Meeting Summary, October 4, 2012
NextGen Advisory Committee (NAC)

The October 4, 2012 meeting of the NextGen Advisory Committee (NAC), hosted by the United States Air Force (USAF) at the Wright-Patterson Air Force Base, Dayton, Ohio, convened at 8:57 a.m. The meeting discussions are summarized below. Attendees are identified in Attachment 1; the presentations for the Committee is Attachment 2 (containing much of the detail about the content of the material covered); the Chairman’s Report is Attachment 3; the FAA Report from Acting Administrator Michael Huerta is Attachment 4; the final report “Measuring NextGen Performance” including the attachment, “Key City Pairs for Measuring NextGen Performance”, approved by the Committee during the meeting is Attachment 5; the preliminary report “Data Sources for Measuring NextGen Fuel Impact” endorsed by the Committee is Attachment 6; and the Tasking letters from the FAA on Performance Based Navigation (PBN) and Implementation of the Categorical Exclusion contained in the FAA Reauthorization law, Section 213 (c)(2) are Attachments 7 and 8.

Welcome and Introductions
Mr. Dave Barger, President and CEO of JetBlue Airways, and the Chairman of the NextGen Advisory Committee, called the meeting to order and welcomed the NAC members and others in attendance.

Designated Federal Official Statement
Designated Federal Official (DFO) The Honorable Michael Huerta, FAA Acting Administrator, read the Federal Advisory Committee Act notice governing the open meeting.

Host Welcome & Facility Overview
Chairman Barger thanked the USAF for hosting the meeting, along with the pre-NAC meeting briefing and discussion of the U.S. military’s unique challenges associated with the implementation of NextGen and the research being conducted by the Air Force Research Laboratory into issues such as sense and avoid, communications and the modeling of procedures and technologies associated with operating Unmanned Aircraft Systems/Remotely Piloted Aircraft. He then introduced Major General James Jones, the host for the meeting, who welcomed the NAC members and members of the general public and showed a brief video on the U.S. Air Force. He highlighted that the Department of Defense has many common interests with civilian aircraft operators, such as accessing airspace and the challenge of implementing new capabilities and technologies in existing aircraft fleets.
Opening Remarks by Cabinet Level Official
U.S. Department of Transportation Deputy Secretary The Honorable John Porcari participated in the meeting and provided his perspective on NextGen in opening comments. He stressed the importance of the NAC partnership between the FAA and the aviation community and explained that NextGen represents the single largest infrastructure investment in the nation. As such, it presents the unique challenge for the aviation community to maintain public support for a technology-based investment program that, unlike roads and bridges, is largely transparent to the public at large.

Committee Introductions
All NAC members were asked to introduce themselves. (NAC and General Public Attendees are identified in Attachment 1.) Chairman Barger recognized the service of NAC members David McMillian of EUROCONTROL and Agam Sinha of The MITRE Corporation who are retiring from their respective organizations. Both organizations will continue to be represented on the NAC.

Approval of May 24, 2012 Meeting Summary
Chairman Barger asked for consideration of the written summary of the May 24, 2012 meeting. The Committee approved the Summary with no revisions or objections.

Chairman’s Remarks
Mr. Barger’s detailed remarks are contained in Attachment 3. He addressed the following topics:
- Visuals
- Inspiration
- Metrics
- City Pairs
- Environment
- Taskings
- Transition

Concluding his remarks, Chairman Barger reflected on the Committee museum visit the previous evening, stating his perspective that we owe much to those who came before us and we must continue to encourage the aviators of the future who will look back at the work of the Committee for direction.

FAA Report
Mr. Huerta presented the FAA report covering the following areas (details of his report are contained in Attachment 4):
- Budget/Sequestration – the FAA has been funded by a Continuing Resolution that provides $77 million more than in FY2012, but expires after March 27, 2013. The Agency is operating in an environment of tight budgets and a time of uncertainty. Under the plans of the Administration detailing how to implement automatic sequestration cuts by federal agencies, the FAA would face very drastic cuts in services and investments.
- DataComm Contract Award – the FAA awarded a $330 million contract in September to deploy DataComm at dozens of air traffic control towers to be completed by 2018. Testing
will be done in Memphis with FedEx, in Newark with United and in Atlanta with Delta to validate the system’s capabilities.

- **Financial and Operational Incentives for Equipage** – the FAA is currently evaluating potentially implementing equipage incentives with the goal of encouraging deployment of aircraft capable of taking earlier advantage of NextGen. The work recognizes the link between financial and operational incentives and includes implementing a loan guarantee program and focusing efforts on specific, localized opportunities to test operational incentives.

- **Response to the Integrated Capabilities NAC Recommendations** (provided by Vicki Cox, FAA, Assistant Administrator for NextGen) – the FAA will use the Tier 1 and Tier 2 Metroplex priorities provided by the NAC in the Agency’s planning process, focusing on highest priority locations and capabilities. The FAA also concurs with the prioritization of PBN, surface management and near-term time-based flow management (TBFM) capabilities. TBFM and surface capabilities are in the investment analysis phase of the FAA’s acquisition process and Tier 1 locations are being included in this analysis.

- **Metroplex** – the lessons from the Greener Skies over Seattle initiative are being applied at other locations. The FAA is working on Metroplex solutions at several locations, including the recent announcement of work being undertaken in South Florida and design and implementation that is underway in Washington, D.C. Mr. Huerta narrated a video implementing Optimized Profile Descents that incorporates waypoints as a tribute to the men and women of the military who made the ultimate sacrifice on September 11 and to U.S. troops who defend freedom around the world.

### NextGen Implementation Metrics

Chairman Barger introduced the Co-chair of the NACSC, Steve Brown, Chief Operating Officer, National Business Aviation Association, who presented a briefing on the recommendations for Measuring NextGen Performance developed by members of the Business Case and Performance Metrics Work Group and the NAC Subcommittee.

Corresponding measurement criteria were included as requested by the FAA. These are:

- **Flight Safety** – measured as the change in airborne/ground separation alert rate
- **Operational Efficiency** – measured as the mean aircraft operation time
- **Fuel Efficiency** – measured as the fuel efficiency normalized by weight and distance
- **ATC Cost Efficiency** – measured as the ATC cost per IFR hour
- **Metroplex Capacity** – measured as the Metroplex peak allowable throughput
- **Metroplex Access** – measured as the Metroplex achieved utilization

Mr. Brown emphasized the need for metrics that are clear to government officials, the public and the aviation community. The intent of the metrics is to measure operational system performance improvement as the result of NextGen implementation. He concentrated on briefing the Access metric because it had not been discussed in previous NAC meetings. Mr. Brown used illustrations such as the Greener Skies initiative in Seattle, WAAS LPV approaches at general aviation airports,
airport deconfliction in a Metroplex, Special Activity Airspace and expansion of surveillance coverage in non-radar covered airspace to explain the Access metric.

In discussion of the metrics, an FAA Committee member raised the question on the meaning of the term “use” in the context of the airspace Access metric. Debby Kirkman, The MITRE Corporation, Co-chair of the Business Case & Performance Metrics Work Group (BCPMWG) explained that to highlight the FAA’s efforts in the Metroplex, the focus is on throughput during times of high demand. A follow-on question was related to what occurs if an airline decreases its schedule – will this result in an improvement in the Access metric? Mr. Brown explained that it would, which reinforces the need for a “suite of metrics” to measure the implementation of NextGen.

Chairman Barger asked the representatives of the international aviation community to comment on how the proposed Metrics compare with those used in other parts of the world. The response was that the terminology is different, but these are generally aligned with those in Europe. The controller representative also commented that the Metrics are on the right track, but that it is important to recognize capacity can be affected by many factors, e.g., wind speed and direction and runway configuration.

Committee Action: The Committee agreed by consensus to approve the recommendation Measuring NextGen Performance (Attachment 5) for submission to the FAA.

Fuel Burn Data Source
Mr. Brown introduced Ed Lohr from Delta Air Lines, Co-chair of the BCPMWG, for a review of the preliminary report outlining sources for fuel burn data that could support the FAA’s efforts to assess the impacts of NextGen on fuel usage. This included two specific recommendations for additional work in this area:

1) establishing a team of Subject Matter Experts from the aviation industry and the FAA to establish detailed requirements for airline fuel and aircraft weight reports in support of high-level fuel efficiency metrics; and

2) the continued research into the use of the Aviation Safety Information Analysis & Sharing (ASIAS) infrastructure to support both high-level and diagnostic-level metrics.

During discussion by the Committee, several members emphasized the importance of including general aviation and military flying as sources for fuel burn data, and representatives of these stakeholders pledged support of their organizations to participate in the associated Work Group efforts. A representative from the FAA expressed his appreciation for the work, that it is “good stuff” and is helpful for augmenting the FAA’s use of modeling with factual data.

Mr. Huerta emphasized the importance of maintaining sensitivity about the voluntary sources collected for other purposes. There is a need to build confidence within the aviation community as uses of the data are potentially broadened.

A representative from an aircraft manufacturer commented that it is difficult to single out one reason for fuel efficiency improvements which underscores the importance of multiple metrics. A general
aviation representative explained that pilots regularly record fuel consumption for each flight and he suggested an effort should be launched to capture this information. The DoD NAC member expressed a commitment, working within the parameters of the DoD’s mission, to provide fuel usage data.

Concluding the discussion, another NAC member stated their support for this work on data sources because it will help evaluate one of the important NextGen goals to reduce aviation’s environmental footprint.

Committee Action: The Committee agreed by consensus to endorse the actions for future work contained in the preliminary report Data Sources for Measuring NextGen Fuel Impact endorsed by the Committee (Attachment 6).

Key City Pairs
NACSC Co-chair Mr. Brown outlined for the NAC members an initial recommendation of 24 key city pairs (see illustration) between which the impact of NextGen on NAS performance can be measured. The metrics to be evaluated at the city pairs, as levied by the FAA Modernization & Reform Act of 2012, Public Law 112-95, include:

- Fuel burned
- Average distance flown
- Flown versus filed flight times

During discussion, the Committee members expressed appreciation for the methodical nature and relative speed of the work. Several NAC Members commented in support of the 24 identified Metroplex city pairs. Others offered two specific suggestions, first for inclusion of U.S. transcontinental pairs that would reflect an important aspect of flights in the country not represented on the list, and key city pairs for regional carriers. The latter would be added under the “diversity” criteria because these operators account for more than 50% of flights in the country.

Committee Action: The Committee agreed by consensus to approve the recommendation Key City Pairs for Measuring NextGen Performance for submission to the FAA. It is included as an attachment to the final report Measuring NextGen Performance approved by the Committee earlier in the meeting. The Committee also directed the NACSC to reconvene the Key City Pairs Task Group to evaluate city pairs for transcontinental traffic and key city pairs for regional carriers.

New Taskings Outlined
Mr. Huerta introduced two new Taskings addressing Performance Navigation Procedures (PBN) and implementing Congressional authority for Categorical Exclusions under the National Environmental Policy Act requirements (CatEx2). These will be the focus of work by the NAC Subcommittee and Work/Task Groups under its jurisdiction.

Performance Navigation Procedures (PBN)
David Grizzle, Chief Operating Officer for the FAA Air Traffic Organization, provided additional details on the Tasking and its importance to the ATO and the NextGen office. The work builds on earlier NAC discussions on non-technical barriers to NextGen implementation, the FAA’s internal review conducted by Brian Lantini and previous work on Metroplex criteria and prioritization.

Related to PBN, the FAA is asking the NAC to:

- Identify obstacles to PBN utilization, both technical and non-technical
- Develop criteria for prioritizing PBN procedures
- Validate criteria for selection & prioritization of the next round of Optimization of Airspace & Procedures in Metroplexes (OAPM) sites

Mr. Grizzle also reviewed the FAA’s steps to implement several scenarios for operational incentives as part of its work implementing the Best Equipped, Best Served (BEBS) policy. These are:

- De-Confliction (JFK RWY 13L, MDW RWY 13C) with Required Navigation Performance (RNP) 0.3 w/ RF legs
- SFO RNP/SOIA with RNP 0.3 w/ RF legs (pending safety review)
- ADS-B East Coast offshore routes
- ADS-B In Trail Procedures (ITP) / South Pacific and Beyond

Several committee members offered comments in response to the presentation, emphasizing the importance of minimizing the impact on equipment changes needed to use new capabilities and the need for evaluating ADS-B In applications. An operator representative expressed encouragement that the principle of Best Capable Best Served (editor’s note: same principle as BEBS) allows for the benefit of equipped operators without harming the non-equipped, and an FAA representative emphasized that the policy is location specific. A committee member representing local communities expressed the importance of considering the effects of PBN procedures on areas where over-flights did not previously occur. Another stated a strong commitment by the NAC to support the FAA’s efforts to address non-technical barriers to NextGen implementation. There was also discussion about the current two-three year project to revise the controller handbook to incorporate new procedures and better reflect the NextGen operating environment.

Concluding the discussion, Margaret Jenny, President, RTCA explained that the plan for addressing the Tasking includes combining the talents and resources of the Airspace and Procedures and the Integrated Capabilities Work Groups as well as subject matter experts from the FAA.

**Environmental Tasking**

Julie Oetinger, Assistant Administrator, FAA Office of International Aviation, Office of Policy, Planning and Environment, and Lourdes Maurice, Executive Director, FAA Office of Environment and Energy, provided a presentation to the Committee on the National Environmental Policy Act (NEPA) that requires the FAA to evaluate impacts of actions that have potential to affect the environment. NEPA covers FAA air traffic procedures, both conventional and PBN. Ms. Oetinger and Ms. Maurice also explained that the authority contained in the FAA Modernization & Reform Act of 2012, Public
Law 112-95, Section 213(c)(2) allows for a categorical exclusion under certain conditions for PBN procedures. The FAA is seeking NAC comments related to implementing this provision.

Under the Environmental Tasking, the NAC will explore how to implement Congressional authority for CatEx2 by reviewing the FAA’s internal analysis, developing recommendations for measuring impacts on a per flight basis and determining whether additional recommendations for streamlining environmental reviews are needed. Ms. Oettinger emphasized that the Tasking includes participation by community stakeholders. Other Committee members also stressed that these types of issues need engagement by the broader aviation community (not just airports and the FAA), as well as engagement with representatives from the local area. Ms. Jenny stated RTCA’s intent to solicit NAC members for suggestions for individuals who could assist in the effort. Several Committee members offered their willingness to identify individuals from their organizations who could offer environmental expertise for addressing the Tasking.

**Chairman Closing**

Chairman Barger offered his closing remarks by thanking the NAC members for supporting him as chairman. He offered the following specific comments:

— I am so very proud of what has been accomplished thus far by our working together.
— I am equally as proud of our partners at the FAA for recognizing that bringing together such a group, with the structure to support it, can and does yield great benefits for the FAA as it moves forward with implementing NextGen.
— The nation and indeed the world expect American leadership in aviation to continue in the 21st century just as it did during the last century.
— I began with this and will end my tenure as Chairman with this: the science is here for NextGen. We have it in our pockets. It is not the hardest part of our work. The hard stuff is the non-technical barriers to implementing NextGen and here, I am a firm believer that our work is making a difference.
— I want to thank Michael, the safety professionals at the FAA, Margaret, Andy and the entire RTCA team and my own colleagues at JetBlue for the support and education over these past two plus years.
— I look forward to continuing on as a member of the NextGen Advisory Committee and working with Bill Ayer during his tenure as our incoming Chairman.

**Introduction of New Chairman**

Bill Ayer, Chairman, Alaska Air Group, was officially announced as the new chairman of the NAC. He expressed his intent to build on the hard work and leadership of Chairman Barger and urged continued engagement and commitment from the Committee members in his efforts as chair for the next two years.

**Other business**
During this portion of the meeting, individual members of the Committee recognized the efforts of the chairman in leading the NAC over the last two years.

**Adjourn**
Chairman Barger closed the meeting of the Committee at 3:10 p.m.

**Next Meeting**
The next meeting of the NAC is February 7, 2013 in Salt Lake City, Utah.
# Attendees:

**October 4, 2012 Meeting of the NextGen Advisory Committee**  
Wright-Patterson Air Force Base, Dayton, OH

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<td>Ayer, Bill(^1)</td>
<td><em>Alaska Airlines</em></td>
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\(^1\) NAC Members names in italics
Welcome to the Meeting of the NextGen Advisory Committee

October 4, 2012
Wright-Patterson Air Force Base
Dayton, OH

Welcome & Introductions

NAC Chairman Dave Barger
President & CEO
JetBlue Airways
In accordance with the Federal Advisory Committee Act, this Advisory Committee meeting is OPEN TO THE PUBLIC.

Notice of the meeting was published in the Federal Register on: September 5, 2012.

Members of the public may address the committee with PRIOR APPROVAL of the chairman. This should be arranged in advance.

Only appointed members of the Advisory Committee may vote on any matter brought to a vote by the Chairman.

The public may present written material to the Advisory Committee at any time.

Welcome & Facility Overview

Gen. James Jones
U.S. Air Force

NAC October 4, 2012
Meeting Host
Honored Guest

The Honorable John Porcari
U.S. Department of Transportation
Deputy Secretary

Introductions

Meeting
NextGen Advisory Committee
October 4, 2012
Dayton, Ohio
Meeting Agenda

- Review & Approval of May 24, 2012 Meeting Summary
- NAC Chairman’s Report
- FAA Report
- NextGen Implementation Metrics
  - Executive-level set of metrics that capture an overall status of NextGen implementation
  - Data Sources for Measuring NextGen Fuel Impact
  - Key city pairs that can be used for NextGen metrics
- Non-Technical Barriers to NextGen Implementation
- Environmental Issues Impacting NextGen Implementation
- Other Business/Anticipated Issues for Next Mtg – Feb 2013
- Adjourn

Review and Approval of:

May 24, 2012 Meeting Summary
Chairman’s Report

NAC Chairman Dave Barger
President & CEO
JetBlue Airways
Thank you

FAA Report

Michael Huerta
Acting Administrator, FAA
DISCUSSION
Measuring NextGen Performance

Steve Brown
NACSC Co-chair

BCPMWG Co-chairs:
Debby Kirkman, The MITRE Corporation
Ed Lohr, Delta Air Lines

Metrics Tasking

Original FAA tasking letter (October 2010):

“…provide consensus recommendations on a suite for operational performance measures, to ensure NextGen implementation is producing desired results.”
NAC High Level Metrics Suite

Responding to the Tasking, six key metrics categories endorsed by the NAC:

- Safety
- Efficiency
- Capacity
- Fuel Efficiency
- Cost-Effectiveness
- Access

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Access vs. Equity: Definitions

- **Access**: A non-judgmental, objective measure of the ability to use NAS assets or services by capable and authorized users.

- **Equity**: A measure of consistency and transparency in the application of Access policies according to the agreed upon rules for service.

*Access and Capacity are closely related. Access measures the ability to utilize inherent capacity. A new runway, for example, increases capacity but not necessarily access. A new approach procedure can increase access.*

Greener Skies over Seattle

*Airlines estimate that industry would save over 2 million gallons a year, or $6.8 million*
Examples of NextGen Capabilities
Improving Access

- LPV approaches that expand landing opportunities
- Airport deconfliction
- Improved scheduling of SAA
- Expansion of surveillance to non-radar airspace

Access Metric Recommendation

Metroplex Achieved Utilization measures the percentage of unconstrained capacity** in the Metroplex that is used in periods of high demand.

Deconflicting airports and increasing IMC throughput improves Metroplex utilization.

**Metroplex Maximum Capacity is the sum of the airport capacities, as defined in the FAA Airport Capacity Benchmark report, “optimum weather condition rate”.
NAC Action

Consider Recommendations on:

Measuring NextGen Performance and Transmit to the FAA

DISCUSSION
Data Sources for Measuring NextGen Fuel Impact

Ed Lohr
Business Case & Performance Metrics Work Group Co-chair

BCPMWG Co-chairs:
Debby Kirkman, The MITRE Corporation
Ed Lohr, Delta Air Lines

Fuel Data Benefit

Many NextGen improvements have a direct impact on fuel use through more efficient procedures

• FAA Reauthorization Bill, section 214, specifies the reporting of fuel use between “key city pairs”
• FAA should report on weight and normalized distance fuel efficiency for key city pairs
• Key data elements needed are fuel use and aircraft weight on a flight-by-flight basis
Fuel Data Attributes

Insufficient data granularity is available for FAA to generate either high-level or diagnostic metrics

- Airline data is collected at a national level of aggregation
- Data from other operators not routinely collected
- Even more data granularity needed for diagnostic analysis

Outreach Efforts to Industry

- Interviews with members of Airlines for America (A4A) to better understand level of data collected and institutional challenges
- Working with the National Business Aviation Association (NBAA) Access Work Group to explore opportunities for business aviation to contribute
- Department of Defense outreach in progress to understand feasibility of collecting data for transport operations
- Aircraft Owners and Pilots Association (AOPA) inputs received on fuel data collection
ACARS Reporting

- Most airlines report fuel onboard using ACARS (Aircraft Communications Addressing and Reporting System) messages
  - “Out” and “In” are most common fuel onboard reporting points
  - “Off” and “On” reports are less consistent by both an airline and fleet level and are less accurate due to fuel tank “sloshing”
- Messages are often automated but are sometimes manual (pilot entry required)
- Sensitivities exist to sharing ACARS OOOI data and differ by carrier

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ASIAS Data Base

- ASIAS airline-provided data captures approximately 95% of all US commercial operations. Of the 44 airlines that contribute data to ASIAS, 26 provide FOQA data, representing ~1/3 of the airline aircraft in the NAS.
- Reports aggregate data quarterly (data agreements do not currently permit reporting on narrower time).
- Monthly fuel consumption to inform city pairs metric likely feasible.
- ASIAS intends to expand participation to non-commercial user groups.

