NEW YORK FLIGHT DELAYS HAVE THREE MAIN CAUSES, BUT MORE WORK IS NEEDED TO UNDERSTAND THEIR NATIONWIDE EFFECT

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Memorandum

U.S. Department of Transportation
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Subject: ACTION: New York Flight Delays Have Three Main Causes, but More Work Is Needed To Understand Their Nationwide Effect
Federal Aviation Administration
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From: Lou E. Dixon
Principal Assistant Inspector General
for Auditing and Evaluation

Reply to Attn. of: JA-1

To: Federal Aviation Administrator

During the summer of 2007, the United States experienced record-setting flight delays, with nearly one in three domestic flights either delayed or cancelled. The New York region's three largest airports—Kennedy, LaGuardia, and Newark—led the Nation with over 40 percent of arriving flights either delayed or cancelled. Although the overall situation improved somewhat in 2009, this region continued to report nearly one-third of its flights as delayed or cancelled. Such delays not only pose a significant problem for air travelers in the New York region but also affect passengers flying to other parts of the country.

The Chairman of the House Subcommittee on Aviation requested that we (1) determine the principal causes of flights delays in the New York region and (2) identify the corresponding effect of these delays nationwide. We conducted the audit from June 2009 through August 2010 in accordance with government auditing standards prescribed by the Comptroller General of the United States. We based our observations and conclusions on interviews with Federal Aviation Administration (FAA), air carriers, and the Port Authority of New York and New Jersey as well as our analysis of air traffic and delay data collected by FAA and the Department of Transportation's (DOT) Bureau of Transportation Statistics (BTS). Exhibit A details our audit scope and methodology.

RESULTS IN BRIEF

Flight delays have been a significant problem for the New York region for many decades.[1] While various factors have contributed to this problem, the three principal causes are a small and densely occupied airspace, limited capacity among the region's three main airports, and continued growth in air traffic. FAA first attempted to manage flight delays at LaGuardia, Newark, and Kennedy in 1970 using flight limits (or caps) under the High Density Rule,[2] but those limits were phased out between 2000 and 2007.[3] While the phase-out had noticeable benefits, such as reduced air fares and service to new markets due to increased competition, it also led to record levels of flight delays for the New York region. To prevent delays from getting worse, FAA reintroduced flight caps in 2008. Yet, these new caps have done little to reduce delays at New York because FAA based the caps on the airports' 2007 operating levels—despite record delays—and did not establish an on-time performance target. For flight caps to have more success in preventing delays from again rising to record levels, FAA will need to reexamine them, basing them on realistic airport operating conditions, air carrier scheduling practices, and an acceptable rate of delay.[4]

While there is substantial agreement within the aviation community that New York delays have a propagation (i.e., ripple) effect across the Nation, the extent and nature of their impact are largely unknown.[5] FAA and others' attempts to measure the ripple effect have been hampered by the volume, complexity, and limitations of existing flight data and analytic methods as well as insufficient leadership and coordination among research groups studying this issue. Although FAA has initiated two projects to measure delay propagation, additional work remains before either will prove to be useful analyses of delay propagation. As a result, no one fully understands the impact of New York flight delays nationwide, whether New York airports absorb or generate delays, or what other airports are affected and to what degree. Gaining a greater understanding of the dynamics[6] of flight delays and their nationwide impact will aid FAA's efforts to reduce flight

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[1] The U.S. Department of Transportation (DOT) defines a flight as delayed when it arrives more than 15 minutes after its published arrival time.

[2] In 1969, FAA imposed flight limits through the High Density Rule, due to concerns with aviation safety, congestion, and flight delays at New York and other large airports. The High Density Rule established limits on the number of hourly flight operations at all three major New York area airports (and Chicago O'Hare and Reagan National), although Newark was soon exempted in 1970.

[3] The Wendell H. Ford Aviation Investment and Reform Act for the 21st Century (AIR-21), Pub. L. No. 106-181 (2005). This law called for the phase-out of the High Density Rule at LaGuardia and Kennedy airports by granting exemptions beginning with passage of the law on April 5, 2000, and eventual repeal of the rule at the two airports effective January 1, 2007.

[4] A rate of delay is the percent of flights delayed.

[5] Delay propagation refers to the ripple effect of an initial delay on subsequent flights of the same aircraft.

[6] To measure dynamics of flight delays, various factors need to be considered, including cause and location of initial delay, duration of delay by type of cause, aircraft turnaround time (i.e., the duration of ground time between an aircraft's scheduled arrival and next departure), and delay absorption or generation (i.e., an airport's tendency to reduce or increase an aircraft's amount of delay).

