTCP85-129 (200 HP)
M90	V2525-D5	2	APU GTCP85-129 (200 HP)
ND2	PT6A-60/-60A/-60AG	2	None
PL2	PT6A-67B	1	None
PN6	IO-360-B	2	None
S20	PW127-C/F/J	2	APU GTCP30-54
SF3	CT7-5	2	APU GTCP 36-150[]
SH3	PT6A-45R	2	None
SH6	PT6A-65R	2	None
SHS	TPE331-2	2	None
SWM	TPE331-3	2	None

T20	PS-90A	2	APU GTCP85-129 (200 HP)
TU3	D-30 (Il series)	2	APU GTCP85-129 (200 HP)
TU5	NK-8-2U (1989)	3	APU GTCP85-129 (200 HP)
WWP	TFE731-3	2	None
YK2	D-36	3	APU GTCP85-129 (200 HP)
YK4	TFE731-2	3	None
YN2	PT6A-27	2	None
YN7	PW127-C/F/J	2	None
YS1	PW127-C/F/J	2	None

Future Year Aircraft-Engine Assignments

Table 17. Aircraft-Engine assignments for aircraft not in the fleet in 2005. Aircraft models refer directly to those included in the DfT forecasts of future aviation traffic. Representative engine types were assigned if the engine type is unknown.

EQUIPMENT CODE	DfT DESCRIPTION	ENGINE	NUM	APU
350	Airbus A350 pax	Trent 1000-C A	2	APU PW901A
358	Airbus A350-800	Trent 1000-C B	2	APU PW901A
359	Airbus A350-900	Trent 1000-C A	2	APU PW901A
380	Airbus A380 pax	Trent 970-84	4	APU PW901A
748	Boeing 747-800	GEnx-2B67	4	APU PW901A
787	Boeing 787 all pax models	Trent 1000-C	2	APU PW901A
CRC	Bombardier C Series	CFM56-5A5 PW1000G	2	APU GTCP 36-300 (80HP)
CCJ	Bombardier Challenger	CF34-3B	2	APU GTCP 36-150[RR]
N19	Post 2016 G2 Airbus A319	CFM56-5A5 N	2	APU GTCP 36-300 (80HP)
N20	Post 2016 G2 Airbus A320	CFM56-5A1 N	2	APU GTCP 36-300 (80HP)
N21	Post 2016 G2 Airbus A321	CFM56-5B3/P N	2	APU GTCP 36-300 (80HP)
N36	New Gen Post 2016 B737-600	CFM56-7B20 N	2	APU 131-9
N37	New Gen Post 2016 B737-700	CFM56-7B22 N	2	APU GTCP85-129 (200 HP)
N38	New Gen Post 2016 B737-800	CFM56-7B26 N	2	APU 131-9
N39	New Gen Post 2016 B737-900	CFM56-7B26 N	2	APU 131-9
G11	New G1 CL1	PW127-C/F/J ACARE 2020	2	None
G12	New G1 CL2	CFM56-3B-2 ACARE 2020	2	APU GTCP85-129 (200 HP)
G13	New G1 CL3	RB211-535E4 ACARE 2020	2	APU GTCP331-200ER (143 HP)
G14	New G1 CL4	GE90-90B ACARE 2020	2	APU GTCP331-500 (143 HP)
G15	New G1 CL5 (Twin)	CFM56-5C2 ACARE 2020	4	APU GTCP 331-350
G16	New G1 CL6	Trent 970-84 ACARE 2020	4	APU PW901A
EX3	Executive Jet Chapter 3	AE3007A3 (Type 3) ACARE 2020	2	APU GTCP 36-150

Future Year Engine Emissions Indices

Table 18. Engine emission indices forfuture year engines. For engines that have now entered service,EIs are taken from the ICAO engine emissions databank. For future engine types, EIshave been adapted from a representative engine with similar maximum thrust according to industry targets (ACARE, 2008) and DfT documentation(DfT, 2011). Mode refers to the ICAO test point thrust settings, 1 – Approach (30% F_{00}), 2 – Climb Out (85% F_{00}), 3 – Take Off (100% F_{00}) and 4 – Idle (7% F_{00}).