Key Findings

- **Finding 1:** Aircraft operators agree with the importance of generating fuel efficiency metrics to communicate the value of NextGen to the public, as well as being useful internally.

- **Finding 2:** Airline-provided data (eg, OOOI reports) used for NextGen fuel efficiency metrics will require each carrier to collaborate internally with employee groups (eg, pilots, dispatchers) to ensure appropriate usage and confidentiality.
Key Findings

- **Finding 3:** The depth and breadth of data needed to inform specific diagnostic metrics is substantially greater than those needed to inform high-level indicators
  - High level fuel efficiency metrics serve as indicators of overall system trends and health
  - Diagnostic analysis, including other data elements, is needed to isolate individual NextGen impacts

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Key Findings

- **Finding 4:** There is no single source for fuel use data. Data availability and utility vary greatly by user type, within user types and among aircraft.
  - Within Part 121 operators, there are significant variations in the generation, formatting, storage and reporting of fuel use data
  - General Aviation data collection does not currently support city pair analysis
  - DOD ability to provide city or base pair data is under exploration
Key Findings

- **Finding 5:** NextGen data collection and analysis efforts will need to be improved through an ongoing process as data sources are broadened and deepened over time. Modeling will be required to mitigate data gaps for the foreseeable future.
  - To address Congressionally-designated fuel use metrics, ACARS OOOI data recorded by Part 121 operators is the most feasible near-term source.
  - The recommended metric would require additional weight information from operators that do not record it via ACARS.
  - Diagnostic-level metrics will be met through a combination of directly-provided user data, use of the ASIAS infrastructure and modeled data.

Recommendations

**Recommendation 1:** FAA and NAC members should assemble a technical team to establish the detailed requirements for airline fuel and aircraft weight reports in support of high-level fuel efficiency metrics. This should be done in parallel with an airlines’ outreach to employee groups on the objectives and scope of the effort.
Recommendations

- **Recommendation 2**: FAA and NAC should continue to explore use of the ASIAS infrastructure to support both high-level and diagnostic-level metrics via the following steps (recognizing and complying with data protection protocols):
  - In initial data exploration phase to understand 1) the utility of different data elements in supporting metrics and 2) tradeoffs between direct fuel data collection and modeled data based on FDR data
  - A follow-on effort that identifies a specific subset of data to be made regularly available for informing fuel-use metrics

NAC Action

Discuss Fuel Data Report and endorse continued NAC Subcommittee work
DISCUSSION

Verizon Wi-Fi
“Jetpack 3BC7”
Pwd: 81af1f89

“Jetpack 3B5C”
Pwd: fe92223d
Recommendation for Key City Pairs for Measuring NextGen Performance

Steve Brown
NACSC Co-chair

FAA Tasking

- **August 2012** -- “Leverage existing Metrics work to provide recommendations on the set of key city pairs mandated by FAA Authorization legislation that could be used for NextGen metrics by October NAC meeting.”

- Task Group formed to provide expedited cross-Work Group expertise
FAA Modernization & Reform Act of 2012
PL 112-95

SEC. 214. PERFORMANCE METRICS

Three of the Twelve Congressional Metrics Address Key City Pairs

- fuel burned between key city pairs
- the average distance flown between key city pairs
- flown versus filed flight times for key city pairs

Key City Pairs Methodology

Criteria:

- City pairs (or Metroplex pairs) should be within the contiguous US
- The Metroplex is expected to have a measurable NextGen impact between 2010 & 2015 (each Metroplex will include the associated airports)
- Consider the ICWG tier 1 Metroplexes (7)
- Consider sites from the FAA/Industry Optimization of Airspace and Procedures in the Metroplex (OAPM1) initiative that are scheduled to begin implementation of capabilities no later than FY2015
- Number of operations (traffic) between city pairs should be considered
- Demand between the city pairs should be considered. The Task Group used ‘amount of delay’ as an indicator of demand.
Key City Pairs Methodology

Other Considerations:
- Data availability
- Ease of reporting (i.e. data that is recorded in an automated and accessible format and a viable approach to reporting the performance can be developed)
- Diversity – as a final review, evaluate the key city pairs for diversity of operations/different stakeholders (e.g., cargo, GA, multiple air carriers)

Applied by adding two city pairs
MEM-NYC
SDF-NYC

24 Key City Pairs (Metroplex Pairs)
Key City Pairs Recommendation

Northern California - Southern California
New York - South Florida
Chicago - New York
Boston - Washington DC
New York - Orlando
Atlanta - New York
Charlotte - New York
New York - Washington DC
Las Vegas - Southern California
Boston - New York
Dallas - Houston
Charlotte - Chicago
Charlotte - Washington DC
Chicago - Washington DC
Phoenix - Southern California
Chicago - Philadelphia
Chicago - Denver
Atlanta - South Florida
Chicago - Minneapolis
Denver - Southern California
Northern California - Seattle
Chicago - Memphis
Memphis - New York
Louisville - New York

How to Measure?
• Must be done at airport level
• Selected top airport pairs contributing to 50% of the overall delay within the Metroplex
• 84 specific airport pairs that have the greatest potential based on the number of delays that were contained in the 24 City Pairs
One Example of Airports Identified to Measure Key City Pairs

Five Airport Pairs = One City Pair
LAX  SFO  Northern California – Southern California
SAN  SFO  Northern California – Southern California
LAX  OAK  Northern California – Southern California
SFO  SNA  Northern California – Southern California
LAX  SMF  Northern California – Southern California

NAC Action

Consider Recommendations on:

Key City Pair Recommendation and Transmit to FAA
DISCUSSION

Verizon Wi-Fi
“Jetpack 3BC7”
Pwd: 81af1f89

“Jetpack 3B5C”
Pwd: fe92223d
Non-Technical Barriers to NextGen Implementation

Overview of New Tasking
Performance-Based Navigation

Presentation to: NextGen Management Board
Presented by: David Grizzle, Chief Operating Officer
Date: October 4, 2012
New Tasking

- Revalidation of Criteria & Philosophy for OPAM 2
- Prioritization of PBN Procedure Development/Retention
- Non-Technical Barriers
  - Industry’s Introspective Analysis
  - Industry’s Perspective of FAA barriers

FAA Activities to Overcome non-Technical Barriers

- Lentini Report
  - FAA Introspective Analysis
  - ID’s 21 barriers in 3 areas
  - PBN Accountability and Responsibility
  - IFP Design and Amendments
  - PBN IFP Utilization
- Updates to Controller Handbook
- Operational Incentive Initiatives
<table>
<thead>
<tr>
<th>Obstacle to PBN Description</th>
<th>Current Mitigation Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>The lack of one single accountable and responsible office to manage and handle all encompassing PBN matters.</td>
<td>Work is underway in the Airspace Services Directorate in Mission Support Services to restructure the PBN Program Office to be a one stop shop for PBN implementation.</td>
</tr>
<tr>
<td>The environmental review process is complicated and can be subjected to a lengthy environmental study (EA or EIS), prolonging PBN implementation.</td>
<td>Work is underway to address the environmental review process as part of the NavLean initiative.</td>
</tr>
<tr>
<td>The process for prioritizing IFPs is not transparent to the facilities.</td>
<td>Work is underway in the Airspace Services Directorate in Mission Support Services to restructure the PBN Program Office to be a one stop shop for PBN implementation.</td>
</tr>
<tr>
<td>There is no step within the IFP Implementation process for a facility to review chart(s) prior to finalization and publication.</td>
<td>No work has begun to address this issue however facility representatives are allowed a final charting review to identify any errors when AVN development delivers the procedure package to QA.</td>
</tr>
<tr>
<td>There exists no QA mechanism for FMS database verification and validation prior to implementation.</td>
<td>No work has begun to address this issue however carrier database verification is incorporated into the draft order for PBN Implementation Process and verification from the operators is captured in the PBN Projects Tracking Tool.</td>
</tr>
<tr>
<td>Testing new concepts at high density airports is sometimes limited due to operational impacts which can devalue the concept of PBN.</td>
<td>No work has begun to address this issue however some new concepts like STARs with Optimized Profile Decent (OPD) characteristics have been implemented at Anchorage (ANC), Charleston (CHS), El Paso (ELP), Louisville (SDF), and Mather AFB (MHR) as well as some large airports including Honolulu (HNL), Las Vegas (LAS), Los Angeles (LAX), and Atlanta (ATL).</td>
</tr>
<tr>
<td>The process for amending and updating procedures is too long and cumbersome, and requires streamlining.</td>
<td>Work is underway to address this issue however, Albuquerque and Washington ARTCCs are currently supporting the issuance of runway assignment.</td>
</tr>
<tr>
<td>The DCP process to FAA Orders 7110.65 and 7210.3 cannot keep pace with the changing needs of the NAS and NEXTGEN.</td>
<td>Work is underway to rewrite FAA Orders to keep pace with the changing needs of the NAS and NEXTGEN.</td>
</tr>
<tr>
<td>Phraseology guidance is inadequate, inconsistent, and unclear throughout the NAS resulting in pilot/controller confusion and unsafe conditions.</td>
<td>No work has begun to address this issue.</td>
</tr>
<tr>
<td>The rational for FAA Public criteria that is based on the lowest common denominator avionics is not fully understood and accepted by industry and ATC.</td>
<td>No work has begun to address this issue.</td>
</tr>
<tr>
<td>ATC field facilities do not have an adequate opportunity to share operational impact on AFIS criteria changes during the development process.</td>
<td>No work has begun to address this issue.</td>
</tr>
<tr>
<td>When implementing new PBN concepts and policy changes, a gap exists for full implementation due to charting, DCP, automation and other factors.</td>
<td>No work has begun to address this issue, however a checklist or life cycle process to facilitate needed changes in advance for Orders, charts, design modifications, missed approaches, etc., could expedite implementation.</td>
</tr>
<tr>
<td>ATC workforce is either not involved in or aware of the development of LPV procedures.</td>
<td>No work has begun to address this issue.</td>
</tr>
<tr>
<td>Optimization of arrival procedures is limited by Center’s ability and/or willingness to provide runway assignment prior to TACON entry.</td>
<td>No work has begun to address this issue however, Albuquerque and Washington ARTCCs are currently supporting the issuance of runway assignment.</td>
</tr>
<tr>
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<tr>
<td>Design of PBN procedures to account for variations in aircraft performance and navigation capability results in sub-optimal procedures that are not consistently used by ATC. Controllers rely on vectoring to maintain efficiency.</td>
<td>No work has begun to address this issue.</td>
</tr>
<tr>
<td>ATC operational workforce has yet to be “effectively” trained on PBN standards and technologies, and familiarized with how PBN can benefit ATC and the customers.</td>
<td>No work has begun to address this issue.</td>
</tr>
<tr>
<td>Human beings entering data in the process introduce risk.</td>
<td>No work has begun to address this issue.</td>
</tr>
<tr>
<td>Procedure design philosophy differs between ATC and Operators.</td>
<td>No work has begun to address this issue however, merging and spacing tools like the Terminal Sequencing and Spacing (TSS) leveraging the Traffic Management Advisor (TMA) may provide a terminal decision support tool that will enable more consistent use of PBN procedures.</td>
</tr>
<tr>
<td>Data block information and capacity is limited and insufficient for ATC to determine aircraft/crew capabilities.</td>
<td>No work has begun to address this issue however, improved data blocks to depict equipage, enable center-to-TRACON clearance transitions, and sector-to-sector clearance transitions are needed.</td>
</tr>
<tr>
<td>Radar video maps for both STARS and ARTS platforms are becoming unreadable and limited in their ability to rapidly develop and depict PBN routes and waypoints.</td>
<td>No work has begun to address this issue.</td>
</tr>
<tr>
<td>Pilots are inconsistently requesting PBN procedures and controllers are not offering them, leading to apathy and confusion regarding procedure availability and who can/wants to fly them.</td>
<td>Work is underway to address this issue. The PBN Dashboard, undergoing beta testing beginning this month, has capabilities that will address the metrics reporting.</td>
</tr>
</tbody>
</table>

**Updates to Controller Handbook**

- Surveyed FAA Managers, FAA Controllers and Industry to identify priority changes
- Top 5 issues from each group
- Some overlap – 12 issues being worked
- Expect handbook changes to begin in 2013
Operational Incentive Initiative

• 10 Scenarios briefed during public meeting
• 5 Scenarios chosen to:
  ➢ Overcome internal obstacles
  ➢ Learn what is operationally achievable
  ➢ Inform policy making
  ➢ Provide benefits
  ➢ Encourage equipage

Operational Incentive Scenarios
(Those selected highlighted in Red)

BEBS 1: De-Conflict Airport Operations/Lower Weather Minimums with RNP0.3 w/ RF legs
  1A. JFK RWY 13L
  1B. LGA
  1C. TEB
  1D. MDW RWY 13C
BEBS 2: SOIA (Paired SOIA Paired Aircraft Approaches) with RNP0.3 w/ RF legs
  2A. PHL
  2B. SFO*
  2C. EWR
BEBS 3: ADS-B East Coast offshore routes
BEBS 4: ADS-B In Trail Procedures (ITP) / South Pacific and Beyond
BEBS 5: NextGen Minimum Capability Priority
  *pending safety analysis
Top 5 Rationale

- **BEBS 1: De-Confliction (JFK RWY 13L, MDW RWY 13C) with RNP0.3 w/ RF legs**
  - Established procedures (special procedure for JFK, public procedure for MDW) which reduces operational risk
  - Extensible (e.g., North Texas metro)
  - Significant differential benefit (positive benefit to equipped and negligible impact to unequipped)
  - Substantial potential NAS wide benefit
  - Large percentage of equipped aircraft (~50%)

- **BEBS 2b: SFO RNP/SOIA with RNP0.3 w/ RF legs**
  - Safety case in process
  - Candidate for West Coast operators

- **BEBS 3: ADS-B East Coast offshore routes**
  - In progress trial which reduces operational and technical risk
  - Creates relief valve in congested NY metro – potential NAS wide benefit

- **BEBS 4: ADS-B In Trail Procedures (ITP) / South Pacific and Beyond**
  - In progress trial which reduces operational and technical risk
  - Substantial fuel savings for long haul flights – extensible to Atlantic and beyond

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**BEBS 1: PBN Approaches to De-conflict NY Metro Airports**

RED: present & mixed capability operations.

BLUE: independent operations using RNP capabilities.

For Demonstration Purposes only.
Drawings are not to scale.
BEBS 2B: SFO SOIA Paired Approaches Runway 28 L & R

For Demonstration Purposes only - Drawings are not to scale

BEBS 3: ADS-B Off-Shore Routes
BEBS 4: ADS-B In-Trail Procedures

**NEED** → **CHALLENGE** = **OPPORTUNITIES**

- Altitude Changes required for better fuel economy, winds, and ride quality
- The combination of locally dense traffic and large separation minima limits altitude changes
- Use airborne ADS-B applications to enable altitude changes otherwise blocked by conventional operations

New PBN Tasking
October 2012
Environmental Issues Impacting NextGen Implementation

NEPA and NextGen
NAC Briefing

October 4, 2012
Introduction

• The National Environmental Policy Act (NEPA) requires Federal agencies, including FAA, to evaluate impacts of actions that have potential to affect the environment.
• Many FAA actions require environmental review, including air traffic procedures – both conventional and PBN.
• FAA is improving its NEPA performance and continues to pursue improvements to achieve more timely, effective, and efficient NEPA reviews.
• This presentation briefly describes the basics of NEPA, how we apply NEPA to air traffic procedures, and steps we are taking to improve/expedite FAA’s NEPA reviews.

Outline

• Basic environmental framework/requirements
• FAA’s NEPA responsibilities
• Environmental impacts reviewed under NEPA
• Three levels of NEPA review
  • Categorical Exclusion (Catex)
  • Environmental Assessment (EA)
  • Environmental Impact Statement (EIS)
• Application of NEPA to air traffic actions
• Expediting environmental reviews
Environmental Framework and Requirements
National Environmental Policy Act (NEPA)
“A national charter to protect the environment”

NEPA applies to all Federal agencies. It is a process – does not dictate a result

Accurate/high quality environmental information must be available before taking federal actions that affect the environment

FAA responsible for complying with NEPA by adequately/accurately reviewing environmental effects of its proposed actions, using a Categorical Exclusion (CATEX), Environmental Assessment (EA) and Finding of No Significant Impact (FONSI), or Environmental Impact Statement (EIS) – depending on the severity of anticipated impacts

FAA’s NEPA Responsibilities

• FAA (not EPA or other agencies) responsible for complying with NEPA for its own actions
• FAA has an environmental order (FAA Order 1050.1E), reviewed by CEQ, that details how to comply with NEPA
• NEPA impacts many FAA’s actions/decisions related to the NAS:
  • Air traffic procedures, airspace redesign, navigational aid installations, facility siting/construction, regulations, approval of airport layout plans, airport development grants, certifications, commercial space licenses, and airline operating specifications
• Many NextGen implementing actions are subject to NEPA
Three Levels of NEPA Review

- **Categorical Exclusion (CATEX)** - no potential for significant impacts, absent extraordinary circumstances.
  - Not an exemption from NEPA
  - Must be in FAA environmental order, reviewed by CEQ
  - Must be justified as normally having no potential for significant impacts
  - Must have option of more detailed review (extraordinary circumstances)

- **Environmental Assessment (EA)** - could result in significant impacts, requiring more assessment to determine. Concluded with a Finding of No Significant Impact (FONSI) or decision to prepare an EIS

- **Environmental Impact Statement (EIS)** – significant impacts, requiring detailed analysis of environmental consequences of proposed action and alternatives. Concluded with a Record of Decision (ROD)

### NEPA Timeframes
- **Less than 6 months**
- **6 to 18 months**
- **Average 3 years**

Application of NEPA to Air Traffic Actions

Environmental Review Varies by Altitude

- **Class A**
  - Above 18k feet AGL – Enroute
  - CATEX

- **Class B**
  - Between 7k/10k* and 18k feet AGL
  - CATEX
  - Noise Screening required
  - Air Quality analysis may be needed

- **Class C**
  - Between 3k and 7k/10k* feet AGL
  - CATEX
  - Noise Screening required
  - Air Quality analysis may be needed

- **Class E**
  - Below 3k feet AGL
  - Some CATEX and some EA, based on aircraft routing over noise sensitive areas
  - Noise Screening or Modeling required
  - Air Quality analysis may be needed
  - Significant impacts would require EIS

*7,000 feet AGL for arrivals and/or above 10,000 feet AGL for departures and/or overflights.
Expediting Environmental Reviews

GOAL: Timely, effective, efficient NEPA reviews within PBN implementation time envelope

- FAA’s NextGen NEPA Plan (Dec. 2011): Guides NEPA improvements in four key focus areas:
  - Policy and Guidance Consultation and Coordination
  - Best Practices Resources and Training
- NavLean has made/is making a difference
- Use of Catexes based on no potential significant impacts, supported with enhanced environmental screening tools
- The record shows the bulk (over 95%) of PBN procedures to date have been Catexed
  (Note: Increases in impacts do not preclude a Catex as long as increases are below significant levels)

NextGen NEPA Challenges

- **NextGen scale and timing**
  - Minimizing differences bet. NextGen & NEPA timing
  - High volume of NEPA review
  - High FAA resource and skill demands, especially air traffic
- **New capabilities and proposals raise issues**
  - RNAV/RNP/Metroplex – overlay vs non-overlay; segmentation; cumulative impacts; Catex, EA, EIS?
- **Weighing of impacts in decision**
  - NextGen efficiency/capacity achievements balanced against environmental impacts
  - Noise vs. fuel burn and greenhouse gas emissions
- **Resource and Budget Issues**
  - Fully trained FAA environmental specialists must manage NextGen NEPA projects effectively and efficiently
  - In lean times, need to address resources smartly to enhance NextGen implementation
Summary

• NEPA does present challenges to NextGen
  • Scale and timing
  • New capabilities and proposals raise issues
  • Weighing impacts
  • Resource/budget issues

• We can and have dealt with these issues in the past
  • NEPA is not a barrier to NextGen

DISCUSSION
Introduction

FAA Modernization and Reform Act of 2012 seeks to accelerate environmental reviews of PBN procedures with two legislative Categorical Exclusions (Catex)

   a. Catex in Sec. 213(c)(1) PBN Catexed unless there are extraordinary circumstances with respect to the procedure

   b. Catex in Sec. 213 (c)(2) requires the Administrator to issue a Catex for PBN procedures that would result in measurable reductions in fuel, CO_2, and noise on a per flight basis compared to existing procedures

This presentation summarizes issues with Catex 2 and outlines a tasking to the NAC
Outline

- Legislative text of Catex
- Summary of CATEX issues
- Aircraft noise characteristics and how FAA measures it
- Technical issues with determining measurable noise reduction on a per flight basis
  - Brief descriptions of methods analyzed
- NAC tasking

FAA Reauthorization
Legislated CATEX – Sec. 213(c)(2)

“(2) NEXTGEN Procedures. - Any navigation performance or other performance based navigation procedure developed, certified, published, or implemented that, in the determination of the Administrator would result in measurable reductions in fuel consumption, carbon dioxide emissions, and noise, on a per flight basis, as compared to aircraft operations that follow existing instrument flight rules procedures in the same airspace, shall be presumed to have no significant affect [sic] on the quality of the human environment and the Administrator shall issue and file a categorical exclusion for the new procedure.”
Legislated CATEX 2- Issues

- Technical issue: How to determine measurable noise reduction on a per flight basis
- NEPA precedent issues:
  - Includes fuel consumption and CO2 emissions as factors governing Catex
  - Relies on impacts per flight instead of cumulative impacts
  - Excludes other factors, e.g. air quality pollutants under the Clean Air Act
- Practical issue:
  - Today CATEX determinations based on no significant impacts
  - New CATEX sets different standard of measurable reductions that may restrict its use

Characteristics of Aircraft Noise Exposure Driving Current FAA Practice

- Noise exposure or “noise dose” from an aircraft operation depends on the level of noise (decibels) and duration of noise (time)
- Noise exposure also depends on relative position of receiver (human) to aircraft
FAA Current Practice for Calculating Noise Impacts

- Aircraft noise impacts on communities are based on total noise from all flights and by identifying increases over noise sensitive areas, not a per flight basis.
- Noise impacts are best correlated with cumulative noise metrics such as the Day/Night Average Sound Level (DNL) used by FAA.
  - DNL accounts for the noise level as well as duration of aircraft operations.
  - DNL accounts for the number of operations experienced over a 24 hour period.
  - DNL adds a nighttime penalty for aircraft operations occurring between 10 pm and 7 am.
  - There is no single total DNL number for the study area.
  - Logarithmic DNL calculations can’t be divided by number of aircraft to produce “noise per flight” values.