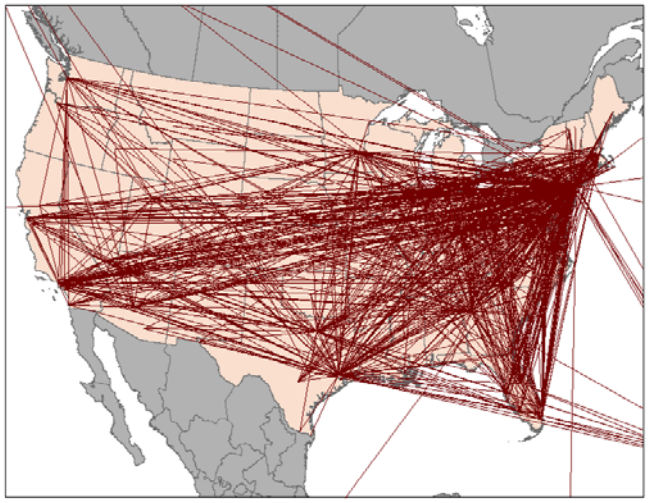
delays and congestion, better manage air traffic, and improve investment decisions.

We are recommending that FAA reexamine its flight caps, enhance existing flight data, and develop a viable methodology for understanding the propagation effects of flight delays.

BACKGROUND

For more than 40 years, the New York region has comprised one of the most congested and delayed aviation areas in the United States. During a typical summer day, more than 1,400 aircraft fly through the 3 main New York airports (i.e., Kennedy, LaGuardia, and Newark), and almost a third of those aircraft fly through multiple times. These aircraft complete a total of 5,400 flights across the country and around the globe, landing at 122 domestic airports and 52 foreign countries (see figure 1).

Figure 1. Typical Daily Flight Itineraries for Aircraft Going Into and Out of Three New York Airports



Source: FAA and BTS

This high flight volume, coupled with dense airspace and limited capacity, have resulted in the 3 New York airports experiencing the highest delay rate among the 55 major U.S. airports. The situation has worsened over the last decade, with 35 percent of flights delayed in 2008 compared to the already high 29 percent in 1999.[7] These delays not only affect aircraft travelling to and from the region but can also create a ripple effect as those aircraft fly throughout the Nation.

Since 2000, we have issued a number of reports and testified before Congress on the growing number of flight delays, air carrier customer service, and air traffic congestion both in New York and nationwide. Our most recent report, issued last year, examined FAA's progress in implementing the New York Aviation Rulemaking Committee's (ARC) 77 initiatives for reducing delays and congestion

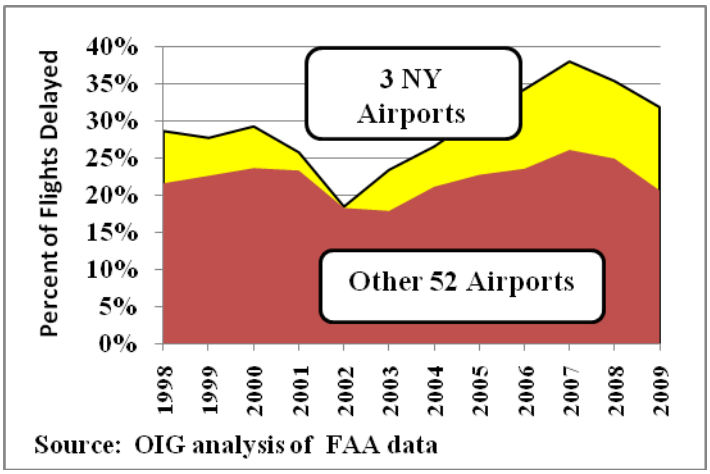
[7] Our analysis focused on operations and delays at the three largest New York airports from 1999 through 2008. In 1999, FAA had not yet begun phasing out flight limits at Kennedy and LaGuardia; subsequent data through 2008 show the effects of the final statutory removal of the flight limits in 2007 and the first year of newly reimposed limits by FAA at Kennedy and Newark.

in the New York area.[8] We concluded that many of the ARC 77 initiatives had not been fully implemented or were used infrequently and thus had little impact on the delay situation. (See exhibit B for a full list of our reports and testimonies related to flight delays in the New York region.)