ENGINE NAME	MODE	CO_EI	HC_EI	NOX_EI	FUEL_KG/S	MODE_SN
Trent 970-84	1	1.4	0	11.4	0.7	2.6
Trent 970-84	2	0.2	0	29.1	2.2	4.7
Trent 970-84	3	0.4	0	37.2	2.6	4.1
Trent 970-84	4	15.1	0.2	5.1	0.3	0.7
CFM56-5A5 PW1000G	1	2.8	0.45	4.806452	0.2346	4.35
CFM56-5A5 PW1000G	2	1.1	0.23	10.74194	0.67915	12.57
CFM56-5A5 PW1000G	3	1.1	0.23	13.32796	0.8262	14.3
CFM56-5A5 PW1000G	4	18.5	1.53	2.306452	0.0833	2.43
Trent 1000-C A	1	0.68	0	13.86	0.74816	3.1
Trent 1000-C A	2	0.48	0	40.33	2.29376	3.8
Trent 1000-C A	3	0.51	0	53.54	2.80896	3
Trent 1000-C A	4	7.66	0.04	5.66	0.27552	0.6
Trent 1000-C B	1	0.68	0	13.86	0.7014	3.1
Trent 1000-C B	2	0.48	0	40.33	2.1504	3.8
Trent 1000-C B	3	0.51	0	53.54	2.6334	3
Trent 1000-C B	4	7.66	0.04	5.66	0.2583	0.6
GEnx-2B67	1	2.53	0.06	9.58	0.701	5.54
GEnx-2B67	2	0.28	0.02	17.94	2.012	0
GEnx-2B67	3	0.17	0.02	31.2	2.451	0
GEnx-2B67	4	18.95	0.57	4.43	0.216	0.05
CFM56-5A5 N	1	2.8	0.45	8.94	0.2346	4.35
CFM56-5A5 N	2	1.1	0.23	19.98	0.67915	12.57
CFM56-5A5 N	3	1.1	0.23	24.79	0.8262	14.3
CFM56-5A5 N	4	18.5	1.53	4.29	0.0833	2.43
CFM56-5A1 N	1	2.5	0.4	8	0.24735	4.4
CFM56-5A1 N	2	0.9	0.23	19.6	0.7327	14
CFM56-5A1 N	3	0.9	0.23	24.6	0.89335	15.8
CFM56-5A1 N	4	17.6	1.4	4	0.085935	2.3
CFM56-5B3/P N	1	1.7	0.5	11.2	0.3111	0.22
CFM56-5B3/P N	2	0.9	0.2	28.5	0.96985	5.06
CFM56-5B3/P N	3	0.8	0.1	37.3	1.2155	4.7
CFM56-5B3/P N	4	19.2	3.5	4.7	0.09775	0.53
CFM56-7B20 N	1	3.2	0.1	9.5	0.2329	0
CFM56-7B20 N	2	0.5	0.1	17.4	0.64685	8.03
CFM56-7B20 N	3	0.6	0.1	20.5	0.77605	11.42
CFM56-7B20 N	4	25.9	3.1	4.3	0.085	0