Challenges with CATEX 2

How to Determine Noise Reduction on a Per Flight Basis

What is the noise of this flight?

Noise at the source depends on aircraft state:
- Power setting, flap setting, gear up/down, speed, attitude

Noise at the receiver depends on noise at the source and relative position to the aircraft of the receiver.
How to Determine Noise Reduction on Per Flight Basis - Methods Analyzed

Use of DNL to produce a per flight metric

Four single event metrics

– Aircraft noise certification levels
– Time above a specified noise level
– Maximum noise level
– Sound exposure level

Source noise of the PBN procedure compared to the source noise of an existing procedure

Determining Noise Reduction on a Per Flight Basis

Challenges with Single Event Noise Metrics

• Individual metrics have drawbacks:
  • A/C certification: No measurable noise differences for procedures
  • Time-above: Inadequate measure of noise level
  • Maximum sound level: No measure of total noise of flight
  • Sound exposure level: Better than others, but still site-specific

• Noise measurement is different at different locations
• Summing or averaging locations has issues - high noise levels near runways dominate calculations
• Non-overlay PBN procedures compound problem of comparing locations to determine reductions
Source Noise Comparison: PBN vs Existing Procedure - Analytical Challenges

- Does not take into account receivers on the ground where sound energy is converted into noise by the human ear
- A determination of noise reduction separate from the receiver would be a departure from noise impact determinations done to date and that would continue to be done for all other FAA actions
- Source noise reduction could still increase noise for receivers
- Need to develop noise screening; no current noise models calculate source noise per flight
- Public review needs to be considered for a new metric and its interpretation

NAC Tasking on Use of Catex

- Provide views on analyses done to date
  - Analyses to determine noise reduction on the ground on per flight basis
  - Analyses considering source noise independently of the receiver
- Provide technical suggestions on other possible approaches for determining measurable reductions in noise on a per flight basis – a technical issue that must be solved to enable the Catex to be used
- To the extent the NAC believes the Catex cannot be implemented effectively and/or even if implemented would not have a desired impact, provide practical and/or legislative recommendations that would help streamline environmental reviews for PBN procedures
- Provide both an interim and a final report. The interim report should include a timeline for completing the task
DISCUSSION

Chairman’s Closing Comments

NAC Chairman Dave Barger
President & CEO
JetBlue Airways
Incoming Chairman’s Comments

NAC Chairman Bill Ayer
Chairman
Alaska Air Group

Other Business/Anticipated Issues for NAC Consideration and Action

Dave Barger
President & CEO
JetBlue Airways
Next Meeting
Wednesday/Thursday
February 6/7, 2013
Salt Lake City, UT

Adjourn
Good Morning.

I am Dave Barger and honored to chair this FAA NextGen Advisory Committee and welcome each of you to this 7th meeting of our full committee.

Welcome to the historic and spectacular Wright Patterson Air Force Base, where the greatness of American Aviation is not only on display in the museum we visited last night but from where our America’s aviation greatness is sent all around the globe.

For those of you who have been to a few of these NAC meetings, you know I like to speak along with the use of visuals, in the form of a word cloud.

If you have found this style beneficial, then I have good news . . . today you get to experience another word cloud.

And, if you have not found these word clouds beneficial, I have even better news: today is my last one.

**VISUALS**

Just as this word cloud will populate with significant visual representations of the key messages I will try to deliver, so too have our collective efforts done the same for the FAA and our industry over the past two years.

We have all become smarter, more aware of the complexities of implementing NextGen, its impediments and its potential.

Through the VISUAL of Embry Riddle Aeronautical University simulations, the visual of NextGen cockpits being mass-assembled on a factory floor, the visual of enjoying a picnic lunch under the wing of a modern NextGen equipped jet on a hangar floor, to the visual reminders we experience last night at the National Museum of the Air Force; these visuals have served to inspire me (and I hope each of you) as to what our industry has accomplished over the past century and how critical our work is today.

**INSPIRATION**

Our work and our debates on the science and especially the non-scientific policy questions surrounding NextGen have been tough.

Yet, walking through the Museum last night inspired me personally to join those men and women who came before us and make a meaningful contribution, through our work on this Committee - to leave behind something in aviation a little better than how we found it.

The giants who created everything we saw last night, that awe-inspiring real-word timeline, were mostly not seen as giants in their day as much as they were just like us; working to make things better and not succumbing to the difficulties they surely faced in their day. Certainly Orville and Wilbur Wright, from their beginnings in Dayton, set a great example for us with their dedication and perseverance.
I have also found inspiration simply by sitting in, as an observer, a room full of dedicated NAC Subcommittee member volunteers slugging away, for days on end, to wrestle consensus out of the midst of differing viewpoints. This experience also inspires me to stay engaged and to stay active.

**METRICS**

This meeting marks an important step for the NAC in completing our recommendations to the FAA on Measuring NextGen performance. We have continually emphasized that investments by the aircraft operators will come as a result of NextGen capabilities being available, or being Visible.

A crucial element of this shared investment strategy is a set of high level metrics that give us benchmarks to measure NextGen implementation and the impacts it is producing for the ATC system. This is helpful for federal investments, industry investments and operational and financial incentives.

**CITY PAIRS**

An associated element to Metrics that we will be discussing and considering for recommending to the FAA is identifying key city pairs. This recommendation will help the FAA with specific measurements for fuel burned, the average distance flown and flown versus flight times all measured by the city pairs.

Just two weeks ago, I joined Michael and NATCA at JetBlue University in Orlando as the FAA announced the implementation of NextGen procedures in Central and South Florida, benefitting the key cities of Orlando, Tampa, West Palm Beach, Fort Lauderdale – Hollywood, Miami and Fort Myers.

**ENVIRONMENT**

One other area that our Committee will be addressing is a specific recommendation on data sources for measuring fuel burn – that is the reduction in fuel burn, and with it, emissions and the green footprint of aviation. This is a key selling point for NextGen to the Congress, the operators and the public at large.

As I have said since the beginning of my time chairing this committee, we are about the implementation of NextGen, where the rubber meets the road – or in our case, the runway.

One of the difficult issues we face is how to gather the specific data needed for decision making. It may seem down in the weeds, but an endorsement by this policy committee can go a long way towards placing the priority for making this information available.

We all stand to gain – most importantly our customers stand to benefit from improvements fostered by good data being available.

**TASKINGS**

The NAC has been assembled and accomplished its work thus far by providing thoughtful answers to the FAA’s questions – what we call Taskings.

We have addressed aircraft equipage, incentives, Metroplex capabilities and prioritization, DataComm, performance Metrics, business case analysis and issues associated with airspace and procedures.
As we reflect on our work and look ahead to helping the FAA with future Taskings, I believe we are at an inflexion point.

We are now being asked to build on our discussion of non-technical barriers to NextGen, the fielding of RNP approaches and the next round of NextGen implementation at Metroplexes.

We are also going to address the challenging issue of implementing a new authority from Congress on environmental categorical exclusions for the new procedures.

**TRANSITION:**

When I think about our work, our work-in-progress, we are in a transition as a Committee. Least of our transition is me stepping down as Chairman and Bill leading us going forward.

As we look around the country, we are an aviation system in transition RIGHT NOW. We are using RNP approaches, relying on satellite-based capabilities, NEXTGEN, today – from Seattle with Greener Skies, to JFK and LaGuardia approaches to Florida and the Gulf. Our nation is transitioning NOW.

I recall my first meeting Chairing this Committee and speaking in terms of never achieving NextGen – NOT because we can’t or won’t, but because with NextGen the goal line is always moving down the field.

With today’s science, today’s budget and business realities and today’s motivations, we are indeed making progress and our work has helped the FAA do their work – implementing NextGen now. The examples are plentiful. Some may say not plentiful enough but I say plentiful and I say that knowing more and more is in the pipeline and that pipeline is a shorter and shorter one each and every day because of our work.

The transition from radar-based to satellite-based and from not-equipped to fully-equipped is happening today as we sit here.

As Chairman, I have been candid that I am one who sees a glass half full, not half empty.

I remain as optimistic as ever that this Committee will continue to provide beneficial wisdom and advice to the FAA.

I urge each of you to continue, as one of you recently mentioned to me on an outreach telephone call: “Please keep providing the industry’s insight on things that matter to the industry.”

I am more passionate about the progress being made by the FAA, under Michael’s leadership and with his leadership team, so many of them with us on this Committee, than ever before. This sentiment is something that I, along with several other committee members, expressed to Congress in our testimony a few weeks ago.

Thinking back to our museum visit last night, we owe so much to those who came before us and took us, in one hundred years, from grounded to space flight. Similarly, we owe that much and more to those
aviators yet to come so they will look back on this Committee’s work and that of the FAA of this day with gratitude for writing the next chapter.

Thank you.
BUDGET/SEQUESTRATION

• NextGen is one of the largest infrastructure projects in the country, and the President’s budget for 2013 requests more than $1 billion for NextGen – an increase of 11 percent over last year.

• The entire FAA budget request for 2013 is $15.2 billion. Of course we will have to work within whatever budget Congress eventually passes for our agency. And Congress did recently enact the FY 2013 Continuing Resolution to provide funding for the FAA and all government operations through March 27th.

• Under the continuing resolution, the FAA receives about $77 million more compared to last year. Still, certain areas are between 3 and 6 percent lower than what we asked for in the 2013
budget, which means we will have to tweak our plans.

- The bottom line is, we are operating in an environment of tight budgets, and it is also a time of uncertainty. The sequester is an issue on everyone’s mind.

- The White House has transmitted its report to Congress detailing how the Administration would implement the automatic sequestration cuts for federal agencies.

- If the sequester were to occur, the FAA would face some very drastic cuts in services and investments. These cuts would impact air traffic control services, NextGen implementation, and aircraft certification – all of which are critical to our ability to move forward with aviation in this century. They would result in significantly less efficient and less convenient air travel service for the American traveling public. We will always, however, maintain the highest levels of safety.
• It’s important that Congress works together to avoid the sequestration, and we are hopeful that they will do so.

• Even as we face a challenging budget climate, the FAA is committed to modernizing the airspace system as well as maintaining the equipment that makes our system run today.

UPDATES RELATED TO PAST NAC RECOMMENDATIONS

DATA COMM CONTRACT AWARD

• Last month we awarded a $330 million contract to deploy Data Comm in dozens of air traffic control towers in the next six years (projected completion by 2018). Later we plan to deploy it in en route centers that manage high altitude traffic.

• Communication between air traffic controllers and pilots is a core element of air traffic control and one that we can improve.
• Under the current system, any change to a departure clearance within 30 minutes of push back must be done by a controller talking on the radio. Bad weather can complicate this – and clearances can change many times for multiple aircraft. This can cause major departure delays.

• If air traffic controllers can send a revised departure clearance in written form at any point before take-off, it would significantly reduce the amount of time needed to issue these clearances.

• To facilitate the roll out of Data Comm, we plan to validate the system’s capabilities at three air traffic control towers around the country in a pilot program. We’ll test in Memphis with FedEx, and later in Newark with United, and in Atlanta with Delta.

• DataComm will provide a two-way data exchange between controllers and flight crews. It will supplement but not entirely replace voice communication on the radio. And it will not only help with departure clearances, but also with
instructions, advisories, flight crew requests and reports.

- Data Comm will enhance air traffic safety by allowing controllers to give more timely and effective clearances. The delivery of messages will be more reliable and will reduce the risk of incidents associated with voice communications.
- Data Comm is just one part of the big NextGen picture. But, it shows the relevance and importance of interconnecting technologies. It also shows how important it is to work together as operators, regulators, unions, and airports.
- Collaboration is key to making NextGen a reality now.

FINANCIAL AND OPERATIONAL INCENTIVES FOR EQUIPPAGE

- We are evaluating both operational and financial incentives. We've come to understand that these incentives are interconnected.
• As you’ll recall, the FAA held a public meeting on operational incentives back in March. We gathered industry feedback on a series of potential projects where aircraft with NextGen equipment would receive an improved level of service or access compared with lesser equipped aircraft.

• Since that time we have selected five pilot projects on operational incentives. David will talk about more those during the non-technical barriers discussion.

• The overall goal of equipage incentives is to encourage deployment of aircraft capable of taking advantage of NextGen sooner. We have made progress over the past few months.
• We are taking steps towards possible implementation of a loan guarantee program. However, consistent with the Federal Credit Reform Act, we need language in an appropriations act before we can actually start issuing loan guarantees.

• We also need to be convinced the program will make a difference towards the goal of accelerating the number of NextGen capable aircraft operating in the NAS.

• We held two public meetings – in May and August – that were well-attended. We received some feedback on the characteristics of a useful loan guarantee program. It should be flexible, the application process should be streamlined, and risk should be shared.
• A key take-away for us is that financial incentives alone are likely insufficient to encourage equipage. There needs to be a tie to an improved level operational service as well.

• In an effort to better understand the potential relationship between financial incentives and the improved level of operational services, we recently released a second market survey.

• The set of questions is intended for both air carriers and members of the general aviation community, although we welcome comments from all stakeholders. We are asking recipients to identify the top three to five NextGen capabilities that are most important to them among other questions.
Turn it over to Vicki for the Integrate Capabilities Recommendations, but it will come back to you at the end for the Metroplex part.

Vicki Cox will speak:

Response to the Integrated Capabilities Recommendations

- In 2010 we asked the NAC to provide recommendations in three areas:
  - What priorities should the FAA consider for improving operations in the nation’s busiest metropolitan regions?
  - Which of these metroplexes should the FAA focus on first?
  - What are the highest-priority capabilities within each of these metroplexes?

- The Integrated Capabilities Working Group leaned into this tasking, recommending a prioritized set of Tier 1 and Tier 2 metroplexes and their associated priority capabilities. We plan to use all of this work as input to our planning, with a focus on the highest priority locations and capabilities.

- In particular, we concur with your prioritization of PBN, surface management, and near-term time-based flow management capabilities.

- As you’ll hear later on in today’s agenda, we are coming to the NAC for additional tasking on increasing PBN utilization and for criteria to prioritize future PBN work.

- Right now the surface and TBFM capabilities are in the investment analysis phase of FAA’s acquisition process, with final investment decisions planned for fiscal 2014. We are directing these programs to include the Tier 1 locations in their analyses.

- In addition to the recommendations themselves, one of the valuable outcomes of this tasking is the ongoing working-level engagement between the ICWG and the FAA. It’s provided us with an opportunity to clarify the intent of various operational improvement increments and receive industry’s feedback.
Vicki: Now, I’d like to turn it back over to Michael to wrap up with a video about our progress on the Washington D.C. metro area Metroplex.

**METROPLEX**

- We have talked a lot about Greener Skies at our previous meetings. We are applying the lessons of Greener Skies at airports across the country.

- We are actively working on Metroplex solutions at several areas around the country and just kicked-off our work for the South Florida Metroplex a few weeks ago.

- We are well on our way to designing and implementing NextGen Metrplex procedures here in Washington, D.C.

- In fact since early August, all major airlines flying into Reagan Washington National Airport have been using Optimized Profile Descents. During the month of August more than 2,400 flights used these fuel saving arrival paths.
These approaches are a tribute to the bravery of the men and women who made the ultimate sacrifice on September 11 and to our troops who defend freedom around the world.

I’d like to play a video for you that shows the waypoints that each aircraft will pass through each time it flies these new NextGen Optimized Profile Descents from the west into DCA.

(On the second part -- “Troops” – say aloud for the audience the names of the military services honored as the plane passes through each waypoint:

“As you can see, the Troops arrival waypoints honor each branch of the military –

- the Navy SEALS,
- the Army RANGERS,
- the MARINES and
- the Air Force PARARESCUE.”
Approved by the NextGen Advisory Committee October 2012
Measuring NextGen Performance

A Report of the NextGen Advisory Committee in Response to Tasking from The Federal Aviation Administration

October 2012
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Introduction

The NextGen Advisory Committee’s (NAC) Business Case and Performance Metrics Work Group (BCPMWG) is chartered with developing metrics to measure the operational impact of NextGen initiatives. In 2011, the BCPMWG developed recommendations for a set of high- and medium-level metrics to address operational changes affecting capacity, efficiency, predictability, and access. These metrics have been accepted by the Federal Aviation Administration, which is implementing a web-based performance reporting capability building on these recommendations. In September 2011, the NAC also requested that the BCPMWG continue its work by refining the metrics recommendation to identify a smaller number of high-level, outcome-based metrics indicative of NextGen implementation.

BCPMWG proposed six high-level categories to the NAC in February 2012: Safety, Metroplex Capacity, Total Trip Time, Fuel Efficiency, NAS Cost Effectiveness, and Access. These categories were endorsed by the NAC, with the direction to refine and complete the metrics recommended for these categories. This report completes the NAC’s request and delivers a comprehensive recommendation on high-level, NextGen related outcome metrics.

Executive Summary

To publicly convey the high-level impacts and operational outcomes of NextGen, a small number of metrics understandable by a broad audience are more meaningful for communication and messaging about NextGen – its contribution to national policy goals, and those captured in the FAA’s Destination 2025 document (FAA, 2011). High-level metrics provide insights on overall trends in areas where NextGen is likely to have an impact.

The high-level outcome metrics, as shown in the table below, are recommended for capturing key NextGen impacts:

<table>
<thead>
<tr>
<th>Performance Area</th>
<th>NextGen High-Level Outcome Metric</th>
<th>Where Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight Safety</td>
<td>Change in Airborne/Ground Separation Alert Rate</td>
<td>NAS-Wide</td>
</tr>
<tr>
<td>Operational Efficiency</td>
<td>Mean Aircraft Operation Time</td>
<td>Key City Pairs</td>
</tr>
<tr>
<td>Fuel Efficiency</td>
<td>Fuel Efficiency Normalized by Weight and Distance</td>
<td>Key City Pairs</td>
</tr>
<tr>
<td>ATC Cost Efficiency</td>
<td>ATC Cost per IFR hour</td>
<td>NAS-Wide</td>
</tr>
<tr>
<td>Metroplex Capacity</td>
<td>Metroplex Peak Allowable Throughput</td>
<td>OAPM Metroplexes</td>
</tr>
<tr>
<td>Metroplex Access</td>
<td>Metroplex Achieved Utilization</td>
<td>OAPM Metroplexes</td>
</tr>
</tbody>
</table>
The NAC recommends the following:

- FAA should establish and report on baseline measurements for all high-level metrics\(^1\) as an initial step to developing target performance levels, and provide to the NAC a forecast of how often the metrics can be reported (e.g., Annually, quarterly, monthly, etc.).
- For metrics associated with key city pairs, the FAA should use the 24 key city pairs contained in the attached recommendation as the set for base-lining and future comparison to the FAA Modernization and Reform Act of 2012, Section 214 “key city pairs”. See Appendix 4: Section 214

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**Background**

Since February 2012, the BCPMWG has revisited a subset of the high-level metrics for which the NAC expressed interest in further work. This paper summarizes the group’s findings since that meeting.