PRINCIPAL CAUSES OF NEW YORK FLIGHT DELAYS ARE DENSE AIRSPACE, LIMITED AIRPORT CAPACITY, AND HIGH AIR TRAFFIC DEMAND

The principal causes of New York flight delays are crowded airspace, airport capacity constraints, and continued growth in air traffic. Together, these factors have caused the New York airports to experience higher levels of flight delays than the Nation's other large airports (see figure 2). The phase-out of flight limits or caps (i.e., FAA's High Density Rule) between 2000 and 2007 at LaGuardia and Kennedy[9] contributed to the growth in air traffic and subsequent congestion and delays. FAA's efforts in 2008 to mitigate delays by reinstating flight caps at Kennedy and Newark, however, yielded little improvement.[10] This is because FAA based its caps on the maximum capacity experienced at the airports during 2007—a year with record delays—and did not use an on-time performance target (i.e., acceptable rate of delays) for determining airports' realistic capacity. While delays have declined during the recent economic recession, flight volume and delays will likely return as the economy recovers.

Figure 2. Flight Delays at the 3 Primary New York Airports Versus 52 Other Large Airports FY 1998 to FY 2009



[8] OIG Report Number AV-2010-003, "Status of the Aviation Rulemaking Committee's 77 Initiatives for Reducing Delays in the New York Area," October 21, 2009. OIG reports are available on our website: www.oig.dot.gov.

[9] While this action led to an 8-percent increase in flights serving New York, the actual number of passenger seats declined by 0.6 percent as carriers substituted larger aircraft with regional jets.

[10] FAA had already imposed new flight limits at LaGuardia in 2001, because the phase-out of the airport's caps in 2000 led to rapid growth in flights and delays.

Principal Causes of the New York Region's Flight Delays

Dense New York Airspace: New York's airspace is one of the densest in the country due to the close proximity of the three major airports and the high volume and complexity of flight operations. Kennedy, LaGuardia, and Newark airports are compressed into less than 100 square miles—an area slightly larger than Washington, DC. This close proximity creates a high degree of operational inter-dependence among the three airports, with changes at one airport frequently impacting flight operations (both on the ground and in the air) at the other two.

For example, changing weather conditions (e.g., wind patterns) may require one airport to use a different runway configuration, which in turn can impact the surrounding airspace and aircraft operations at the other two airports. The congested airspace also requires close attention to spacing between aircraft, which can add further time (and delays) to affected flights. Thus, it is not surprising that nearly two-thirds of flight delays at the three New York airports are attributable to weather and high volume (congestion)—twice that of the other 52 largest airports that FAA tracks (see table 1).

Table 1. Comparison of Delay Causal Factors June through August 2009

Causal Factor	3 NY Airports	52 Other Airports
Weather	51%	21%
Volume	10%	6%
Late Arriving Aircraft	20%	36%
Air Carrier	15%	26%
Other	4%	11%
Total	100%	100%

Source: OIG analysis of DOT data

Further, the three New York airports together represent the most heavily used combination of airports in a single metropolitan area in the Nation. During a typical summer day, more than 3,500 flights—involving 1,400 aircraft—begin or end at 1 of these airports. Moreover, the New York Terminal Radar Approach Control (TRACON), which manages flights into, out of, and through the New York region, handles nearly 2 million flights per year, second only to the Southern California TRACON.[11] Likewise, the New York Air Route Traffic Control Center (ARTCC)[12] manages the densest en route airspace on either side of the Atlantic.[13] In addition to the flights landing at and taking off from the three major airports,

[11] TRACONs are FAA facilities that guide aircraft approaching and departing airports generally within a 30- to 50-mile radius up to an altitude of 10,000 feet as well as aircraft that may be flying through that airspace.

[12] ARTCCs control aircraft primarily during the en route (i.e., high altitude) phase of the flight, and the New York ARTCC is responsible aircraft flying over five states and much of the North Atlantic.

[13] The calculation of New York ARTCC's airspace density does not include the oceanic portion.

the New York TRACON and ARTCC handle aircraft using more than a dozen nearby airports as well as those flying through the New York airspace.[14]

The rapid growth in regional jet operations has further compounded the density and complexity of the New York airspace. Since 1999, air carriers have increased their use of regional jets (i.e., 35-100 seats) by 500 percent at the New York airports, replacing nearly all turboprop aircraft as well as some larger jets.[15] The increased use of regional jets, however, was not without some negative repercussions, as the smaller jets—unlike turboprops—occupy the same airspace and use the same runways as larger jet aircraft. In effect, the influx of regional jets has further saturated New York's already crowded airspace, routings, and runways, while those formerly occupied by turboprop aircraft are now used less.