CFM56-7B22 N	1	2.5	0.1	10	0.2533	0
CFM56-7B22 N	2	0.6	0.1	19	0.7174	10.48
CFM56-7B22 N	3	0.5	0.1	23.1	0.86785	11.96
CFM56-7B22 N	4	22.8	2.5	4.5	0.08925	0
CFM56-7B26 N	1	1.6	0.1	10.8	0.2873	0
CFM56-7B26 N	2	0.6	0.1	22.5	0.84915	11.9
CFM56-7B26 N	3	0.2	0.1	28.8	1.03785	14.7
CFM56-7B26 N	4	18.8	1.9	4.7	0.09605	0
PW127-C/F/J ACARE 2020	1	3.4	0	10.4	0.064213	-1
PW127-C/F/J ACARE 2020	2	1.9	0	16.9	0.115709	-1
PW127-C/F/J ACARE 2020	3	2	0	19.1	0.130624	-1
PW127-C/F/J ACARE 2020	4	8.3	0	7.5	0.041213	-1
CFM56-3B-2 ACARE 2020	1	3.4	0.073	8.7	0.24649	2.5
CFM56-3B-2 ACARE 2020	2	0.9	0.047	16.7	0.68923	3
CFM56-3B-2 ACARE 2020	3	0.9	0.036	19.4	0.82896	6
CFM56-3B-2 ACARE 2020	4	30.1	1.75	4.1	0.093118	2.2
RB211-535E4 ACARE 2020	1	1.14	0.04	6.78	0.4082	0.96
RB211-535E4 ACARE 2020	2	0.5	0.01	32.06	1.18535	1.84
RB211-535E4 ACARE 2020	3	0.77	0	44.88	1.4601	1.73
RB211-535E4 ACARE 2020	4	13.31	0.37	3.46	0.1413	0.5
GE90-90B ACARE 2020	1	1.16	0.05	16.94	0.72435	3.2
GE90-90B ACARE 2020	2	0.13	0.04	39.5	2.254725	2.7
GE90-90B ACARE 2020	3	0.12	0.04	52.48	2.7621	3.6
GE90-90B ACARE 2020	4	13.21	0.43	6	0.240075	2.5
CFM56-5C2 ACARE 2020	1	1.75	0.082	10	0.293535	1
CFM56-5C2 ACARE 2020	2	0.8	0.008	25.8	0.8877	8.5
CFM56-5C2 ACARE 2020	3	0.93	0.008	32.6	1.0791	11.1
CFM56-5C2 ACARE 2020	4	34	5.68	4.19	0.096938	1.1
Trent 970-84 ACARE 2020	1	1.4	0	11.4	0.5775	2.6
Trent 970-84 ACARE 2020	2	0.2	0	29.1	1.815	4.7
Trent 970-84 ACARE 2020	3	0.4	0	37.2	2.145	4.1
Trent 970-84 ACARE 2020	4	15.1	0.2	5.1	0.2475	0.7
AE3007A3 (Type 3) ACARE 2020	1	7.65	0.03	6.93	0.084466	0.01
AE3007A3 (Type 3) ACARE 2020	2	0.5	0.03	13.48	0.235108	0.01
AE3007A3 (Type 3) ACARE 2020	3	0.5	0.03	15.4	0.281266	0.01
AE3007A3 (Type 3) ACARE 2020	4	41.29	4.1	4.12	0.035168	0.01

Layout of the Thames Estuary hub airport

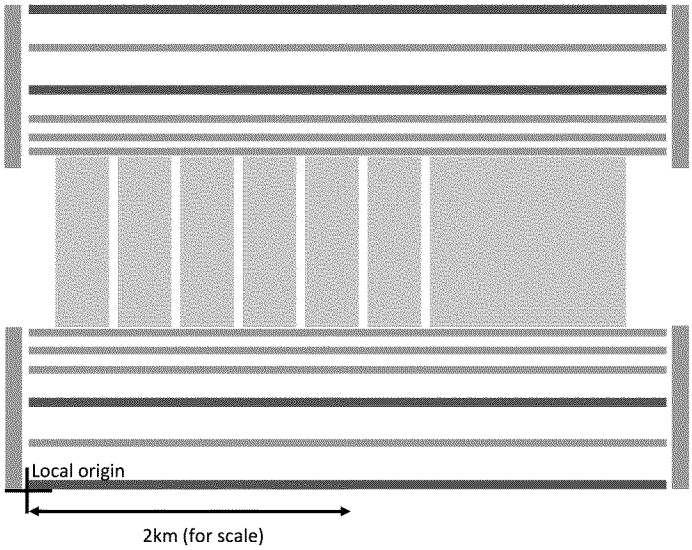


Figure 4. Layout of the Thames Estuary hub airport considered in this study (Lord Foster (2012)). Runways are shown in red, taxiways in blue and the apron in grey. These correspond to area sources used in the local dispersion calculations.