Metrics exist on a spectrum that can range from broad indicators of general trends (lacking detail on the underlying drivers of change), to detailed diagnostic or accountability metrics directly correlated to a NextGen initiative. Different metrics and levels of metrics will be desired and suitable to different users and audiences depending on their own needs and goals. Note that no high-level metric can isolate NextGen impacts discretely – as high-level metrics by definition will be indicative of the NAS as a system with all the direct and indirect influencing factors therein. The FAA will be reporting a variety of NextGen metrics to communicate to the public and other agencies operational outcomes related to NextGen.

With the NAC interest in a single-digit number of metrics, BCPMWG has focused current work only on high-level, outcome based metrics which NextGen is meant to influence but will typically not be the sole driver for observed trends (whether positive or negative). Lower-level metrics – such as diagnostic metrics that can directly identify the impacts of NextGen initiatives – will require significant work to analyze and tailor to specific operational environments, possibly making advance identification of the appropriate metrics impractical. Instead, an iterative approach may be required as FAA and industry partners jointly analyze capabilities to refine diagnostic metrics in the post-implementation phase. Consistency of measurement is also important for understanding the tradeoffs. The impacts of an initiative cannot be compared easily if metrics are calculated on different geographical or chronological scopes.

\(^1\) Note – The Fuel Efficiency metric will require empirical fuel and weight data from key user groups before a viable baseline can be established. Data sharing alternatives are being developed to achieve this means.
Recommendations
This report identifies six high-level metrics that capture areas of community interest: Flight Safety (Change in Airborne/Ground Separation Alert Rate), Operational Efficiency (Mean Aircraft Operation Time), Fuel Efficiency (Fuel Efficiency Normalized by Weight and Distance), ATC Cost Efficiency (ATC Cost per IFR Hour), Metroplex Capacity (Metroplex Peak Allowable Throughput), and Metroplex Access (Metroplex Achieved Utilization). Because, these are high-level metrics the scope of measurement will be either on a national level or at a Metroplex level.

Recommendation 1: FAA should establish and report on baseline measurements for all high-level metrics as an initial step to developing target performance levels, and provide to the NAC a forecast of how often the metrics can be reported (e.g., annually, quarterly, monthly, etc).

Recommendation 2: For metrics associated with key city pairs, the FAA should use the 24 key city pairs contained in the attached recommendation as the set for as the set for base-lining and future comparison to the FAA Modernization and Reform Act of 2012, Section 214 “key city pairs”. See Appendix 4: Section 214.

Note – The Fuel Efficiency metric will require empirical fuel and weight data from key user groups before a viable baseline can be established. Data sharing alternatives are being developed to achieve this means

Key Findings:

Improved Safety
The primary goals of NextGen are to enhance the safety and reliability of air transportation, improve efficiency in the NAS, and enable sustainable aviation growth. Safety is paramount in all aspects of the air transportation system and remains the driving force in all NextGen programs and decisions. Ultimately, the desired outcome for safety is the reduction in fatalities, and the FAA’s Destination 2025 goals reflect this. Therefore, it is important to identify existing metric(s) that will help determine the effects on safety related to NextGen. Strategies to reduce accidents and fatalities generally target the highest magnitude safety risks, in parallel with data mining, to better understand emerging risks. Because of this iterative nature, the focus for safety metrics will change over time as contributors to safety risk are identified and mitigated.

The FAA is working with a number of established venues to define high-, medium-, and diagnostic-level metrics for safety. These venues include the Commercial Aviation Safety Team (CAST), the General Aviation Joint Safety Council (GAJSC), and the Aviation Safety Information Analysis and Sharing (ASIAS)
Executive Board. BCPMWG defers to these groups for the definition of safety metrics, including those that will, in the future, isolate NextGen impacts.

The recommended provisional metric to reflect NextGen impacts on safety, and situational awareness is the Change in Airborne/Ground Separation Alert Rate, reported at a national level aggregated across the NAS Core airports and en route operations. This metric would capture the relative change, year-on-year, in the normalized rate of TCAS Resolution Advisories\(^2\) (RAs) and TAWS alerts\(^3\). The recommended baseline year is 2011; changes in the normalized rate would be reported year-on-year, beginning in 2012. TCAS RAs and TAWS alerts are currently tracked by the FAA’s Aviation Safety Information Analysis and Sharing (ASIAS) program. The normalized rate of TCAS RAs and TAWS alerts should be computed by dividing the total number of RAs and alerts detected for flights into or out of the NAS core airports by the total number of operations performed at those airports over a year.

For example if, in 2012, there is a 10% increase in operations and a 10% increase in the number of alerts, the normalized rate would be the same and a zero percent change would be reported for 2012 in comparison to 2011. If in 2013, the number of operations stays the same but the number of alerts is reduced by 10%, the normalized rate would be 10% less in 2013 versus 2012.

This metric is designated as a Provisional metric because additional work is needed to refine data sources and the exact scope of measurement. The metric should capture both direct improvements in commercial operations (the primary users of TCAS and TAWS) and indirect improvements in general aviation situational awareness through the reduction of GA errors that result in TCAS alerts. By calculating this metric based on operations into or out of the NAS Core airports, there will be a relatively direct link between year-on-year safety performance and changes initiated as a result of NextGen policies, procedures and technology deployments related to those airports.

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\(^2\)TCAS Resolution Advisory (RA): A display indication given to the pilot by the traffic alert and collision avoidance system (TCAS) recommending a maneuver to increase vertical separation relative to intruding aircraft. The resolution advisories include positive, negative, and vertical speed limit advisors. A resolution advisory can be either preventive or corrective. (From the McGraw-Hill Dictionary of Aviation)

\(^3\)TAWS Alert: The Terrain Awareness and Warning System using is a computer-based system providing the flight crew with visual and acoustic alerts about the unintended approach to the terrain, taking into account the flight stage, flight crew response time, and aircraft speed. There are two types of TAWS—Class A and Class B. Class A equipment is for installations on large aircraft; it displays FLTA (forward-looking terrain alert), premature descent, excessive closure rate to terrain, flight into terrain when not in landing configuration, excessive downward deviation from an ILS (instrument landing system) glide slope, excessive rate of descent, and negative climb rate or altitude loss after takeoff alerts. It also displays a voice callout about the altitude above the terrain, terrain display, terrain/airport database, and a voice callout about the passing of a set altitude. Class B equipment does not require a display. The Class B system is required to provide FLTA, premature descent, excessive rate of descent, and negative climb rate or altitude loss after takeoff alerts and international voice callouts. The latter version is used in smaller aircraft and helicopters and does not require interfacing with the radio altimeter. (From the McGraw-Hill Dictionary of Aviation)
Note that NextGen will not affect every type of accident in the NAS and that the occurrence rates of some accident types (unrelated to NextGen) could vary independently with NextGen implementation. It is important, therefore, to develop a baseline risk number that tracks the relevant accident risk for NextGen changes, and provides a reasonable basis to assess the impact of the NextGen program. Development of metrics providing insights into risk is in progress as part of the FAA’s System Safety Management Transformation (SSMT) initiative; BCPMWG will coordinate with the safety community on the status of developing a NAS-level risk assessment metric.

**Increased Efficiency**
Increased efficiency has consistently been a national system objective, and the importance of improving efficiency and predictability while reducing delays is captured in the FAA’s Destination 2025 document. Performance Based Navigation (PBN), in particular, is identified as a key enabling technology for efficiency.

The recommended high-level metric is **Mean Aircraft Operation Time**, which is defined as the actual end-to-end time between pushback and destination gate arrival.

The scope of measurement for this would be a representative of set of key city pairs.

This metric will be affected by many of the planned operational improvements of NextGen, including the RNAV SIDs and STARS and Optimized Profile Descents, among other PBN and airspace improvements, expected to result from the Optimization of Airspace and Procedures in the Metroplex (OAPM) Program, ADS-B (e.g., in the Gulf of Mexico), Surface Traffic Management Initiatives, ATC Digital Communications, Time Based Flow Management (TBFM), and closely-spaced parallel runway operations (CSPO). For example, Performance Based Navigation (PBN) procedures are expected to reduce flight times in the en-route and terminal airspace, while surface traffic management initiatives are expected to reduce aircraft taxiing times.

**Increased Fuel Efficiency**
NextGen is expected to improve aviation fuel efficiency via shorter flight paths and times, reduced delays, more optimum altitude profiles, and better flight planning predictability which reduces the need to carry reserve or contingency fuel.

The recommended high-level metric is **Fuel Efficiency Normalized by Weight and Distance**, represented in units of ton-miles per gallon, which indicates the fuel efficiency associated with carrying the entire aircraft weight (i.e., ramp weight) from the beginning of taxi to engine shutdown (e.g., from departure to the arrival gate) for monitored flights within the NAS. The miles represented in the numerator are the great circle distance between the origin and destination rather than actual track miles flown. Thus, improvements in actual flight paths will positively influence this metric by reducing the required amount of fuel. Lower-level metrics will illustrate how a reduction in the fuel component...
of ramp weight allows for increases in payloads. (Refer to Appendix 1: Fuel Efficiency Metric.) The metric would be calculated over a representative set of key city pairs.

If NextGen improvements as outlined above are realized, the amount of fuel required for an aircraft to travel from gate to gate will decrease. However, as is the case with all high-level, outcome metrics the proportion of fuel savings attributable to NextGen will not be easily discernible at this level of aggregation from among other factors including aircraft and engine technological advancements. However, it is an important starting point to improve the understanding of system trends. BCPMWG has found that there is a significant level of variation in the level of data that is available for different user groups. BCPMWG believes that the FAA should initially pursue data collection for Part 121 operators, for high-end General Aviation, and for DoD transport aircraft; these groups are likely to have the most complete and robust set of measurements. There are currently no mechanisms to enable sharing of data to inform the proposed NextGen metric. Until user data sharing agreements are in place, FAA may need to continue to model fuel usage, and may consider estimating typical payloads. For more information on data availability, see the BCPMWG’s report, ‘Data Sources for Measuring NextGen Fuel Impacts’ (October 2012).

While the BCPMWG has defined a high-level fuel metric, the work group recognizes the need for further effort to establish data sharing practices. A dedicated work group that includes subject matter experts (SMEs) representing participating operators and FAA personnel would be useful to facilitate these practices. Initial outreach efforts have been promising, and the BCPMWG is optimistic that a short-term data collection test could soon be recommended in support of a high-level metric. This could later be followed by a longer term diagnostic level data collection effort.

**FAA Cost Efficiency**

One of the ways that NextGen can contribute to enhancing the economic viability of the air transportation system is to enable FAA to use its air traffic management resources more productively. Businesses typically use metrics that measure the productivity of their resources by looking at costs-per-output or output-per-unit-of-input. The Civil Air Navigation Services Organization (CANSO) includes IFR flight hours per controller and costs per flight hour in its system performance metric framework. Eurocontrol has also explored measures for evaluating the efficiency of providing air traffic services.

The desired high-level metric for NAS Cost Efficiency is **ATC Cost per IFR Flight Hour**. IFR flight hours captures the number of hours that aircraft are under positive air traffic control and being provided direct service (output) by the FAA. Costs should ideally include only the variable costs to the ATO of controlling these flights. Fixed costs could potentially be included as an amortized, per-period “cost of

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4 A unit cost metric could also theoretically be expanded to include the operating costs to system users, but we recommend against this. The most direct user cost component that is likely to be impacted by NextGen is fuel cost, but the dollar cost
capital,” but there are difficulties in calculating this number accurately. On the other hand, a unit cost measure based solely on direct variable costs is already produced by the FAA; the BCPMWG recommends that it be used as the preferred high-level cost metric.

Recognizing that the user community may have additional needs for cost related metrics, we suggest that additional metrics could be developed at a lower level, measuring such things as the level of user investment in avionics, or changes to the reported non-fuel operating costs that commercial operators must currently submit via DOT Form 41. These lower-level metrics would require more study, however, and we recommend that the FAA move forward with using the Direct Variable ATC cost per IFR flight hour, as the primary measure of changes in FAA’s NAS costs.

**Increased Capacity**

The problem of air traffic congestion and resulting limitations to economic growth is most apparent in large Metroplexes. Conflicting traffic from adjacent airports, miles-in-trail (MIT) restrictions, limited departure headings, and other airspace constraints, limits the ability to maximize both current and future airfield and airspace capacity. Overall community attention has been on addressing Metroplex capacity (as well as efficiency) both in terms of overall priorities as well as the focus for NextGen.

The recommended metric for increased capacity is **Metroplex Peak Allowable Throughput** as measured by the aggregate (AARs and ADRs) during peak hours per Metroplex, measured across a set of peak hours to be determined for each Metroplex. The Metroplex Peak Allowable Throughput metric would be reported for each of the Metroplexes in the NGIP.

The concept of capacity as used in this metric is a measure of maximum throughput capability. This concept is why the metroplex level of detail is recommended for this metric—one can usually calculate the maximum throughput capability of a Metroplex as the sum of the maximum throughput capabilities of the individual airports in that Metroplex, under a common time period and considering configurations, as long as those individual capabilities take into account the dependencies or conflicts between the airports in the Metroplex. The other important dimension of this metric is “time” – it is most meaningfully measured or estimated for relatively short time intervals such as an hour or a 15-minute period.

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5 Airport Arrival Rates (AARs) and Airport Departure Rates (ADRs) are set by the FAA to reflect the maximum number of landings and takeoffs that can be handled under a given set of operating conditions including visibility, runway use, winds, facility and procedure availability, etc. AARs and ADRs are established on both an hourly and 15-minute basis. Data on existing AARs, ADRs, and (AARs+ADRs) are available from the FAA’s ASPM database but only for the 22 reporting carriers operating to and from the 77 ASPM airports. Further work is required to collect such data for other flights in the NAS.
This metric will be affected by many of the planned operational improvements of NextGen, including OAPM, airport de-confliction, PBN (for additional paths), reduced aircraft separation requirements (via ADS-B Surveillance, ADS-B In), and CSPOs. For example, PBN and CSPO are expected to increase runway throughput in adverse weather conditions by increasing the number of simultaneous movements that are possible. ADS-B In is expected to enable a reduction of certain aircraft separation requirements in adverse weather conditions. Trajectory-based operations and interval management are expected to decrease average spacing buffers. Integrated surface/arrival/departure operations are expected to increase overall throughput at an airport.

Improved Access to the NAS
Discussions about “Access” or “Access and Equity” can be complicated when participants approach the topic with differing definitions of these terms. BCPMWG uses these definitions to improve the clarity and quality of discussions about this topic:

Access: A non-judgmental, objective measure of the level of utilization achieved by a set of users authorized to use a NAS asset or service (airspace, airport, approach, runway, etc.).

Equity: A measure of consistency and transparency in the application of Access policies according to the agreed upon rules for service.

Access for a set of users is increased, for example, when runway throughput is improved during Instrument Meteorological Conditions (IMC) (e.g., with the addition of LPV approaches that enable access to runway ends not served with an ILS).

The metric recommended for improved Access is Metroplex Achieved Utilization as measured by the percentage of unconstrained capacity, across periods of high demand, to be determined for each Metroplex. Unconstrained capacity is the maximum throughput under perfect weather conditions. The FAA Airport Capacity Benchmark, Optimum Weather Condition rate, is the basis for determining unconstrained capacity. Refer to Appendix 2: Understanding the Access Metric for more details.

Factors constraining capacity include the number of unequipped aircraft, spacing buffers, runway and airport dependencies, runway clearance times, airspace restrictions, and environmental limitations. Reducing these factors will increase the percentage of utilization achieved. Lower-level metrics can evaluate the impact of constraints.

In sum, the capacity metric states the maximum sustained throughput capability of an airport or metroplex; whereas the access metric conveys what percent, of an airport or metroplex’s unconstrained capacity, is achievable. Refer to Appendix 3: Comparison of Access & Capacity Metrics, for a detailed comparison.

6 Airport capacity benchmarks are readily available and understandable. To find the unconstrained capacity for a metroplex, take the sum of the airports’ Optimum Weather Condition rate (a.k.a. “Optimum VMC Capacity”).
Like many of the other high-level metrics identified, measurement at a Metroplex level provides a microcosm of how users are able to access the NAS. The Metroplex environment encompasses the diversity and operational needs of NAS operators and often has limits on capacity and efficiency that could see improvements brought about through the introduction of NextGen initiatives, such as the OAPM process, UAS integration, and airspace de-confliction. By de-conflicting airports and increasing IMC throughput, it improves metroplex utilization.

**Key City Pairs for Measuring High-Level Metrics**

Using an analytical process supported by quantitative criteria and qualitative analysis by Subject Matter Experts, the Key City Pairs Task Group developed a list of 24 city pairs that serve as the initial group for the FAA to use in measuring the impacts of NextGen. The criteria include such factors as locations where NextGen capabilities are being initiated between 2010 and 2015, ranking by delays and traffic volumes, diversity of operations and availability of data. The Task Group recommends that the city pairs be reviewed on a periodic basis as NextGen is implemented.

The Task Group determined that the Metroplex was the appropriate proxy to use for city pairs rather than specific airports. For the purposes of this report ‘Metroplex’ and ‘city pair’ are synonymous. The Metroplex was chosen to provide a clear summarized “picture” that would be relevant for policy makers, the public and others interested in understanding the impact of NextGen in key city pairs.

**Acknowledgments**

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In addition to the BCPMWG members listed above, additional participants in the KPI task group contributing to this document include: Akira Kondo (FAA); Ricardo Parra (FAA); Ben Stanley (Helios), Bernard Miaillier (Eurocontrol), Bo Redeborn (Eurocontrol), Robert Graham (Eurocontrol), H Sudarshan (ICAO), Marc Hamy (Airbus), Mike Lukacs (FAA), Vincent Galotti (ICAO)

Many thanks as well to Steve Brown, Tom Hendricks, Margaret Jenny, and Andy Cebula, of RTCA for their guidance.
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FAA, Destination 2025, 2011


ICAO 9854, Global Air Traffic Management Operational Concept, 2005


SESAR, Air Transport Framework – The Performance Target (D2), 2006.

FAA Airport Capacity Benchmark Report 2011

The 2011 capacity benchmarks have not yet been published by FAA.
Appendix 1: Fuel Efficiency Metric

Background
The FAA currently models fuel usage to report on aggregate fuel usage. Also, as discussed in the Data Sources for Measuring NextGen Fuel Impact report, existing fuel modeling by the FAA is insufficient to accurately assess the impacts of NextGen on fuel usage. So in order to track this metric at a high level, sufficient, reliable and informative data, must be collected and provided to the FAA. The various user groups collect and report data today in different formats and scope. However, the desire of all user groups including DoD, to participate in informing fuel efficiency metrics has been made clear to the work-group. In the short-term, based on their ability to contribute at a sufficient level, it is expected the following user groups will provide data:

- Part 121 Main-line (and Regional), including passenger and cargo operations
- Part 25 business jets
- DoD transport operations

Note: flights conducted where the origin and destination airports are the same should not be included in the metric.

Recommended High Level Metric: Fuel Efficiency Normalized by Weight and Distance

The recommended high-level metric is Fuel Efficiency Normalized by Weight and Distance, measured in Ton-miles per gallon, which indicates the fuel efficiency associated with aircraft ramp weight, from the beginning of taxi, for monitored flights within the NAS. The miles represented in the numerator are the great circle distance between the origin and destination rather than actual track miles flown. As NextGen efficiencies in communication, navigation, and surveillance are achieved, aircraft will fly optimized 4DT nearer to the great circle distance. This manifests a greater fuel efficiency ratio for a given ramp weight. Higher fuel efficiency means operators can carry more payload and/or less contingency fuel.