Limited Airport Capacity: Due to significant space and operational constraints, Kennedy, LaGuardia, and Newark are severely limited in the number of flights that they can safely and efficiently accommodate (i.e., capacity). Although new technology and procedures can enhance airport capacity, new runways typically bring the greatest increase. Yet, the last new runway added at any of the New York major airports occurred at Newark in the early 1970s, and there are no plans to add any new ones. For example, an August 2007 Port Authority of New York and New Jersey (Port Authority) study determined it was not feasible to construct a new runway at Kennedy, although it proposed several smaller capacity improvements (e.g., additional runway extensions and taxiway improvements). The study concluded that any new runway project would not only be very costly and controversial but also extremely difficult to advance as it would be built within a protected environmental area. In contrast, 17 other major airports across the Nation have added new runways since 1999. These include busy airports such as Chicago O'Hare, Atlanta Hartsfield, Boston Logan, and Washington Dulles. While the existing New York airspace may be used more efficiently in the future due to FAA's ongoing airspace redesign, the Agency states that this project will not increase airport capacity.

Increases in Air Traffic Demand: Over the last decade, flight demand in the New York region has grown considerably. Between 1999 and 2008, the number of flights departing the New York area increased by 8 percent (from 567,000 to 612,000)—the equivalent of adding a mid-sized airport's flight operations (e.g., Albuquerque or New Orleans) without building a single new runway. This increase was due to various factors:

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[14] Congestion in the New York region is not a problem involving only the commercial air carriers. For instance, general aviation accounts for less than 3 percent of the flight activity at the three New York airports, but represents about 25 percent of New York TRACON's total operations.

[15] Air carriers decided to use regional jets because they are faster and more cost effective than turboprop aircraft, and in 2000 the Congress exempted such aircraft from then existing flight limits at LaGuardia and Kennedy.

- *Emergence of JetBlue Airways in the New York Region:* In 2000, JetBlue inaugurated operations at Kennedy airport and subsequently added flights at both Newark and LaGuardia. Between 2000 and 2008, JetBlue's departures from the three New York airports increased by more than 1,000 percent (5,071 to 64,881), with the greatest increase at Kennedy.

- *Establishment of Delta Air Lines International Hub at Kennedy:* In late 2006, Delta Air Lines established an international hub at Kennedy, and the carrier's scheduled departures at the airport jumped by 46 percent (from 43,400 to 63,400) the next year.[16] The creation of Delta's Kennedy hub was made possible by the ending of FAA's High Density Rule in 2007.

- *Phase-Out of FAA's High Density Rule at LaGuardia and Kennedy:* In 2000, after Congress voted to phase out the High Density Rule flight caps, air service began between New York and several new domestic and international markets, and air fares in the New York region declined. By the time the caps had expired at LaGuardia and Kennedy in 2007, both airports had experienced a sizable increase in flight operations.[17] For example, during the summer of 2007, the average number of daily flights in the New York area increased by about 6 percent (3,100 to 3,300 flights) over the previous summer (22 percent growth at Kennedy alone).

Resulting Increase in Flight Delays: The increase in flights over the last decade, coupled with New York's already dense airspace and constrained airport capacity, resulted in a 46-percent increase in the number of flights delayed. As shown in figure 3 below, between 1999 and 2008, the number of on-time flights remained fairly constant at about 100,000 per summer. However, as the number of flights grew over the same time period so did the number of delays. The net effect, therefore, was that any new growth in flight activity translated exponentially into a higher number and rate of delays. Conversely, as the number of flights declined (i.e., 2002-2003 and 2009) so did the number and rate of delayed flights.