Results of local dispersion calculations

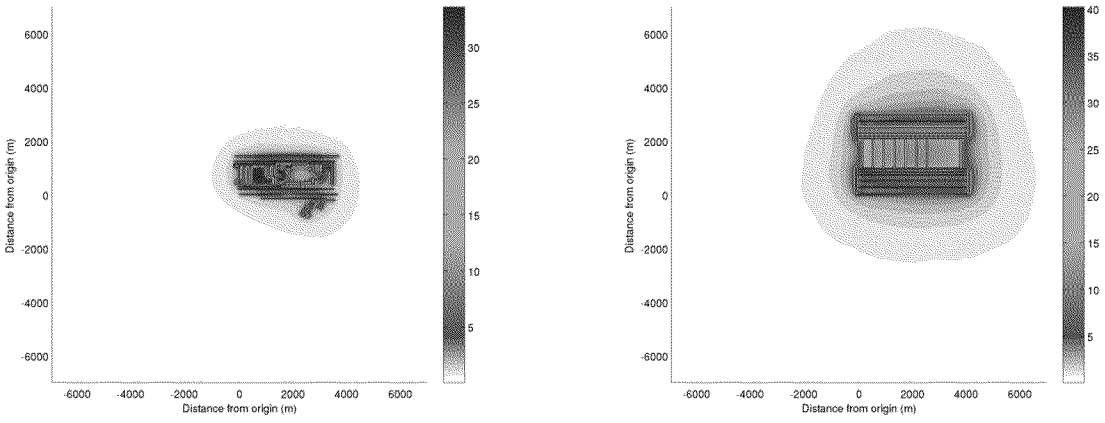


Figure 5. The sample figures of the mean $PM_{2.5}$ concentrations ($\mu g/m^3$) of local dispersion calculation (left) at Heathrow in 2005 and (right) at the Thame Estuary hub airport in 2030. Note: the plume correction factors are not applied in these results.

Local Exposure Analysis

To assess the near-airport $PM_{2.5}$ exposure due to local aviation emissions, we analyse the mean concentration distributions from all airport in Southern Great Britain. Figure 6 depicts the mean ground-level concentrations as a function of distance from airports. The primary particulate matter due to the airport ground operations (black carbon and organic carbon) account for ~44% of PM exposure near the airports (<4 km) and ~21% at 10km.