Ton-Miles/gallon can be derived using either payload or ramp weight. Both have advantages. The payload method is a viable metric used by some Part 121 airlines for matching equipment to demand. It is also valuable as a normalizing factor for other metrics. However, for application across different aircraft types and mission profiles, BCPMWG recommends using ramp weight to calculate ton-miles/gallon as a universal high-level fuel efficiency metric. Though, the payload method is suitable for larger aircraft – extra capacity is inherent in the aircraft design – it is not appropriate for smaller aircraft, because of its bias towards heavy-lift. Consequently, it is not the best measure for comparing fuel efficiency of a variety of aircraft types, like, the Ramp Weight method. Using ramp weight versus payload manages diversity by measuring the efficiency of lifting total aircraft weight (BEW plus fuel and payload) into the air. Thus, it is a better comparison of fuel efficiency across various aircraft types.

Here, are two examples using the Ramp Weight method:

The first example shows Ton-Miles/Gallon increasing with constant ramp weight (payload increased equally to the amount of fuel savings realized by NextGen efficiencies).

The second example shows Ton-Miles/Gallon decreasing with constant ramp weight (payload decreased equally to the amount of fuel savings realized by NextGen efficiencies).
Assumptions

- Great Circle distance – 1500 nm
- Pre-implementation Track Miles – 1700 nm
- Post-implementation Track Miles – 1600 nm
- Fuel Weight – 6.7 lbs/ Gallon
- Ramp Weight Constant (gains in fuel efficiency offset with increased payload)

### Fuel Efficiency Normalized by Weight and Distance - Increased Payload because of Fuel Savings

<table>
<thead>
<tr>
<th>A/C</th>
<th>Max Ramp Weight (lbs)</th>
<th>Ramp Weight (Tons)</th>
<th>(1500 Baseline Distance)</th>
<th>Total Fuel Burn (1700 Actual Miles) (gallons)</th>
<th>Total Fuel Burn (1600 Actual Miles) (gallons)</th>
<th>Ramp Weight Ton-Miles/Gallon (1700 Actual Air Miles)</th>
<th>Ramp Weight Ton-Miles/Gallon (1600 Actual Air Miles)</th>
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<tr>
<td>B777-200</td>
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<td>22,913</td>
<td>830</td>
<td>781</td>
<td>27.61</td>
<td>29.34</td>
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</tbody>
</table>

The Ramp Weight Ton-Miles/Gallon method includes all fuel (trip fuel, reserve fuel, and contingency fuel). NextGen efficiency achievements that reduce Actual Air Miles and/or Actual Flight Time, will decrease Total Fuel Burn and will increase the Ramp Weight Ton-Miles/Gallon ratio. In this example Ton-Miles/Gal increased and Ramp Weight remained constant because of increased payload and less trip fuel.

The next example shows Ton-Miles/Gallon increasing and ramp weight decreasing (ramp weight decreased equally to the amount of fuel savings realized by NextGen efficiencies).

Assumptions

- Great Circle distance – 1500 nm
- Pre-implementation Track Miles – 1700 nm
- Post-implementation Track Miles – 1600 nm
- Fuel Weight – 6.7 lbs/ Gallon
- Ramp Weight Reduced (gains in fuel efficiency offset with decreased fuel quantity)

### Fuel Efficiency Normalized by Weight and Distance - Decreased Ramp Weight Weight because of Fuel Savings

<table>
<thead>
<tr>
<th>A/C</th>
<th>Ramp Weight - Before (Tons)</th>
<th>Ramp Weight - After (Tons)</th>
<th>Ton-Miles - Before Fuel Savings (1500 Baseline Distance)</th>
<th>Ton-Miles - After Fuel Savings (1500 Baseline Distance)</th>
<th>Fuel Weight Savings (lbs)</th>
<th>Ramp Weight Ton-Miles/Gallon - Before Fuel Savings (1700 Actual Air Miles)</th>
<th>Ramp Weight Ton-Miles/Gallon - After Fuel Savings (1600 Actual Air Miles)</th>
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The Ramp Weight Ton-Miles/Gallon method includes all fuel (trip fuel, reserve fuel, and contingency fuel). NextGen efficiency achievements that reduce Actual Air Miles and/or Actual Flight Time, will decrease Total Fuel Burn and will increase the Ramp Weight Ton-Miles/Gallon ratio. In this example Ton-Miles/Gal increased and Ramp Weight decreased because of less trip fuel.
Appendix 2: Understanding the Access Metric

In its simplest terms, Access measures the ability of users to enter the NAS and utilize services needed to fulfill their operational requirements, whereas Equity is the ability of those users to receive fair and impartial treatment within the policy and rules established for the system.

This appendix provides a tutorial to understand the Access metric, provides additional definition of the recommended high-level metric for Access (Metroplex Achieved Utilization), and provides a list of potential next steps for developing additional access metrics.

Background

The ability of each user segment approved to operate in the NAS to achieve their individual goals is an integral component of all ATM modernization efforts. NextGen, SESAR, and the ICAO Block Upgrades all list access as a key performance indicator. Access to the NAS is important to all current as well as future users and is not exclusive to any one segment. Access, or the lack thereof in certain circumstances, can impact operators that do not even utilize ATC services, such as VFR operations, or commercial space flight. In practice, Access and Equity policy issues are addressed via the Collaborative Decision Making (CDM) process that takes place whenever adverse weather or other conditions affect airport or airspace effective capacity.

The BCPMWG is using the following working definitions for Access and Equity:

Access: A non-judgmental, objective measure of the level of utilization achieved by a set of users authorized to use a NAS asset or service (airspace, airport, approach, runway, etc.).

Equity: A measure of consistency and transparency in the application of Access policies according to the agreed upon rules for service.

Access is affected by three major considerations:

1. Does the operator want to use the asset? Currently, the level of demand can be measured by past flights that have been filed. Note, however, that it is difficult to estimate “discouraged demand” that is not filed due to restrictions that may affect an operator’s decision to file through airspace or into an airport.

2. Does the operator have the required capabilities to use the asset (based on rules of service)? For example, certain surveillance or Performance-Based Navigation (PBN) capabilities may increase access or a specific capability may be a requirement for access.

3. Is the operator authorized to use the asset? Authorization may include policy decisions based on factors other than aircraft capability.
Examples of NextGen capabilities that improve access include the creation of LPV approaches to expand landing opportunities, establishment of improved scheduling capabilities to manage special activity airspace, airspace redesign to de-conflict airports, and expansion of surveillance capabilities into airspace not covered by radar. Each of these enables operators to gain more use of a NAS asset.

Access and capacity are closely related. Access measures the ability to utilize the inherent capacity of an asset. A new LPV approach, for example, can increase access to an airport not currently served by a precision approach. In this case, the inherent capacity of the airport is not changed. A new runway, on the other hand, will increase the overall capacity of an airport but may not affect the overall level of access.

Definition of the High-Level Access Metric: Metroplex Achieved Utilization

The recommended metric, Metroplex Achieved Utilization, captures the percentage of the Optimum VMC Capacity of the metroplex that can be used during periods of high demand. Optimum VMC Capacities originate in the FAA Airport Capacity Benchmarks report. The metric is calculated by averaging the utilization level of each airport of interest within the Metroplex.

Mathematically, the average Metroplex Achieved Utilization ($U$) is calculated as:

$$U = \frac{1}{N} \sum_{A=1}^{N} U_A$$

Where:
- $U_A =$ the utilization level for individual Airport $A$
- $N =$ the number of airports within the Metroplex

The utilization level for individual Airport $A$ ($U_A$) is calculated as the average utilization over the peak demand period as follows:

$$U_A = \frac{1}{P} \sum_{h=X}^{X+P} \frac{T_h}{C_A}$$

Where:
- $T_h =$ the throughput achieved at hour $h$
- $C_A =$ the Optimum VMC Capacity for Airport $A$
- $X =$ the hour when the peak demand period begins
- $P =$ the duration of the peak demand period in hours

Optimum VMC Capacity, $C_A$, is the maximum throughput that can be achieved at an airport under ideal conditions (e.g., under visual flight rules with optimal traffic mix, runway-use configuration, and aircraft performance, as reported in the FAA Airport Capacity Benchmarks Report). The duration of the
peak demand period reflects typical airport usage and patterns and is set according to FAA standard practice.

NextGen efforts to de-conflict airports and to increase throughput during low visibility conditions should result in net increases of the Metroplex Achieved Utilization rate. In other words, achieved Metroplex access is measurable at a high-level; though, the desire for Metroplex access would be addressed as a lower-level metric.

**Potential Next Steps in Developing High-Level and Lower-level Access Metrics**

In addition to a high-level metric for Access, the BCPMWG believes that additional insights can be gained through the development of additional lower-level metrics associated with Access. Potential areas for exploration include the following:

- **Authorized User Diversity**, measuring the level of operator diversity that can be accommodated within a NAS asset, such as a metroplex or an airport. There are a number of issues associated with how to differentiate between groups (e.g., by capability, by operating rules, by aircraft performance, etc.) before a working definition could be developed.

- **Capability-based Access**: BCPMWG has explored metrics to measure impact of access to an asset that differentiates among different capabilities. For example, what is the level of access achieved by users with RNP capability versus those with RNAV capability?

- **Policy equity**: BCPMWG has postulated that the level of equity achieved can be evaluated based on a comparison of expected user access under the rules of service versus realized user access.

- **Airspace access**: Access to airspace or particular routes, such as Special Activity Airspace or T-routes, may also provide insights to the FAA and to the aviation community.

Subject to subject matter expert availability and FAA feedback on priorities, BCPMWG will continue to explore these additional Access metrics.
Appendix 3: Comparison of Access & Capacity Metrics

While there are similarities between the Access and Capacity metrics, different insights can be gained by evaluating both metrics for a given NAS resource. This appendix provides an example of the calculation of both these metrics, using the Dallas-Ft Worth airport as an example. Note that the high-level capacity metric, Metroplex Peak Allowable Throughput, captures, in absolute value, the maximum service level that can be achieved. Metroplex Achieved Utilization, on the other hand, provides a sense of whether the ability to utilize latent capacity is improving, provided that there is a sustained demand within the metroplex.

For example, given DALLAS/FORT WORTH INTERNATIONAL (DFW):

- Arrival Runways 13R, 17C, 17L, 18R; Departure Runways 13L, 17R, 18L
- Peak Demand Period (spans six periods between June 2010 – December 2010\(^7\))
- Facility Provided AARs plus ADRs\(^8\)
- The benchmark rate in optimum conditions is 265 operations per hour\(^9\) (estimated capacity)

The following table shows:

DFW is operating at 75% (UA) of its Optimum VMC Capacity (CA) and has an Airport Peak Allowable Throughput of 225, during peak demand periods (P).

<table>
<thead>
<tr>
<th>Airport Data</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Airport</strong></td>
<td><strong>Peak Demand Periods</strong></td>
</tr>
<tr>
<td>DFW</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4</td>
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<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td><strong>Total Throughput</strong></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>(\Sigma T_n/C_A)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Utilization level (U_A)</strong></td>
</tr>
</tbody>
</table>

\(^7\) Source: Operations Network (OPSNET) Delay Report, Federal Aviation Authority (FAA)

\(^8\) Facility reported rates were provided by ATC personnel at DFW

\(^9\) Source: FAA Airport Capacity Benchmark Report 2011. The 2011 capacity benchmarks have not yet been published by FAA.
Summary

1) 75% of DFW was utilized during this time period (UA), meaning...
   The airport has latent assets or services that when required to meet sustained demand, will increase the percentage of user access and the facility utilization.

2) DFW had an Airport Peak Allowable Throughput of 225, during peak demand periods (P), meaning...
   There was residual airport capacity to meet user demand; total throughput achieved (Th) was 1190; airport peak allowable throughput was 225.
   Note – Neither metric can incorporate discouraged demand, desired demand, denied access, or measure demand not present.

Observations

In summary, the **Metroplex Achieved Utilization Metric** will show how:
   NextGen capabilities increase the level of airport (UA) and metroplex (U) utilization achieved up to the Optimum VMC Capacity, and

The **Metroplex Peak Allowable Throughput Metric** will show how:
   NextGen operational improvements increase throughput (Th) up to the Optimum VMC Capacity (CA)

Definitions:

- **Peak Demand Period (P)** = Interval of time (Daily, Quarterly, Annually) with maximum Throughput (Th)
- **Hourly Throughput Achieved (Th)** = maximum throughput achieved at hour h
- **Optimum VMC Capacity (CA)** = The maximum throughput that can be achieved at an airport under ideal conditions (e.g., Under visual flight rules with optimal traffic mix, runway-use configuration, and aircraft performance, as reported in the 2011 Airport Capacity Benchmarks 10)
- **Airport Utilization Level (UA)** = Sum of Hourly Throughput Achieved (Th) / Optimum VMC Capacity (CA) x 1/(P)
- **AARs & ADRs** = Airport Arrival Rates (AARs) and Airport Departure Rates (ADRs) reflect the maximum number of landings and takeoffs that can be handled under a given set of operating conditions including visibility, runway use, winds, facility and procedure availability, etc.
- **Airport Peak Allowable Throughput** = Sum of AARs plus ADRs
- **Maximum Throughput Capability** = Sum of AARs plus ADRs/ Peak Demand Periods (P)
- **Metroplex Achieved Utilization** = Sum of (UA)/Number of Airports (N)
- **NAS Asset or Service** = airspace, airport, approach, runway, etc.

10 The Optimum Weather Conditions table found in the 2011 Airport Capacity Benchmarks Report, was used for (CA) to calculate **Metroplex Achieved Utilization Metric**
Appendix 4: Section 214

While FAA has been seeking aviation community advice on metrics specific to NextGen, Congress has also specified that FAA report on a number of NAS-wide metrics in Section 214 of the FAA Modernization and Reform Act of 2012. While there are similarities in the metrics, the high-level metrics recommended in this document are aimed specifically at highlighting NextGen impacts. Below is the Section 214 text.

SEC. 214 PERFORMANCE METRICS

(a) IN GENERAL.—Not later than 180 days after the date of enactment of this Act, the Administrator of the Federal Aviation Administration shall establish and begin tracking national airspace system performance metrics, including, at a minimum, metrics with respect to—

(1) actual arrival and departure rates per hour measured against the currently published aircraft arrival rate and aircraft departure rate for the 35 operational evolution partnership airports;
(2) average gate-to-gate times;
(3) fuel burned between key city pairs;
(4) operations using the advanced navigation procedures, including performance based navigation procedures;
(5) the average distance flown between key city pairs;
(6) the time between pushing back from the gate and taking off;
(7) continuous climb or descent;
(8) average gate arrival delay for all arrivals;
(9) flown versus filed flight times for key city pairs;
(10) implementation of NextGen Implementation Plan, or any successor document, capabilities designed to reduce emissions and fuel consumption;
(11) the Administration’s unit cost of providing air traffic control services; and
(12) runway safety, including runway incursions, operational errors, and loss of standard separation events.

(b) BASELINES.—The Administrator, in consultation with aviation industry stakeholders, shall identify baselines for each of the metrics established under subsection (a) and appropriate methods to measure deviations from the baselines.

(c) PUBLICATION.—The Administrator shall make data obtained under subsection (a) available to the public in a searchable, sortable, and downloadable format through the Web site of the Administration and other appropriate media.
(d) REPORT.—Not later than 180 days after the date of enactment of this Act, the Administrator shall submit to the Committee on Commerce, Science, and Transportation of the Senate and the Committee on Transportation and Infrastructure of the House of Representatives a report that contains—

(1) a description of the metrics that will be used to measure the Administration’s progress in implementing NextGen capabilities and operational results;

(2) information on any additional metrics developed; and

(3) a process for holding the Administration accountable for meeting or exceeding the metrics baselines identified in subsection (b).

Attachment: Recommendation for Key City Pairs for Measuring NextGen Performance
Approved by the NextGen Advisory Committee October 2012
Recommendation for Key City Pairs for Measuring NextGen Performance

A Report of the NextGen Advisory Committee in Response to Tasking from The Federal Aviation Administration

October 2012
Recommendation for Key City-Pairs

Introduction/ Background

Executive Summary

Approach

Methodology

Recommendations

Appendix A

Appendix B

Appendix C
Introduction/ Background

In October 2010, the FAA asked the NAC to develop recommendations for outcome-based performance metrics that will show how NextGen implementation impacts the performance of the National Airspace System. As part of this task, the NAC was expected to provide input on the related methodologies. The NAC’s recommendations have been accepted by the FAA and served as input for the NextGen Performance Snapshots web site and overall FAA work on performance metrics.

Section 214, Performance Metrics from the FAA Modernization and Reform Act of 2012 (Public Law 112-95) calls for the FAA to begin tracking and reporting performance against a set of metrics, including three that are to be measured among “key city pairs”:

- fuel burned between key city pairs
- the average distance flown between key city pairs
- flown versus filed flight times for key city pairs

In August, 2012, to assist some immediate FAA work, the FAA requested that the NAC leverage discussions already taking place to provide recommendations on the set of key city pairs that could be used for NextGen metrics. Building on the work of the Business Case and Performance Metrics Work Group (BCPMWG) to develop metrics for determining NextGen implementation, a Task Group was created to expedite the development of recommendations on the set of key city pairs that could be used for NextGen metrics. The Task Group included the Co-chairs from the Airspace and Procedures Work Group (APWG), Integrated Capabilities Work Group (ICWG), BCPMWG and the NAC Subcommittee (see Appendix A for list of participants).

Executive Summary

Using an analytical process supported by quantitative criteria and qualitative analysis by Subject Matter Experts, the Task Group developed a list of 24 city pairs that serve as the initial group for the FAA to use in measuring the impacts of NextGen. The criteria include such factors as locations where NextGen capabilities are being initiated between 2010 and 2015, ranking by delays and traffic volumes, diversity of operations and availability of data. The Task Group recommends that the city pairs be reviewed on a periodic basis as NextGen is implemented.

The Task Group determined that the Metroplex was the appropriate proxy to use for city pairs rather than specific airports. For the purposes of this report ‘Metroplex’ and ‘city pair’ are synonymous. The Metroplex was chosen to provide a clear summarized “picture” that would be relevant for policy makers, the public and others interested in understanding the impact of NextGen in key city pairs.

The Task Group agreed that the term “city pairs” (as referenced in the reauthorization bill) refers to all the key airports within the city at either end of a city pair. A “Metroplex” refers to all the airports within a given city or metropolitan area, which can in some cases span beyond a single city (e.g., South Florida).
“Airports” refer to the individual airports within a given city (e.g. New York) or Metroplex (e.g., New York, Northern California).

**Approach**

To develop the list of key city pairs, the Task Group followed a methodical approach leading to repeatable and transparent results. The steps in that process were as follows:

1. Identified the specific performance metrics related to city pairs contained in Section 214, Performance Metrics from the FAA Modernization and Reform Act of 2012 (Public Law 112-95), (see Appendix B). These are:
   - Fuel burned between key city pairs
   - The average distance flown between key city pairs
   - Flown versus filed flight times for key city pairs

2. Considered the applicability of locations and capabilities contained in the RTCA NextGen Mid-Term Implementation Task Force (TF5) and the FAA NextGen Implementation Plan (NGIP) as potential input for determining key city pairs.

3. Reviewed and discussed the relevance and potential criteria used by the ICWG to determine Metroplex prioritization and the outcome of applying the Metroplex selection criteria, namely, the prioritized list of Metroplexes. The documents are:
   
   “Findings and Recommendations: Metroplex Prioritization and Integrated Capabilities Scoping & Requirements” (September 2011)
4. Reviewed the draft metrics recommendations developed by the BCPMWG for consideration by the NAC at the October 2012 meeting as well as preliminary work on potential criteria to determine key city pairs. The Task Group reached a consensus that “city pair” included Metroplexes, or any of the airports within the metropolitan area around the city. That is, the scope was broader than single airport-to-airport pairs such that it may include Metroplex-to-Metroplex pairs.

5. Subsequently refined the criteria used by ICWG and BCPMWG, as well as other considerations identified to create a single set of criteria. The criteria were designed to identify locations where: (1) a large need for improvement exists (e.g. due to significant delays); (2) NextGen investments have been made and where improvements are expected; (3) a large volume of operations occur; (4) a range of user constituencies and stakeholders can be represented; and (5) data and resources are available with which to establish a baseline and compute the necessary metrics.

6. Conducted final review of the criteria by Subject Matter Experts to refine the weighting of criteria and apply additional qualitative analysis and other considerations.

To begin the process of evaluating and refining the criteria, the initial list of city pairs was expansive, but it was an important step to determine the relevance of the criteria.

**Methodology**

The Task Group developed and applied the following set of criteria to identify the key city pairs:

**Criteria:**
- City pairs (or Metroplex pairs) should be within the contiguous US
- The Metroplex is expected to have a measurable NextGen impact between 2010 & 2015 (each Metroplex will include the associated airports)
- Consider the ICWG tier 1 Metroplexes (7)
- Consider sites from the FAA/Industry Optimization of Airspace and Procedures in the Metroplex (OAPM1) initiative that are scheduled to begin implementation of capabilities no later than FY2015
- Number of operations (traffic) between city pairs should be considered
- Need between the city pairs should be considered. The Task Group used ‘amount of delay’ as an indicator of need.

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1 City pairs are meant to be non-directional.
2 Because the available means to measure NextGen implementation is by airport pairs, the Task Group identified 84 airport pairs that have the greatest potential based on the number of delays that were contained in the Metroplex. These were selected based on identifying the numbers of delays and are identified in Appendix C.
In addition to the Criteria, the Task Group developed the following set of “Other Considerations”:

**Other Considerations:**
- Data availability
- Ease of reporting (i.e. data that is recorded in an automated and accessible format and a viable approach to reporting the performance can be developed)
- Diversity – as a final review, evaluate the key city pairs for diversity of operations/different stakeholders (e.g., cargo, GA, multiple air carriers)

The Task Group applied the above criteria and produced an initial list of 24 Metroplexes. To reduce the number of Metroplex pair combinations by half, the Task Group first agreed that all such pairs would be non-directional. The group then rank-ordered each Metroplex pair by delay, considering all potential airport pairs between the two Metroplexes. From this rank-ordered list, the group identified 22 Metroplex pairs that had high levels of delay and which encompassed all of the Metroplexes under consideration.

Recognizing that the actual measurement between city pairs must be done at the airport level, the Task Group considered all airport pairs within one of the 22 Metroplex pairs. Given that many airport pairs had negligible impact on delay, the group agreed that a subset of airport pairs would be appropriate to capture NextGen impacts within a Metroplex pair. To reduce the number of airport pair combinations to a manageable number, the Task Group analyzed all the airports by amount of delay, and within each Metroplex, selected the top airport pairs contributing to approximately 50% of the overall delay within the Metroplex.

The resulting list of approximately 80 airport pairs represents the top 50% delay contributors within each of the 24 Metroplexes. To ensure that the list did not exclude airport pairs with substantial delay that did not appear in the top 50% for a particular Metroplex, the Task Group included all city pairs with delay at least as high as the city pair with the lowest amount of delay on the initial list.

Finally, the Task Group applied the “Other Considerations” and additional modifications to the list as described below:

- Data availability – The Task Group agreed that data could be collected for the three metrics for all pairs on the list. The most difficult to collect are data for the fuel burn metric that is being addressed in a separate report on fuel data collection.
- Ease of reporting - The Task Group looked at a number of options for reporting performance between city pairs for each of the three metrics and agreed that a viable approach could be developed. That information can be made available to the FAA if needed, as the Agency implements the metrics tracking.
Diversity – This analysis led the Task Group to add two city pairs to encompass cargo carrier traffic: EWR-MEM and EWR-SDF. The Task Group participants agreed that no additional airports needed to be added to address business jet traffic for this exercise.

The resulting list of airport pairs within the Metroplexes is in Appendix C.

**Recommendations**

The following list contains the 24 key city pairs selected based on the criteria above. It is important that the list of key city pairs be re-evaluated on a periodic basis to ensure the list includes the relevant locations for NextGen improvements.

**Key City pairs**

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## Appendix A

### Members of Metrics City Pair Task Group

**NACSC** co-chairs:  
Steve Brown, NBAA (Task Group Chair)  
Tom Hendricks, A4A/National Air Transportation Association

**ICWG** co-chairs:  
Tom Bock, PANYNJ  
Sarah Dalton, Alaska Airlines

**BCPMWG** co-chairs:  
Debby Kirkman, MITRE  
Ed Lohr, Delta Air Lines

**APWG** co-chairs:  
Mark Hopkins, Delta Air Lines  
Bill Murphy, IATA

**FAA:**  
Lynn Ray (ATO)  
Gisele Mohler (NextGen)

**RTCA:**  
Andy Cebula/Margaret Jenny/Jennifer Iversen  
Jim Kuchar (MIT LL)
Appendix B  
FAA Modernization and Reform Act of 2012  
(Public Law 112-95)  

Section 214 Performance Metrics  

(a) IN GENERAL.—Not later than 180 days after the date of enactment of this Act, the Administrator of the Federal Aviation Administration shall establish and begin tracking national airspace system performance metrics, including, at a minimum, metrics with respect to—

(1) actual arrival and departure rates per hour measured against the currently published aircraft arrival rate and aircraft departure rate for the 35 operational evolution partnership airports;

(2) average gate-to-gate times;

(3) fuel burned between key city pairs;

(4) operations using the advanced navigation procedures, including performance based navigation procedures;

(5) the average distance flown between key city pairs;

(6) the time between pushing back from the gate and taking off;

(7) continuous climb or descent;

(8) average gate arrival delay for all arrivals;

(9) flown versus filed flight times for key city pairs;

(10) implementation of NextGen Implementation Plan, or any successor document, capabilities designed to reduce emissions and fuel consumption;

(11) the Administration’s unit cost of providing air traffic control services; and

(12) runway safety, including runway incursions, operational errors, and loss of standard separation events.

(b) BASELINES.—The Administrator, in consultation with aviation industry stakeholders, shall identify baselines for each of the metrics established under subsection (a) and appropriate methods to measure deviations from the baselines.

(c) PUBLICATION.—The Administrator shall make data obtained under subsection (a) available to the public in a searchable, sortable, and downloadable format through the Web site of the Administration and other appropriate media.
(d) REPORT.—Not later than 180 days after the date of enactment of this Act, the Administrator shall submit to the Committee on Commerce, Science, and Transportation of the Senate and the Committee on Transportation and Infrastructure of the House of Representatives a report that contains—

(1) a description of the metrics that will be used to measure the Administration’s progress in implementing NextGen capabilities and operational results;

(2) Information on any additional metrics developed; and

(3) A process for holding the Administration accountable for meeting or exceeding the metrics baselines identified in subsection (b).
## Appendix C

### Measuring the NextGen Impact at the Key City Pairs

The following 84 airport pairs would provide the means to measure the impact of expected NextGen implementation of the key city pairs.

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Approved by the NextGen Advisory Committee October 2012

Data Sources for Measuring NextGen Fuel Impact

A Report of the NextGen Advisory Committee in Response to Tasking from The Federal Aviation Administration

October 2012
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**Introduction**

In order to understand NextGen impacts, FAA needs access to specific data elements not available today. The FAA has identified fuel burn data as a priority because existing fuel modeling by the FAA is insufficient to assess impacts of NextGen on fuel usage. FAA has asked the Business Case and Performance Metrics WG to work with the flight operator community to address the key gaps in data needed to inform NextGen metrics; fuel data is one of the highest priority requests from FAA that the Business Case Performance Work Group is addressing.

The scope of this report focuses on data in support of the high level metric. The high level metric of Fuel Efficiency Normalized by Weight and Distance metric is proposed to be measured in the unit of Ton-Miles/Gallon. The NAC Measuring NextGen Performance Report separately addresses the high level metric.

**Executive Summary**

BCPMWG has found that all user groups approached support the goal of providing more granular data to track and analyze the impact of NextGen. The BCPMWG expects that improvements of fuel usage metrics involve the following steps.

- In the near future, FAA needs to continue using modeling for generating fuel use metrics until data sharing agreements are finalized.
- To address Congressionally-designated fuel use metrics, ACARS OOOI data that includes fuel status data, recorded by Part 121 operators, is the most feasible near-term source. Weight data to support the BCPMWG-recommended fuel efficiency metric will require additional sources of data from Part 121 operators.
- Long term data collection, including data supporting diagnostic metrics, will be best met through a combination of directly-provided user data, use of the ASIAS infrastructure, and modeled data. Data from other user groups should be available, as well, to supplement Part 121 data to generate city-pair metrics related to fuel efficiency.

BCPMWG is pursuing data sharing agreements that will support the FAA’s needs for both high-level metrics and diagnostic analysis. High-level metrics are useful to provide to the public insights on overall trends and to identify areas for further analysis. Lower level metrics can detect NextGen impacts but require significant levels of analysis to isolate NextGen changes from these external factors for a specific location.

BCPMWG recommends the establishment of an appropriately resourced group of Subject Matter Experts (SMEs) to identify the data elements available and required to determine NextGen impacts, create analyses and reports for FAA and the NAC, and continue to iterate and improve the quality of data synthesis and analysis over time.
BCPMWG further recommends that FAA and NAC should establish a working relationship with the ASIAS executive board to explore longer term data sources that can inform fuel usage metrics.

Fuel burn data collection must inform and therefore be useful to the FAA at different levels. It also should be useful to operators across all user groups, all of whom have embraced the need for useful fuel data gathering. In all cases, both the FAA and the aviation community will need to weigh the cost of generating and collecting data with the utility of the insights that can be gained from it. This is partially addressed in Appendix 1 that discusses alternative methodologies.

**Fuel Data Considerations**

A major objective of NextGen is to increase the efficiency of flight and to reduce environmental impacts associated with air transportation. The FAA estimates, for example, national fuel use and generates an annual estimate of Teragrams per Kilometer flown. While FAA reports annualized fuel use data and models expected fuel savings from NextGen initiatives, the current data available to FAA is insufficient to provide insights on fuel usage efficiencies that are attributable to NextGen. Fuel savings (and associated environmental improvements) are of national importance. Congress, for example, has specified in the FAA Modernization and Reform Act of 2012 that FAA report on fuel burned between city pairs.

FAA has asked the Business Case and Performance Metrics WG to work with the flight operator community to address the key gaps in data needed to inform NextGen metrics; fuel data is one of the highest priority requests from FAA that BCPMWG is addressing. The BCPMWG has recommended that FAA report, as a high-level metric, *Fuel Efficiency Normalized by Weight and Distance* aggregated across a selected set of city pairs to capture NextGen impacts. In addition to data needed to support this high-level metric, FAA also needs flight-specific data to baseline and assess the impacts of NextGen initiatives in specific locations.

Currently, FAA collects data for Part 121 operators through Form 41 reports filed by some operators with the Department of Transportation. This data is not granular enough to meet the requirements set by Congress. Some data can be collected as part of a cooperative agreement with airlines for a specific evaluation, but is not generally available on a routine basis. FAA can also estimate annual fuel usage overall for Part 91 or Part 135 operators, but again the data is highly aggregated.

BCPMWG is pursuing data sharing agreements that will support the FAA’s needs for both high-level metrics and diagnostic analysis. High-level metrics are useful to provide to the public...
insights on overall trends and to identify areas for further analysis. While providing a national view, a high-level fuel use metric cannot isolate NextGen impacts from other factors such as changes in fleet characteristics, changes in the operator selected cost index for a set of flights, or weather impacts. Lower level metrics can detect NextGen impacts but require significant levels of analysis to isolate NextGen changes from these external factors for a specific location. Lower level metrics can be used to provide FAA and operators with actionable results but alone cannot be used to assess progress against FAA strategic goals.

Fuel burn data has a wide range of accuracy, quality, and completeness. While modern aircraft with flight data recording have highly detailed fuel burn data, the data is not always collected on a routine basis, and it only covers a portion of the US Part 121 fleet. Older aircraft will have much less resolution. For most general aviation operators, there is no automated fuel data collection on an individual basis except in isolated cases; flight lengths may also be unknown, especially for VFR flights. Payload information is also not consolidated today, although it is calculated for each flight.

Identification and collection of new data is a continuing, evolving process to understand NextGen impacts. As data is made available for analysis, the community will gain increased understanding on additional needs and what data provides the most value. As a first step in this broader process, the BCPMWG is working with the FAA to establish the sharing of fuel burn data; lessons learned from this initiative will help inform efforts to collect data to inform other NextGen metrics. In all cases, both the FAA and the aviation community will need to weigh the cost of generating and collecting data with the utility of the insights that can be gained from it.

Key Findings and Recommendations

Finding 1: All user groups support the goal of providing more granular data to track and analyze the impact of NextGen. This effort will only be successful if the NextGen Advisory Committee members also commit their organization’s ongoing support to the continuing data access efforts that will track the impacts of NextGen on the NAS.

During our outreach efforts to A4A, NBAA, DoD, and NACSC all users have indicated strong support to improve data availability to track NextGen impacts. Users have unanimously relayed that moving NextGen forward is important, and that providing adequate data to prioritize and track NextGen is a key component of their overall support for NextGen.

Part 121 carriers are supportive of potentially utilizing the existing data infrastructure and protocols of ASIAS to support NextGen data needs. Similarly, NBAA is exploring the potential of a tablet-based application to improve the data collection and tracking of high-end business aircraft data. The Department of Defense is increasing visibility of fuel cost, capacity and allocation while recognizing that additional development is required. The global mission of DoD aircraft makes reporting a National Airspace fuel metric complex. To deduce fuel burn data that directly relates to NextGen is even more
problematic. However, the USAF Air Mobility Command’s fuel efficiency data closely mirrors the ton-miles/gallon metric used by industry and may eventually be suitable for comparisons.

**Finding 2:** Airline provided data (e.g., OOOI reports) used for NextGen fuel efficiency metrics will require each carrier to collaborate internally with employee groups (e.g., pilots, dispatchers) to insure appropriate usage and confidentiality

In BCPMWG’s outreach to Part 121 operators, we found that there are sensitivities to using any data from the aircraft (whether ACARS or FOQA) that might be identifiable or publicly available. These sensitivities require that each airline collaborate internally with affected departments and employee groups to insure that the data provided is used for appropriate purposes (i.e., tracking NextGen fuel consumption impacts) and is not published publicly in an identifiable form.

**Finding 3:** Depth and breadth of data needed to inform diagnostic metrics is substantially greater than those needed to inform high-level indicators

High-level metrics are indicators of overall system trends and health, and generally require less granular data to inform than diagnostic metrics. For example, the high-level metric “ton-miles per gallon” in key city pairs could be an annual aggregation of aircraft weight and fuel gallons consumed between two airports. However, the reason for observed changes in the metric from year-to-year cannot be discerned from these two data inputs alone. Other data elements would be required to determine the “why”, including aircraft type, equipage, payload, departure weight, fuel consumed in different phases of flight, weather conditions, winds, altitudes, congestion, etc.

**Finding 4:** There is no single source for fuel use data. Data availability and utility vary greatly by user type, individual user, and aircraft.

Part 121 air carriers generally have the broadest and deepest foundation of available data elements, due to automated systems on many aircraft that continuously track and record multiple flight parameters. This data availability is improving over time as fleet renewal replaces older aircraft lacking these automated systems. There is not, however, within Part 121 users a perfectly uniform set of flight data available due to user differences in fleets, data analysis and storage policies, and IT infrastructure, for example.

Newer high-end turbojet aircraft also have many of the same automated systems as air transport aircraft, but fleet sizes are typically smaller and user policies and procedures more diverse, creating challenges to aggregating data at a useful level of detail. Older high-end GA aircraft – similar to older transport category aircraft – lack the automated flight parameter recording systems and would have to rely on manual record keeping which is less than ideal in determining NextGen impacts.

Piston general aviation aircraft also primarily rely on manual record keeping and less precise measuring technologies (e.g., Hobbs meter engine operating hours, logbook entries, etc.). Efficiency measures are also complicated by the fact that many piston GA flights depart and land at the same airport.
Finding 5: NextGen data collection and analysis efforts will be an ongoing process as data sources are broadened and deepened over time.

BCPMWG has found that most of the airlines surveyed routinely collect fuel use data with ACARS OOOI (out, off, on, and in) reports, although there are variations among operators, as well as within fleets, on how OOOI reports are used.

In addition, about one-third of the Part 121 fleet contributes FDR data to ASIAS today, and this proportion is growing as fleet renewal occurs. The NBAA and DoD fuel data collection efforts are in their infancy, but will become more robust over time. The fast growth of hand-held GPS and tablet aviation applications for piston GA aircraft may enable better data collection for that community than currently exists. For all these reasons (and others), the data collection and analysis process will be one of continuous improvement, lacking a defined end-date or end-state.

Based on BCPMWG evaluations of data availability among different user groups, BCPMWG finds that:

To address Congressionally-designated fuel use metrics, ACARS OOOI data that includes fuel status data, recorded by Part 121 operators, is the most feasible near-term source. Weight data to support the BCPMWG-recommended fuel efficiency metric will require additional sources of data from Part 121 operators.

Long term data collection, including data supporting diagnostic metrics, will be best met through a combination of directly-provided user data, use of the ASIAS infrastructure, and modeled data. Data from other user groups should be available, as well, to supplement Part 121 data to generate city-pair metrics related to fuel efficiency.

Further work to be completed by an SME task group is to take the unit of Ton-Miles/Gallon for the Fuel Efficiency Normalized by Weight and Distance metric and break it down into the who, when, where and how detail to support this high level metric, where data is accessible to the FAA and useful to both FAA and user groups.

An SME task group would need to consider the current methods of data collection by the various user groups while leveraging existing data collection so that user groups are not burdened with significant additional effort.

An SME task group would need to consider the granularity of data necessary to support high level and diagnostic metrics. The different user groups will have varying levels of difficulty in meeting the level of granularity required.

Recommendation 1: With reference to Finding 5, the NAC recommends the establishment of an appropriately resourced group of Subject Matter Experts (SMEs) to identify the data elements available and required for determining NextGen impacts, create analyses and reports for FAA and the NAC, and
continue to iterate and improve the quality of data synthesis and analysis over time. This work should be in parallel with airline’s outreach to pilot unions on the objectives and scope of the effort.

**Recommendation 2:** FAA and NAC should establish a working relationship with the ASIAS executive board to explore data sources that can inform fuel usage metrics that should be done in the following steps:

1. An initial data exploration phase for a limited period of time to look at various data elements in ASIAS in informing NextGen fuel use metrics, as well as tradeoffs between direct fuel data collection and modeled data based on FDR data.

2. A follow on effort after the evaluation period that identifies a specific subset of data to be made regularly available to help FAA with both high level metrics reporting as well as diagnostic needs, recognizing and complying with ASIAS data protection protocols.

**BCPMWG Outreach Effort**

Ideally the FAA would like to collect empirical flight data with 100% user participation, but this is not currently possible. However, it is possible to obtain fuel data from a smaller number of users like Part 121 mainline carriers, Part 25 Business Jets, and DoD aircraft, to begin assessing the impact of NextGen on different users. Then, as collecting and reporting methods become more robust, more user groups may be included, such as regional carriers and piston GA.

Since the NAC considers fuel efficiency and aviation emission reductions important NextGen goals, the BCPMWG reached-out to different user groups to find any potential paths for fuel data collection. A4A, NBAA, DoD, and AOPA all share strong community interest in finding solutions to capture fuel data needs.

**Individual outreach effort**

There were 4 outreach efforts specifically to A4A, NBAA, DoD and AOPA.

Recommendation 2 reflects the results of the initial outreach to A4A, while the NBAA Access Committee is currently working on a wider set of data collection and initially evaluating a tablet application as the method for data collection at the source. DoD (Air Force Air Mobility Command), reports worldwide operations fuel data for specific aircraft types and wider efforts at fuel data collecting and reporting are being looked into. AOPA reports significant flight operations that include fuel, across a wide selection of aircraft categories. BCPMWG is exploring ways to use this data to help analyze NextGen, or to recommend reporting changes that will provide meaningful data to support NextGen.
flights are for training and often remain in the local area, another dimension is added to where data measuring can be accomplished because city pairs will not apply.

**Next Steps**

With reference to Recommendation 1, while the BCPMWG has no specifics for who should form an SME task group, one possible next step could be for an initial group of SME’s representing both FAA and industry to define the technical requirements in support of the congressionally defined fuel efficiency metric as well as the Weight and Normalized Distance Fuel Efficiency metric. This use of SMEs could be a separate group or could be part of the BCPMWG.

The BCPMWG also plans further outreach to user groups such as RAA with respect to regional airlines. As required, BCPMWG will address other data needs for NextGen metrics, building on what has been learned in evaluating fuel use data availability.

Note that next step activities will need to be adjusted as FAA feedback is received.

**Members of the Business Case and Performance Metrics WG**

These recommendations were developed by the Business Case and Performance Metrics Work Group. Contributing members are: Chris Benich (Honeywell), Joe Bertapelle (JetBlue), Alex Burnett (UAL), Joe Burns (UAL), Carlos Cirilo (IATA), Forrest Colliver (MITRE), Jim Crites (Dallas Ft Worth International Airport), Tony Diana (FAA), Bill Dunlay (LeighFisher), Rob Eagles (IATA), Ken Elliott (Jetcraft Corp), Dan Elwell (AIA), Stephanie Fraser (Metron), Steve Fulton (GE Aviation), Peggy Gervasi (FAA), Pamela Gomez (FAA), Pascal Joly (Airbus), Debby Kirkman (MITRE), Matt Klein (FAA), Mike Lewis (Jeppesen), Jim Littleton (FAA), Ed Lohr (Delta Air Lines), Cheryl Miner (FAA), Debi Minnick (Federal Express), Alma Ramadani (FAA), Kirk Rummel (Houston Airport System), Bill Sears (Beacon), Geoff Shearer (Boeing), Rico Short (Beacon), Stephen Smothers (Cessna), E.J. Spear (MITRE), Craig Spence (AOPA), Maj. Patrick Stovall (DoD), Allison Talarek (FAA), and Eunsuk Yang (IATA).