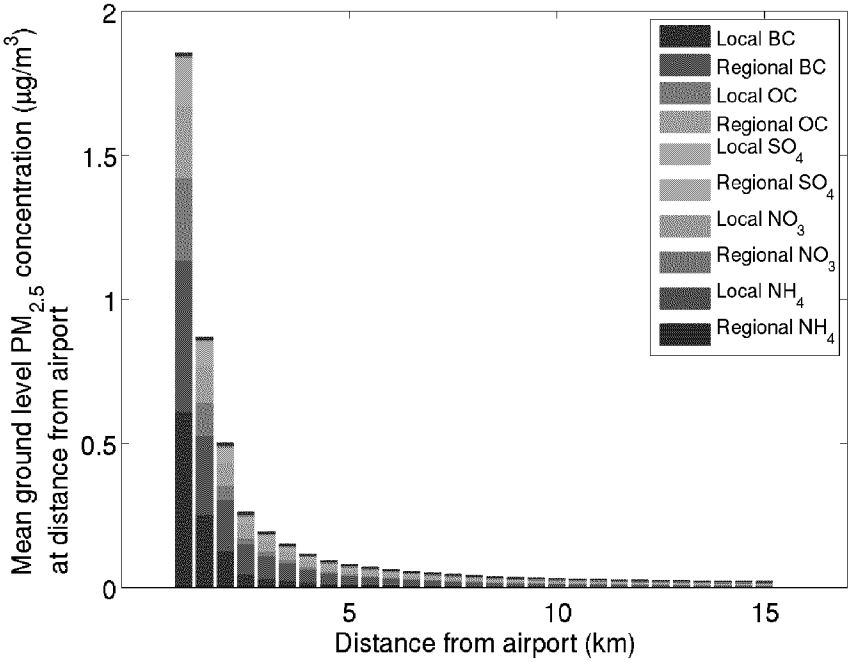


Figure 6. The mean $PM_{2.5}$ concentration attributable to aviation emissions in 2005 as a function of distance from all airports in Southern Great Britain The colours represent different particulate matter species accounted for in the RDC (local) and CMAQ (regional) calculations.

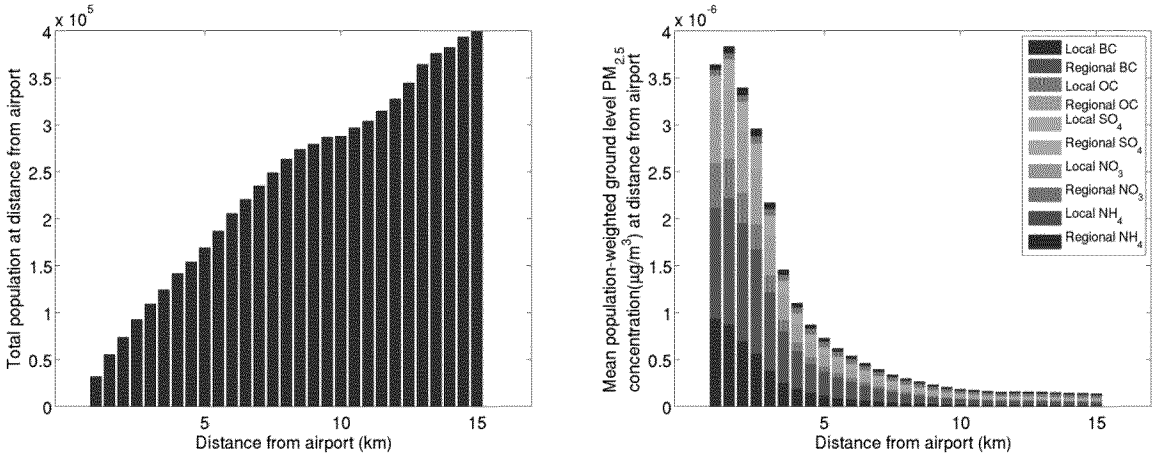


Figure 7. (Left) The population and (right) the aviation emission-attributable population-weighted $PM_{2.5}$ concentration in 2005 as a function of distance from all airports in Southern Great Britain in 500 m increments. The peak of mean population-weighted

$PM_{2.5}$ is at 1.5 km away from airport. After 1.5 km, the mean population exposure to $PM_{2.5}$ declines and becomes constant after 10 km away from airport.