Many thanks as well to Steve Brown and Bob Lamond of NBAA, Tom Hendricks and Paul McGraw of A4A, Margaret Jenny, Andy Cebula and Cyndy Brown of RTCA, Peter Moertl of MITRE CAASD and Heidi Williams of AOPA for their guidance.

**Appendix 1: Discussion on Alternative Methodologies to Generate Fuel Usage Metrics**
Operational impact assessment based on modeled vs. empirical data

Operational impact assessment based on modeled data typically supports business case decision making and target setting. Prior to the implementation of advanced capabilities, we simply have to resort to modeling to determine potential impacts the advanced capabilities may have in the real world. Actual post-implementation impacts, on the other hand, cannot be accurately evaluated using models because of their limited representation of the real world: we can easily misinterpret noise in outcomes generated by imperfect models for actual operational impacts.

In order to truly understand both anticipated and unanticipated operational performance impacts post-implementation of NextGen capabilities, we need accurate empirical data. This is especially true for diagnostic performance assessment and supporting causality and correlation evaluations. For instance, in addition to the actual 4DT, fuel burn is highly dependent on aircraft weight and winds en route; assuming nominal take-off weight can produce noise in fuel burn estimations that can easily mask true NextGen related impacts.

High-level operational impact assessment vs. diagnostic

(Including level of detail and reporting frequency)

Irrespective of the operational performance impact of interest, data reporting needs may significantly vary with the level of metric reporting they support. These variations include data elements (level of detail), type of operations, and frequency of reporting.

For instance, in the case of high-level reporting, we typically need gate-to-gate fuel burn data limited to a particular set of city-pairs and operation types; in addition to overall fuel burn, this data may need to include aircraft model to support understanding of fleet-mix related impacts too, but generally does not necessitate any other additional details. This data can be reported on a flight-by-flight level, or aggregated in a manner that would provide for further evaluation of the reporting metric requirement. Likewise, data provision would have to be coordinated with the required metric reporting frequency.

Diagnostic assessment, on the other hand, frequently demands more granular data elements that provide for identifying cause-effect relationships between deployed operational changes and observed performance impacts, as well as trade-offs between different performance impacts; for instance, we need to be able to evaluate changes in fuel burn by phase of flight and to differentiate between flights with different performance capabilities. Diagnostic assessments, however, are typically not conducted in regular time-intervals but are more ad-hoc in nature. They may demand large number of data elements, but the actual list of required data elements will vary from one assessment to another. As a result, data reporting requirements can be managed in a case-by-case basis; however, data sharing policies will be needed to assure timely provision of the necessary data by different user groups.
Appendix 2: Current Results of A4A Data Sharing Survey

Survey Methodology
To better understand factors affecting the use of fuel burn data from Part 121 operators, BCPMWG’s co-chairs briefed the Airlines for America Airline Operations Committee (A4A AOC) on the Working Group’s tasking, solicited AOC member’s perspectives on potential paths forward, and requested support to schedule more in-depth conversations with fuel analysis experts at interested airlines.

The AOC members provided contact information for fuel analysis and safety experts at their respective airlines, and from that list interviews were scheduled with interested parties.

The airline interviews included a survey sent in advance which then guided the live conversation. Broadly, this survey asked each operator to provide information regarding:

1. The type of fuel-burn data being collected, their granularity, and whether the data was equally available on all sub fleets
2. Preferences and suggestions on the methodology for sharing fuel burn data to inform NextGen metrics
3. Areas of concern or other constraints to sharing NextGen data

Detailed interviews were conducted with Delta Air Lines, Hawaiian Airlines, and Alaska Airlines – perspectives on the opportunities and obstacles to the proposed approaches to fuel data sharing was generally consistent for all three airlines.

Fuel Burn Data Collection Alternatives
Interviewees indicated that their airline collect actual and planned fuel burn data on a per flight basis for most flights. Three alternatives of collecting fuel burn data were discussed as shown in Figure 1.

![Figure 1 Discussed Fuel Burn Data Collection Alternatives](image-url)
Airline Feedback on Data Collection Alternatives

**Method 1a (ACARS OOOI data direct from airlines):** Airlines currently collect consumption data via automated messages from ACARS (Aircraft Communications Addressing and Reporting System). This data is typically used by the airlines’ fuel analysis departments to track trends and improve fuel consumption models to better optimize fuel usage forecasting - improving the efficiency of flight operations.

“Out” and “In” fuel are routinely collected by all airlines – but “Off” and “On” fuel are not consistently collected across or even within airlines. To illustrate, the tables below summarizes for Delta Air Lines which fleets collect fuel onboard at all four OOOI points; and at the airline level for carriers who participated in the surveys.

<table>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td>718</td>
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### ACARS Fuel Onboard Reported At:

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<tr>
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<tr>
<td>United</td>
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<td>YES</td>
<td>NO</td>
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</tr>
</tbody>
</table>

Note: All airline indicated that the OFF and ON fuel onboard data points – even if collected - is unreliable due to the “slosh” factor (i.e., fuel readings can be inaccurate since the aircraft is not in straight and level flight).

While ACARs is commonly used by airlines for this purpose, there is no commonality on the data element formats, IT or software infrastructure, or storage duration policies. Airlines expressed concern that if each airline shared its internal fuel data with FAA using each carrier’s internal formats and data element definitions that aggregated analysis would be difficult if not impossible.

Airlines also had differing sensitivities as to the share-ability of this ACARS messaged fuel data. Some felt that with appropriate internal consultation their pilots and dispatchers would agree with the value of sharing more granular fuel data; others saw this as potentially problematic, requiring specific coordination and collaboration with affected employee groups and departments to insure appropriate data usage and confidentiality.

**Method 1b (FDR data direct from airlines):** Airlines also collect fuel consumption data via Flight Operational Quality Assurance (FOQA) programs. Modern aircraft Flight Data Recorders (FDR) track many flight parameters near continuously during a flight including fuel onboard and consumption rates. Airlines may have limited access to this data directly based on agreed protocols for use and storage. External sharing of FDR data directly from airlines was considered essentially impossible from all carriers interviewed.

**Method 2 (utilizing ASIAS data):** Most airlines provide FOQA data to the FAA’s Aviation Safety Information Analysis & Sharing (ASIAS) office - which analyzes and creates reports in a protected environment subject to pre-agreed uses and protocols.

There are 26 airlines with FDR data in the ASIAS FOQA database today - with 10 more in some stage of initial data quality checking but not yet merged into the system. The process to integrate a new airline is quite extensive, taking about 4 months to complete. There are 45 airline stakeholder partners in ASIAS today, but this number changes over time (airlines cease to operate, mergers, etc.)

All Part 121 aircraft have flight data systems that produce a record in a standardized, though not common, format. The ARINC 717 standard defines that format generally, but there are variations concerning which parameters are recorded, frequency, and where specifically in the dataframe the parameter is located. Each airline provides this downloaded data as an input to ASIAS – though not in a common format, and at least one airline reported that these are provided in a de-identified format.
Once in ASIAS, a software package transcribes the input data into a common format to enable analysis and reporting.

The data provided – even once formatted commonly – is not uniformly common or reliable. For example, there are currently a little over 14 million flights in the ASIAS FOQA database. 13M of those flights include a “gross weight at touchdown” measure. However, gross weight is a parameter that is not consistently reliable – with potentially only 75% of records having a high confidence in the measure. Confidence varies quite a bit by parameter, and even by question being asked.

While ASIAS has 14M flights that have been analyzed and are used for aggregated measure, new question can only query about 9 - 10M flights. ASIAS data retention rules do not allow direct query of flight data older than 3 years.

Airlines interviewed believed that ASIAS presented the preferred path to more granular fuel data for NextGen tracking and analysis purposes. The reasons most commonly stated were:

- Infrastructure and protocol for requesting access already in place – does not place an additional burden on airlines
- Data recorded in ASIAS is more extensive than ACARS OOOI data
- Percentage of flights in the NAS contributing to ASIAS will grow as fleet renewal occurs and modern aircraft replace ones with less sophisticated FDRs

**Method 3 (aircraft fuel consumption models):** Modeling of fuel consumption is used extensively in the airline industry, from evaluation of potential aircraft purchases to dispatching aircraft on revenue flights. Aircraft manufacturers have models that can quite accurately predict aircraft fuel consumption based on weight, winds, altitudes, engine deterioration, aerodynamic cleanliness, and other factors. MITRE – using protected actual FOQA data – has also built fuel consumption models for multiple aircraft types.

- For assessing NextGen fuel impacts, it may be possible to analyze known surveillance data (altitude, speed, track, etc.) using aircraft specific fuel models to determine the fuel consumption difference between a “before” and “after” NextGen trajectory – as an example.
- Airlines were supportive of this approach - being very familiar with the use of modeling for airline internal purposes – but also recognizing that additional empirical data may be needed to supplement models to discern NextGen impacts from other factors.
September 21, 2012

Ms. Margaret Jenny
President, RTCA, Inc.
1150 18th Street NW.
Washington, DC 20036

Dear Ms. Jenny:

As you know, the predecessor of the NextGen Advisory Committee (NAC), the Air Traffic Management Advisory Committee, helped the Federal Aviation Administration (FAA) determine the criteria for our current Optimization of Airspace and Procedures in Metroplexes (OAPM) effort. As we look toward the conclusion of Round One of OAPM, the Agency would like to consider ways to build on the gains we are making through airspace and procedures. Therefore, we would like to task the NAC with addressing the following, with the suggestion that they be worked jointly by the Airspace and Procedures and the Integrated Capabilities Work Groups, to benefit from the knowledge and experience of experts from both groups.

Task 1: Obstacles to Performance Based Navigation Utilization

An internal FAA work group was commissioned to provide an overview of obstacles to Performance Based Navigation (PBN) utilization that have been encountered throughout the National Airspace System. The results were relayed in three areas: PBN accountability and responsibility; Instrument Flight Procedures design and amendments; and PBN Instrument Flight Procedures Utilization. The FAA has been aware of some of the identified issues and has been actively working at the national and local levels to resolve them. To assist in this effort, we request that the NAC:

- Examine and expand, if necessary, on the potential obstacles to PBN utilization already identified by the FAA’s internal analysis, including both technical and non-technical obstacles (e.g., training, culture, and varying business/operational models). FAA will provide information from our internal review; and

- Provide specific remedies and incremental action steps, including both technical and non-technical, the FAA can take as well as specific remedies and incremental action steps, including both technical and non-technical, for industry to take in order to relieve these obstacles in the near term.
Task 2: Input on the Criteria for Prioritizing Production of PBN Procedures

For some time, the FAA has been working diligently to produce PBN procedures. Now that we have reached a "critical mass" of published procedures, we have an opportunity to evaluate our approach to developing and managing our inventory of procedures. Our intent is to make the best use of our resources while ensuring the most effective, efficient, and useful routes and RNP procedures for both the FAA and operators. As input to this effort, the FAA would like the NAC's recommendations on criteria for:

- prioritizing requests for new PBN procedures;
- modifying existing PBN procedures; and
- eliminating PBN procedures that do not provide measurable benefits.

Task 3: Revalidate OAPM Criteria for Future Use

The FAA would like industry's assistance in validating criteria for selection and prioritization of OAPM sites, specifically:

- Review and revalidate the criteria used to select and prioritize the current OAPM sites. This task could result in modifications, additions, and/or deletions of the original criteria so the OAPM process continues to meet the needs for an expedited and systematic analysis of airspace and procedures in designated metropolitan areas.

The FAA will make subject matter expertise available to the NAC, but would not participate in deliberations. The FAA appreciates RTCA's many past contributions and looks forward to a continued long and productive relationship that serves the best interests of the public. If I can be of further assistance, please contact me or our point of contact for this activity, Mr. Dennis Roberts, Director of Airspace Services, by phone at (202) 267-9205 or email at dennis.roberts@faa.gov.

Sincerely,

[Signature]

Michael P. Huerta
Acting Administrator

cc: Victoria Cox, Assistant Administrator, NextGen
    David Grizzle, Chief Operating Officer, Air Traffic Organization
    Elizabeth Ray, Vice-President, Mission Support Services
    Dennis Roberts, Director, Airspace Service
September 21, 2012

Ms. Margaret Jenny
President, RTCA, Inc.
1150 18th Street, NW.
Washington, DC 20036

Dear Ms. Jenny:

The FAA Modernization and Reform Act of 2012 Section 213 (c) (2) seeks to accelerate the introduction of NextGen Technologies by legislating a Categorical Exclusion under National Environmental Policy Act (NEPA) requirements:

Any navigation performance or other performance based navigation procedure developed, certified, published, or implemented that, in the determination of the Administrator would result in measurable reductions in fuel consumption, carbon dioxide emissions, and noise, on a per flight basis, as compared to aircraft operations that follow existing instrument flight rules procedures in the same airspace, shall be presumed to have no significant affect on the quality of the human environment and the Administrator shall issue and file a categorical exclusion for the new procedure.

While this Categorical Exclusion (referred to as CatEx 2) may appear straightforward it presents several issues. First, legal and technical issues on how to measure noise reduction on a per flight basis must be solved in order to use this legislative CatEx. Second, for purposes of implementation of Section 213(c)(2), CatEx 2 sets a new requirement for including fuel consumption and carbon dioxide (CO₂) emissions in the Federal Aviation Administration’s (FAA) determinations of impacts for performance-based navigation (PBN) procedures, while excluding air quality pollutants under the Clean Air Act. Finally, there is an issue of the practical use of CatEx 2. All other CatEx determinations are based on having no extraordinary circumstances and no significant impacts; therefore, procedures that would result in increases in impacts are still eligible for a CatEx as long as the increases do not reach significant levels and there are no extraordinary circumstances. CatEx 2 sets a more demanding standard of “measurable reductions” that may restrict its use compared to other CatExes that are available for PBN procedures.
The legal and technical issues are linked and merit more discussion.

A new statute is interpreted to be consistent with existing statutes that apply to or cover the same subject matter as does the new statute. *Miami Dolphins v Metropolitan Dade County*, 394 So.2d 981 (Fla. 1981). 2 Singer and Singer, Sutherland Statutes and Statutory Construction, § 51:3 (7th Ed. 2012). The other relevant statutes here are NEPA\(^1\) and the Aviation Safety and Noise Abatement Act (ASNA).\(^2\) The Day-Night Average Sound Level (DNL) is the metric that the FAA adopted over 20 years ago to measure noise in its regulations implementing ASNA and its policies and procedures implementing NEPA for environmental decision-making purposes.

The FAA spent substantial effort analyzing how to interpret Section 213(c)(2) to use DNL. The FAA to date has not been able to identify a technically sound approach to measure reductions in noise on a per flight basis with DNL. DNL, which captures both the loudness and number of aircraft operations, is calculated at thousands of points on the ground to determine noise impacts on people. There is no total DNL number for an airspace study area, and logarithmic DNL calculations cannot be divided by the number of aircraft to produce “noise per flight” values. Hence, there appears to be a conflict between the requirement to measure “noise, on a per flight basis, as compared to aircraft operations that follow existing instrument flight rules procedures in the same airspace” under Section 213 and to measure noise in terms of “surveyed reactions of people to noise” and “exposure of individuals to noise” under ASNA. Similarly, interpreting Section 213(c)(2) to measure noise without the ability to correlate noise with effects on people that DNL provides could be considered to be at odds with even a very broad definition of “effects” under NEPA, as interpreted by the CEQ regulations.

If these provisions cannot be reconciled, and no other interpretation is possible to give meaning to Section 213(c)(2), then it may be interpreted to measure noise changes attributable to PBN without regard to reactions of people on the ground. See, *Watt v Alaska*, 451 U.S. 259 (1981).

As a next step, the FAA considered a way to give effect to the new statute by using single event noise metrics. However, single event noise metrics do not resolve the technical problems.\(^3\) A single aircraft produces different amounts of noise during the course of its arrival or departure. Determinations of the amount of noise depend on varying noise levels at the aircraft source and the relative position of the aircraft with respect to noise sensitive receivers on the ground. The same aircraft will result in different amounts of noise at the thousands of points on the ground comprising an airspace study area. There are technical issues in trying to compare thousands of noise values, some lower and some higher than existing procedures, to determine measurable reductions of noise per flight. The entire flight could not be used to support such a determination because the highest noise levels nearest the runway would dominate the calculation, washing out the difference in noise between procedures.

Another option is to look at changes from PBN by examining the source noise of the PBN procedure compared to the source noise of an existing procedure, disregarding receivers on the

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\(^1\) 42 U.S.C. § 4321-4370a

\(^2\) 49 USC §47502

\(^3\) FAA supplements DNL on a case by case basis with supplemental noise metrics. There is no scientific correlation between single event noise metrics and how people react to noise.
ground. By separating the source from the receiver, one is able to simplify the issue by removing two technically complicated dimensions—the amount of noise on the ground and the impact of noise on people—and concentrate solely on the engine state of the aircraft. If it can be shown that the engine is in a state of lower thrust throughout the entire procedure, then one can assume a lower noise emanating from the aircraft.

Variations in source noise during arrival and departure would still need to be determined via some sort of screening analyses in comparing procedures. While arguably consistent with the requirements of Section 213(c)(2), this approach differs from the traditional analysis in that it does not focus on the receiver on the ground which is where the sound energy is converted into noise by the human ear. As discussed above, a determination of a noise reduction divorced from the hearer would be a marked departure from noise impact determinations done to date and that would continue to be done for FAA actions not covered by this provision. Such an approach would be sustainable as a matter of statutory interpretation only if the conflicts between Section 213(c)(2) and ASNA and NEPA are irreconcilable. Public review and comment issues need to be considered both as to the new metric and the interpretation.

We would like to ask the NextGen Advisory Committee’s (NAC) assistance in further exploring how to make use of this legislative CatEx.

**Task:**

- Provide views on the analyses done to date, per the technical enclosure;
  - Views on the analyses to determine noise reduction on the ground on a per flight basis; and
  - Views on the analyses considering source noise independently of the receiver. Views should include screening methods that might need to be developed to implement this approach.

- Provide technical suggestions on any other possible approaches for determining measurable reductions in noise on a per flight basis—a technical issue that must be solved to enable CatEx 2 to be used;

- To the extent the NAC believes CatEx 2 cannot be implemented effectively and/or even if implemented would not have a desired impact, provide practical and/or legislative recommendations that would help streamline environmental reviews for PBN procedures; and

- Provide both an interim and a final report. The interim report should include a timeline for completing the task.

To successfully complete the task, an appropriate representation of both operators (airlines and airports) and community stakeholders interested in noise must be engaged in the work. The FAA will make subject matter expertise available to the NAC, but would not participate in deliberations.
The FAA appreciates RTCA's many past contributions and looks forward to a continued long and productive relationship that serves the best interests of the public. If I can be of further assistance, please contact me or our point of contact for this activity, Dr. Lourdes Maurice, Executive Director of Environment and Energy, at (202) 267-3576 or lourdes.maurice@faa.gov.

Sincerely,

Michael P. Huerta
Acting Administrator

Enclosure
Summary of Analyses

cc: Julie Oetinger, Assistant Administrator for Policy International Affairs and Environment
    Victoria Cox, Assistant Administrator for NextGen
    David Grizzle, Chief Operating Officer for Air Traffic Organization
    Christa Fornarotto, Associate Administrator for Airports
    John Hickey, Deputy Associate Administrator for Aviation Safety
Technical Analysis of Categorical Exclusion (CatEx) (c)(2) in Section 213 of

FAA Modernization and Reform Act of 2012

The Categorical Exclusion in Section 213 (c)(2), Acceleration of NextGen Technologies states:

"Any navigation performance or other performance based navigation procedure developed, certified, published, or implemented that, in the determination of the Administrator would result in measurable reductions in fuel consumption, carbon dioxide emissions, and noise, on a per flight basis, as compared to aircraft operations that follow existing instrument flight rules procedures in the same airspace, shall be presumed to have no significant affect on the quality of the human environment and the Administrator shall issue and file a categorical exclusion for the new procedure."

While this Categorical Exclusion (referred to as CatEx 2 in this paper) may appear straightforward it presents some technical issues in determining “measurable reductions” with respect to noise. A single aircraft produces different amounts of noise during the course of its arrival or departure. Determinations of the noise produced depend not only on the varying noise levels at the aircraft source as it flies, but also on the relative position of the aircraft with respect to noise sensitive receivers on the ground during the course of its flight.