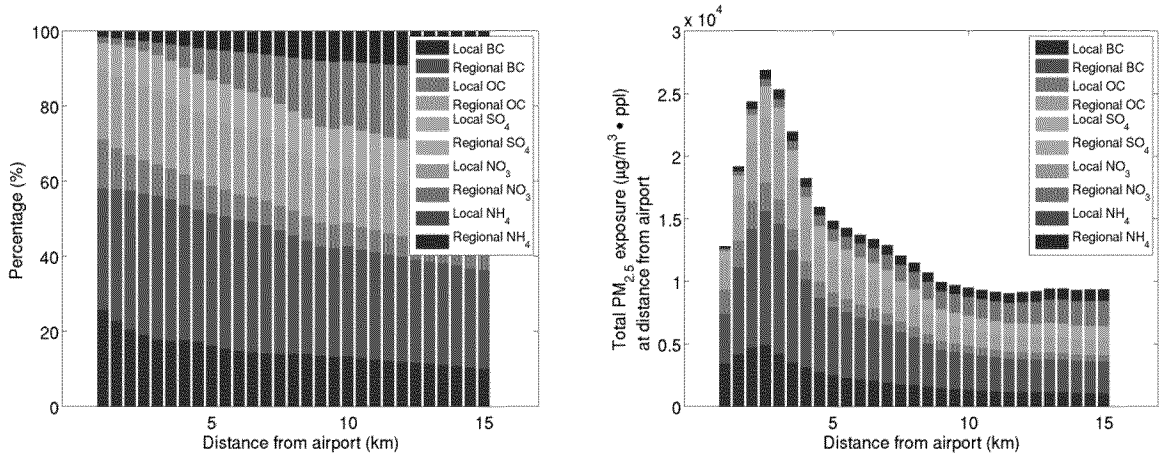


Figure 8. (Left) The population-weighted $PM_{2.5}$ species apportionment ($\mu g/m^3 \cdot ppl$) and (right) the total $PM_{2.5}$ exposure ($\mu g/m^3 \cdot ppl$) attributable to aviation emissions in 2005 as a function of distance from all airports in Southern Great Britain

The total $PM_{2.5}$ exposure increases awayfrom airports and reaches a peak (2.69×10^4 $\mu g/m^3 \cdot ppl$) at 2.5 km as shown in Figure 8 Thereafter, the total exposure decreases and becomes approximately $9.49 10^3$ at 10 km, which is35% of the peak value, before decreasing at greater distances.

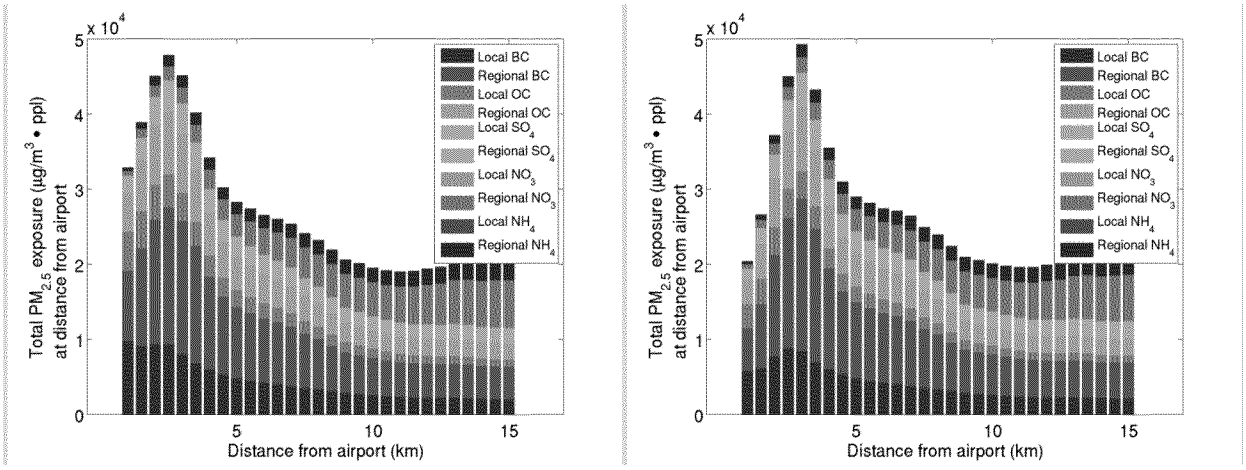


Figure 9. The total $PM_{2.5}$ exposure ($\mu g/m^3 \cdot ppl$) at distance from all airports (left) with and (right) without capacity constraints in 2030.

Comparing to thepresent-day, a similar pattern of total $PM_{2.5}$ exposur is observed at Heathrow with and without expansionas shown in Figure 9. However, the exposure peaks in the cases with and without constraints are 78% and 83% higher than that in current year – in part due to emissions increasing, and in part due to demographic and atmospheric factors. Comparing to the total $PM_{2.5}$ exposure at 10 km in current year, the total exposurin the two expansion scenarios (with and without runway capacity

constraints) increases by 105% and 112%, indicating that the airport emissions are likely to impact further away from the airport in 2030.

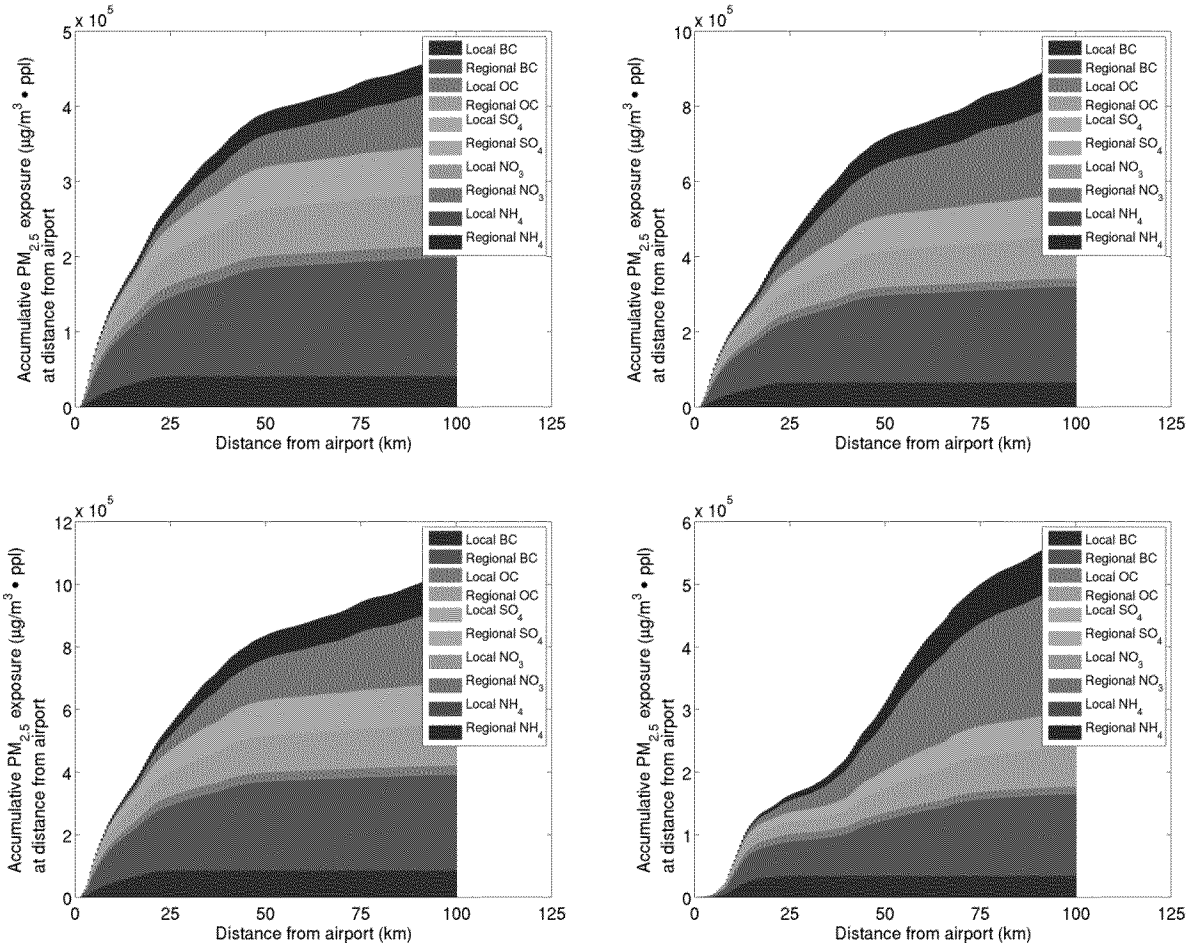


Figure 10. The cumulative $PM_{2.5}$ exposure within distance of (top left) Heathrow in current year, (top right) Heathrow in future year with runway capacity constraints, (bottom left) Heathrow in future year without runway capacity constraints and (bottom right) of the new airport at Thames Estuary in future year.