Background. The methodology for determining noise exposure from aircraft operations is complex. To measure the impact of noise on the ground, there are a multitude of factors that are considered including the state of the aircraft (power setting, flap setting, etc.), the position of the aircraft relative to the receiver on the ground, the magnitude of the noise levels, the tonal quality of the noise, the duration of the events, the number of events, and the time of day of the events. Aircraft noise impacts on communities surrounding airports are best correlated with cumulative noise metrics such as the Day/Night Average Sound Level (DNL), which can capture many factors. The FAA established DNL as its primary noise metric in the early 1980’s in response to the Aviation Safety and Noise Abatement Act of 1979, which directed the FAA to establish by regulation a single system for measuring noise and determining the exposure of people to noise that includes noise intensity, duration, frequency, and time of occurrence. In 1992, the Federal Interagency Committee on Noise (FICON) concluded that “there are no new descriptors or metrics of sufficient scientific standing to substitute for the present DNL cumulative noise exposure metric” and recommended to “Continue use of the DNL metric as the principal means for describing long-term noise exposure of civil and military aircraft operations.” More recent research by FAA and the Partnership for Air Transportation Noise and Emission Reduction (PARTNER) has yet to produce any potential new metrics that would improve upon DNL for determining aircraft noise impacts.

Single event noise metrics are used to describe aircraft noise impacts for specific noise-sensitive locations or situations, or to assist in the public’s understanding. For example, single event analysis has sometimes been conducted to evaluate sleep disturbance and, less frequently, some
speech interference, primarily at locations where the DNL is below 65 dB. However, single
event metrics are limited in their application and do not reflect all factors of noise that are
accounted for by the DNL metric. There is no accepted methodology for aggregating the single
event noise results into some form of cumulative impact metric and no ability to correlate noise
with effects on people as DNL provides. Single event metrics are used to supplement DNL, but
are not an adequate substitute for DNL and are not used by the FAA to determine noise impacts.
The FAA determines noise impacts on the basis of the cumulative noise from all flights, rather
than on a single event per flight basis.

Analysis of Noise Metrics to Support CatEx2. The FAA considered the potential innovative
use of DNL and analyzed four single event metrics for computing noise to try and determine if
there is a sound technical method for determining measurable noise reductions on the ground on
a per flight basis. The four single event metrics analyzed were (1) aircraft noise certification
levels, (2) the time an aircraft operation is above a certain noise level, (3) the maximum noise
level of an aircraft operation, and (4) the sound exposure level of an aircraft operation. In
addition, FAA also explored the option of looking at the aircraft source noise.

DNL. The FAA spent substantial effort analyzing how to interpret Section 213(c)(2) to use
DNL. DNL is used to calculate the cumulative noise from all aircraft in a NEPA study area and
to identify locations where noise would increase by certain amounts over noise sensitive areas.
There is no single total DNL value for a study area. In an airport environs, tens of thousands of
individual grid points are calculated for DNL values, based on the contribution of all aircraft to
noise at those points. Grid points with values of DNL 65 dB, 70 dB, and 75 dB are joined to
draw noise contours around the airport. For air traffic and airspace procedure actions where the
study area is larger, hundreds of thousands of grid points are calculated to determine the change
in DNL noise exposure that would result from the proposed actions.

These thousands of cumulative DNL grid points, calculated logarithmically via a formula, cannot
be arithmetically divided by the number of aircraft to produce noise per flight values. The FAA
to date has not been able to identify a technically sound approach to measure reductions in noise
on a per flight basis with DNL.

Aircraft noise certification. The FAA’s regulatory program for aircraft noise requires the
quantification of aircraft noise levels measured during type certification under 14 CFR part 36
and ICAO Annex 16. Noise is measured at three certification points in terms of Effective
Perceived Noise Level (EPNdB). Effective perceived noise level assesses the noisiness of a
single noise event by taking into consideration both the tone and duration components of a noise

1 The analysis presented in this paper was done with INM v7.0c. If further analysis is done, AEDT 2a is recommended since
many of the effects being studied are at distances from the airport that are beyond the operating envelope for INM. Aircraft
performance data in INM is not validated for distances beyond 10,000 feet altitude. AEDT 2a has the necessary data to extend
aircraft profiles to the distances subject to analysis.
event. The perceived noise level of a single event is adjusted for the added annoyance due to duration and for the presence of discrete frequencies (tones).

The three certification measurement points represent the noise from the aircraft during three distinct phases of flight in the vicinity of an airport (Figure 1). The approach measurement accounts for the aircraft noise during approach with full landing flaps and landing gear deployed. The lateral or sideline measurement accounts for aircraft noise during take-off at a full power throttle setting. The flyover measurement point accounts for aircraft noise during the climb-out phase, typically at a power setting less than full power. The three measurement points are designed to capture aircraft noise at various aircraft states (power setting, flap setting, etc.) that is experienced by communities around airports. There are specific procedures that are followed to measure certification noise levels, and these levels are fixed for a given aircraft. Although the certification noise levels correlate well with community noise metrics, aircraft noise certification is not helpful for implementing CatEx 2 because the certification noise levels are fixed and would not change due to performance based navigation procedures.

**Time-above threshold.** Time above threshold is the time of noise exposure in minutes above some pre-selected threshold of sound level. The time-above metric describes the duration of noise exposure experienced at a specified geographical location. It can provide a useful single number indicator of the potential for speech interference and has also been used by the FAA for noise analyses in national parks. For use in supporting the CatEx2 noise determination, the concept would be to calculate the total time above a selected threshold for the study area and divide the total time by the number of aircraft in the study area to achieve noise measurement on a per flight basis.

The benefit of the time-above metric is that one can calculate a total number divisible by the number of aircraft, similar to how one would calculate fuel burn. However, there are major limitations on the use of this metric. The most important limitation is that it calculates the difference in the time of noise exposure, for example, 3 minutes versus 2.5 minutes above DNL 65 dB; but it does not describe the magnitude of the noise level of aircraft events or capture changes in noise levels. The FAA has experienced situations in using the time-above metric in which the duration of noise exposure is reduced while the level of aircraft noise is increased. The FAA does not consider noise to be measurably reduced if the noise level rises and, therefore, would be concerned that time-above results would not provide a reliably sound technical basis for determining a measurable reduction in noise to support CatEx2.

Another drawback to this metric is that time-above noise exposure is over-stated where aircraft operations are occurring simultaneously. INM and its successor model AEDT2 assume no overlap among aircraft operations and sum the time above the selected threshold for all aircraft in the study area. However, in a busy operating environment the actual duration of time is more compressed due to overlapping noise events. In addition, the selection of a threshold for time-above analyses is not trivial. It may not be prudent to choose the 65 dB level that can be
associated with the FAA level of significance for NEPA purposes since CatEx2 pertains to air traffic actions where noise is routinely analyzed to levels as low as 45 dB. Finally, the time-above metric is not correlated with estimates of community reaction for noise events above a certain threshold.

**Maximum A-weighted sound level.** The A-weighted sound level is the sound pressure level of an event modified to deemphasize the low frequency portion of sounds. It is one of several such weightings (A, B, C, D) found on a sound level meter which attempts to approximate the human ear's response to sound. The A-weighted sound level is used to approximate the relative "noisiness" or "annoyance" of many commonly occurring steady state or intermittent sounds. It is often employed in measuring transportation noise such as aircraft flyovers and vehicular traffic.

The maximum A-weighted sound level (LAMAX) is simply the maximum sound level of a particular event. Figure 2 shows a graph of A-weighted sound level for an aircraft operation. The aircraft noise for this operation peaks at around 5 seconds at a level of 101 dB. This value is the LAMAX for the aircraft operation. The maximum sound level can be useful in providing supplemental information for describing the loudest single event noise around an airport and can be used for specific noise impacts such as speech interference. However, LAMAX is not useful for comparing noise levels of different events because it does not capture the duration of an event. For example, an aircraft operation that has a comparatively large maximum sound level but short duration could have a lower overall contribution to noise at a noise sensitive location than an aircraft operation with a comparatively low maximum sound level of long duration. Therefore although LAMAX captures the maximum noise level of an event, it does not capture the total sound energy of the event. Since LAMAX does not capture the total noise of a flight, it does not appear to respond to the legislative mandate to determine noise reduction on a per flight basis.

LAMAX presents some policy challenges as well. In addition to duration, aircraft location relative to a noise sensitive receiver is also important in making determinations of noise reductions. Performance based navigation procedures can change the position of aircraft relative to points on the ground. Therefore, even if a procedure results in lower aircraft source noise, the change in position of the aircraft could result in higher noise at some locations on the ground. To illustrate this point a sample departure flight track for a 737-700 was constructed as shown in Figure 3. The backbone of the flight track is straight off the runway to a distance of 40 miles. Sub tracks adjacent to the backbone were constructed to simulate the dispersion of flights along a particular flight track that is common in airport operations. The width of the dispersion of flight tracks is assumed to be 12 miles across at a distance from the runway of 40 miles.

A grid point analysis of LAMAX levels was used to compare the noise of two different flight procedures. The departure of a 737-700 at maximum takeoff weight (154,500 lbs.) was modeled on the outer most flight track. The departure of a 737-700 at a lower takeoff weight (130,300
lbs.) was modeled on the backbone flight track. The 737-700 on the backbone track was flown at a lower weight to simulate a performance based navigation procedure that could potentially be quieter than the baseline procedure. Aircraft flown at lower weights are generally quieter because they can climb at steeper angles, increasing the distance between noise source and receiver at a faster rate. Figure 4 shows the grid layout in relation to the flight tracks. An analysis of the grid point data shows that as expected, the maximum value of LAMAX within the grid is produced by the heavier 737-700. The maximum LAMAX value is 59.3 dB and occurs at point 1 in Figure 4. The maximum LAMAX value for the lighter 737-700 is 56.8 dB and occurs at point 2 in Figure 4. However, the value of LAMAX at point 2 for the heavier 737-700 was only 53.9 dB. Therefore although the lighter aircraft produced a lower LAMAX noise level within the parameter of the grid, the receiver located at point 2 experiences a net increase in noise from the quieter flight (+2.9 dB). This illustrates a overarching concern with trying to compare noise values calculated at grid points, with some having higher and some having lower noise values than existing procedures, to determine measurable reductions of noise per flight. Summing or averaging grid point locations for the entire flight does not work because higher noise levels near runways dominate the calculations and wash out differences among procedures that occur farther out.

Sound Exposure level. The Sound exposure level (SEL) is the energy averaged A-weighted sound level over a specified period of time or single event, with reference duration of 1 second. The sound energy produced by the aircraft noise event illustrated in Figure 2 is equivalent to the sound energy of a constant sound level of 105 dB lasting 1 second. Therefore the SEL for this event is 105 dB. Sound exposure level was developed to provide a means of measuring both the duration and the sound level associated with a particular time period or event measured at a specific site. SEL is particularly useful in comparing noise levels of different aircraft operations because it captures both the magnitude and duration of the aircraft noise event. SEL is also advantageous because it is the building block of the cumulative noise metric, DNL, which is used by FAA to determine impacts to communities exposed to aircraft noise.

The FAA regards SEL as the best of the single-event metrics analyzed. However, the technical problem remains that the noise from an aircraft operation depends on the relative position of the aircraft during the operation to the noise sensitive receiver on the ground. Therefore, the noise level of a particular aircraft event depends on where you measure the noise on the ground. One way to capture noise over a large area is to use a noise contour, which connects points of equal noise level. An example of an SEL noise contour of 70 dB for the 737-700 at maximum takeoff weight is shown in Figure 5. The INM model could be used to compute SEL noise contours for individual aircraft flying both the current baseline procedure and the performance based navigation procedure. SEL contours could be compared to show an overall reduction in contour area. A reduction in SEL contour area could be interpreted as a reduction in overall sound energy contribution from the aircraft operation, taking into account the magnitude of the noise level, the duration of the noise, and the position of the aircraft relative to the ground. An overall
reduction in SEL contour area on a per flight basis would translate to an overall reduction in
DNL contour area, assuming the number of operations between the baseline and performance
based navigation procedures does not change.

If contours are used to compare the noise of different flight procedures, then the question
becomes what noise level do you use to make the comparison? The noise level of the contour
should be chosen to include the area where the change in navigation procedures would come into
effect. One problem with this is that the change in navigation procedures usually takes place a
long distance from the airport (approximately 30 to 40 miles). At these distances SEL noise
contours become quite large and noise models become less accurate when developing contours
of this size. Also, analysis of procedures using contours will require contours so large that the
majority of the contour area will cover areas that are not relevant to the navigation procedures
being studied. This could distort the relative changes in contour area due to the procedures.

Grid point analysis is used in place of contours at great distances from the airport. A grid such as
the one depicted in Figure 4 could be used to compare the noise from two different navigation
procedures. However, a similar problem arises when using grid points. How large should the
grid area be? How dense should the grid be to capture the effects of the navigation changes?
How do you ensure that the grid points chosen do not bias one procedure over another? If you
create a grid, how do you create a single noise value? If this is done by converting the noise
values to energy and adding the noise at all the grid points, do you then average that sum? Also,
because decibels are on a logarithmic scale, high noise areas such as under the flight path on the
runway would dominate the calculation and mask differences in noise. It is not clear if and how
one could remove these points in a way that would make the calculation meaningful.

SEL does not account for the temporal aspects of noise exposure. Nighttime noise is considered
more annoying, and the DNL metric accounts for this by applying a 10 dB penalty to nighttime
events. Any change in time of day of events due to performance based navigation procedures
would not be captured with SEL. Another drawback of comparing SEL contour areas is the
spatial aspect of noise exposure. As was demonstrated with the LAMAX metric, if the
procedure moves the aircraft ground track, people not exposed to aircraft noise under the
baseline procedures could be newly exposed to noise under the performance based navigation
procedure. In such a circumstance, there would be both increases and decreases in noise,
depending on where it is calculated. This effect would not be captured by simply analyzing SEL
contour changes in size.

A measurable reduction in SEL on a per flight basis does not ensure that community noise will
be reduced. Though it is not clear that Section 213 (c)(2) requires this, such a departure from
traditional approaches could raise policy issues. The following example illustrates this point.

An SEL contour was developed for a 737-700 at maximum takeoff weight along the backbone of
the flight tracks depicted in Figure 3. Another SEL contour was developed for a lighter 737-700
along the same track to simulate a lower noise flight. As expected the lighter 737-700 produced a smaller SEL contour. At 65 dB SEL, the lighter 737-700 contour area is 218.4 sq. mi. whereas the heavier 737-700 produced a contour area of 283.5 sq. mi. for the same SEL value.

To determine how this area change might affect cumulative noise, DNL contours were constructed for both the maximum weight and lighter weight 737-700. For both aircraft, 500 operations/day were assumed for the DNL calculation. The maximum weight 737-700 was modeled on the dispersed tracks depicted in Figure 3, with operations being normally distributed among the backbone and sub tracks. The lighter 737-700 was modeled assuming RNP procedures would narrow the dispersion to 1 mile (Figure 6). Operations were also assumed to be normally distributed among the backbone and sub tracks. As expected, the lighter 737-700 produced smaller DNL contours than the heavier 737-700. At DNL 45 dB, the lighter 737-700 produced a contour area of 131.9 sq. mi. whereas the heavier 737-700 produced an area of 145.5 sq. mi. This would indicate that a reduction in SEL contour area on a per flight basis would result in a reduction in DNL contour area.

A grid point analysis of SEL and DNL under the backbone flight track shows a slightly different result. The difference in SEL along the backbone track between the two aircraft is shown in Figure 7. The difference in DNL along the backbone between the two aircraft is shown in Figure 8. The SEL for the lighter aircraft is lower as expected, however the DNL values of the two aircraft begin to converge further along the track. This is due to noise "focusing" caused by the tighter dispersion of the RNP tracks. Dispersed tracks spread out the noise somewhat, causing the noise to be reduced along the backbone. Conversely, more precise routes with less dispersion will concentrate the noise along the backbone of the track, increasing cumulative noise exposure. This can be seen in Figure 9, which gives the DNL along the backbone track for the maximum weight 737-700 flying 500 operations on the dispersed tracks and the DNL for the same aircraft weight flying the RNP tracks.

**Source Noise Comparison of PBN and Existing Procedure.** Another option is to look at changes from PBN by examining the procedure itself, regardless of its location relative to the ground. By separating the source from the receiver, one is able to simplify the issue by removing two technically complicated dimensions—the amount of noise on the ground and the impact of noise and people—and concentrate solely on the engine state of the aircraft. If it can be shown that the engine is in a state of lower thrust throughout the entire procedure, then one can assume a lower noise emanating from the aircraft.

The key concern with this approach is that the dimensions being lost are important. The ear of the receiver on the ground is where sound energy is converted into noise. For all proposed actions under the National Environmental Policy Act (NEPA), including air traffic airspace and procedure actions, noise is computed at noise sensitive receivers on the ground. A determination of a noise reduction divorced from the hearers on the ground would be a marked departure from noise impact determinations done to date and that would continue to be done for FAA actions not
subject to CatEx 2. There is also a concern that conventional NEPA analysis may show that noise would actually increase with respect to the receiver on the ground. PBN procedures have the potential to impact people that have not been impacted by aircraft noise in the past.

Variations in source noise during arrival and departure would still need to be determined via some sort of screening analyses to compare procedures. A technical concern is that FAA noise models are designed to take source and receiver into consideration through Noise-Power-Distance (NPD) curves. If it is deemed appropriate to calculate source noise separate from the receiver, the FAA does not currently have a way to model the reduction of source noise independent of the receiver.

PBN provides a great opportunity to take advantage of enhanced performance levels of aircraft that have become available as technology has advanced. The two main components of PBN are Area Navigation (RNAV) and Required Navigation Performance (RNP). Advancing technologies allow the creating of PBN procedures, which include such advancements as greater turn radius precision and tighter dispersion. PBN procedures can be an enroute, arrival or a departure procedure. An arrival procedure has an additional opportunity to be an optimized profile descent (OPD). OPDs can exist for both PBN and non-PBN arrival procedures. If the PBN arrival is also an OPD, the procedure will be using an engine setting of near idle. Analysis has shown that OPDs over the whole arrival procedure can show a slight noise decrease near the airport, but can cause a slight noise increase at DNL levels of 45 dB – 60 dB. If the PBN arrival does not also include an OPD, the procedure may have altitude limits defined along the route, but engine state along the procedure is not defined. Hence, there is no way to determine if the engine state for the new procedure will create a lower thrust, creating a lower source noise throughout the procedure. For PBN departure procedures, the same logic and argument regarding engine state assumptions as for the non-OPD PBN arrival procedures applies.

**Summary.**

Based on the traditional approach to measuring noise impacts on the ground, an initial analysis of the cumulative DNL noise metric and four single-event noise metrics has been done to determine how measurable reductions in aircraft noise on a per flight basis could be determined as required to support CatEx 2. DNL and three of the single-event metrics (noise certification levels, time above, and maximum sound level) were fairly soon found to have significant limits in terms of using them to implement CatEx 2. The sound exposure level (SEL) appears to be the best of the existing metrics analyzed; however, there are some technical and policy issues with using SEL that also undermine its usefulness for this purpose.

Another issue with any single event metric is noise focusing. Performance based navigation procedures that reduce the amount of dispersion in flight tracks can have the effect of concentrating noise in certain areas. Therefore, reducing noise on a per flight basis may not equate with reducing noise for noise sensitive areas where the flight tracks are focused. Determinations of aircraft noise reduction per flight that may not be reflected in community
noise reductions can engender community opposition and litigation. The consideration of aircraft source noise without consideration of the noise receiver on the ground simplifies some of the technical challenges, but cannot be calculated with current noise models and may not produce a technically reliable determination regarding measurable noise reductions.

Among all of the potential environmental impacts of aviation, aircraft noise is often the predominant concern of the public and the most likely to engender opposition to aviation capacity and efficiency proposals. Any noise determinations need to maintain the technical and legal integrity of the FAA’s NEPA reviews, or risk unwanted setbacks in our ability to implement NextGen procedures.
Figure 1: Noise Certification Measurement Locations.

Trajectory and Certification Locations

- Approach Reference
- Lateral Reference
- 450 m
- 2000 m
- 6500 m
- Certification Points:
  - Flyover
  - Lateral
  - Approach

Figure 2: A-weighted Sound Level of Aircraft Operation

Legend
- Instantaneous level
- Leq for L>65 dB
- Leq for L>91 dB

SEL = 105 dB
L_{max} = 101 dB

\begin{align*}
\text{L}_{\text{eq}} &= 97.0 \text{ dB} \\
\text{L}_{\text{eq}} &= 92.8 \text{ dB}
\end{align*}

Time (seconds)
Figure 3: Dispersed Departure Tracks

Figure 4: Grid Point Layout
Figure 5: SEL 70 dB Noise Contour

Figure 6: Simulated "RNP" Tracks
Figure 7: SEL Along Backbone Flight Track (Heavy versus Light Weight Aircraft)

Figure 8: DNL Along Backbone Flight Track (Heavy versus Light Weight Aircraft)
Figure 9: DNL Along Backbone Track (Dispersed Tracks versus RNP Tracks)