Hub-Specific Airport Health Impacts

We note that under the expansion scenarios, emissions at all airports change. For example, relative to the 2030 constrained scenario, both an expanded Heathrow and a Thames hub results in a UK-wide increase in fuel burn of 6%. At LHR or THA the increase is 34% (relative to a constrained LHR), while at the remaining London airports fuel burn is estimated to decrease by 12%, consistent with DfT forecasts. We have therefore not focused on detailed scenarios related to individual airports in isolation due to the coupling between of effects associated with increasing emissions at the hub airport (LHR or THA) and decreasing emissions elsewhere – because such results would not represent consistent UK aviation scenarios and the domain of air quality influence of each airport is >50 km (indicating they cannot meaningfully be separated). However, as these numbers may be of practical interest, we provide estimates for the hub-specific health impacts.

In the baseline present-day scenario, 70% of the ~110 UK-wide airport-attributable early deaths each year are caused by the five main London airports (based on detailed simulations), which is consistent with the London airports contributing 73% of fuel

burn. LHR accounts for 65% of fuel burn (and most emissions) at the London airports. This suggests LHR in isolation contributes ~50 early deaths per year. Alternatively the figure can be estimated by noting that LHR accounts for 54% of SGB fuel burn, a domain in which there are ~92 early deaths per year due to airports from detailed simulations. This also implies a figure of ~50.

In the 2030 constrained growth scenario, LHR accounts for 44% of SGB fuel burn, indicating that it causes ~110 early deaths per year. This represents a 120% increase over the present-day. We compare this to an estimate based on contributing multiplicative factors relative to the present day – a 21% LHR fuel burn increase, a 27% increase due to changing baseline disease rates, a 17% increase in population, and a fuel burn-related residual (as previously defined) of 25% – which yields an estimated increase of 124%, differing by 3% from the previous estimate. Detailed simulations show that moving (unconstrained) LHR emissions to the Thames Estuary reduces early deaths in 2030 by ~66. Alternatively, detailed simulations indicate that there would be ~60 fewer early deaths per year in an unconstrained aviation scenario with a Thames hub airport relative to a constrained scenario with an unexpanded Heathrow. The hub-specific health impacts are therefore anticipated to be reduced by 55% under an unconstrained Thames Estuary hub airport scenario relative to a constrained Heathrow scenario, or 60% relative to an unconstrained growth Heathrow scenario.

Finally to corroborate these estimates, we calculated the number of early deaths per year due to aircraft emissions within 20 miles (32 km) of the hub airport. Based on the cumulative exposure plot with radial distance (Figure 10) from airports, we estimate this will capture ~70% of the airport's impacts, while avoiding significant influence from other airports. This approach leads to estimates for hub-specific impacts within 20 miles of ~32 for LHR in the present-day scenario, ~67 in 2030, ~83 if Heathrow is expanded, or ~25 under a Thames hub scenario. This implies a 63% reduction in health impacts within 20 miles for a Thames hub relative to Heathrow with constrained growth, or 70% relative to unconstrained growth.

Taking the estimate based on reductions within 20 miles is an upper bound on the reduction in health impacts of a Thames hub relative to Heathrow, and the previous estimate as a lower bound, we overall find that a Thames hub would result in hub-specific health impacts in 2030 that are 60-70% lower than expansion of London Heathrow, and still 55-63% lower than an unexpanded Heathrow.

Additional References

All other references are listed in the main paper.

ACARE (2008). 2008 Addendum to the Strategic Research Agenda. Advisory Council for Aeronautics Reasearch in Europe (http://www.acare4europe.org/documents/acare2008-addendum).

WHO (2008). World Health Organization. Gbbal Burden of Disease (GBD); Available at: http://www.who.int/healthinfo/global_burden_disease/en/