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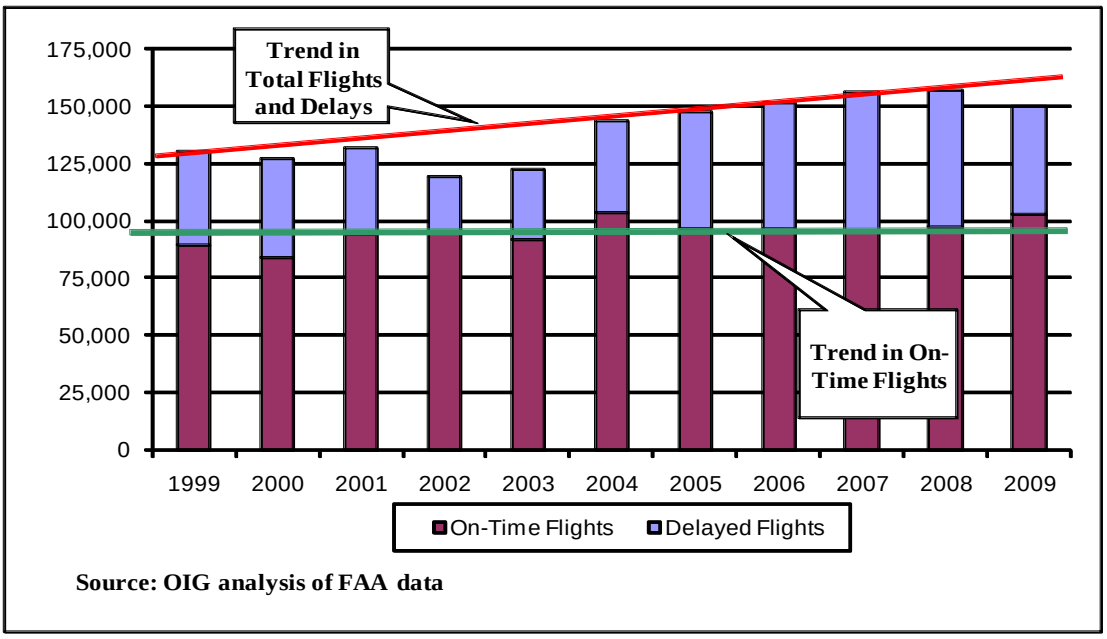
[16] The increase in Kennedy flight operations also forced FAA to change its management of air traffic (and delays) in the New York area. Before the increase, FAA favored operations at Newark and LaGuardia; after the increase, the Agency had to balance use of the airspace among the three airports. This, in turn, resulted in additional constraints on Newark and LaGuardia flight operations.

[17] Starting in 2000, AIR-21 (Pub. L. No. 106-181) also permitted exemptions to slot controls at LaGuardia for new entrants and regional jet operators, resulting in a 26-percent increase in scheduled flights and a 525-percent increase in delays from November 1999 to November 2000. In 2001, FAA attempted to alleviate the resulting gridlock by reducing the number of new flights, limiting the overall growth to about 14 percent. These caps remained in effect beyond the legislated termination of the HDR in 2007.

Figure 3. Corresponding Increases in Flight Operations and Delays (June through August at Kennedy, LaGuardia, and Newark Airports)



Source: OIG analysis of FAA data

FAA's Current Flight Caps Are Not an Effective Solution for Reducing Delays at New York Airports

Following the record delays of summer 2007, FAA reimposed hourly flight caps at Kennedy and Newark and maintained caps at LaGuardia in 2008. However, FAA's goals were to keep delays from getting worse and to reduce their severity, but not to reduce the number or rate of delays.[18] In effect, FAA set the new caps near the airports' maximum capacity in optimum weather conditions and then allowed air carriers' schedules to exceed those caps during certain time periods. As a result, there was little meaningful improvement in New York's delay situation during the summer of 2008. In contrast to FAA's efforts, the three major London airports set their flight caps with consideration of seasonal weather variations and a performance target that helps reduce the rate of delays. While FAA recognizes that its caps may be too high and has taken steps to improve them, much work remains to ensure the caps can effectively prevent delays from again rising to record levels.

[18] FAA's goals were to reduce the average minutes of airport departure delay at Kennedy, keep arrival and departure delays from increasing at Newark, and reduce the number of severe delays (i.e., greater than 1 hour) at both airports.

FAA Designed the 2008 Flight Caps with Limited Goals: In calculating the caps for 2008, FAA used a model to identify the number of hourly flights that would achieve its limited delay-reduction goals. The model was based on the highest hourly capacity experienced at the New York airports during 2007, when delays were at their highest. As shown in table 2, the resulting caps are near the airports' maximum capacity[19] in optimum weather conditions, despite the fact that nearly two-thirds of New York delays occur as a result of poor weather or high volume of flight activity.[20] Moreover, FAA did not establish a maximum rate of delay as a goal to use in calculating flight caps. Such a goal would help determine the number of hourly operations an airport could reasonably sustain without exceeding that goal. In addition, the goal could also be a benchmark toward which passengers can base expectations and the Agency and airlines can manage and measure their performance.

Table 2. Comparison of Total Hourly Capacity Measures with Flight Caps at Three New York Airports During Summer 2008

Airport	Airport Capacity In Poor Weather Conditions (IFR)	Caps (Scheduled and Unscheduled)	Airport Capacity In Optimum Conditions (VFR)
Kennedy	64-67	83	75-87
LaGuardia	69-74	81	78-85
Newark	61-66	83	84-92

Source: OIG analysis of FAA data

FAA's decision to allow air carrier schedules to exceed the caps during certain time periods during the day exacerbated the delay situation in New York. To ensure the caps were enacted prior to the summer of 2008, FAA negotiated with the air carriers to curtail their planned increases in summer flights and to shift flights to less congested times.[21] As part of the negotiations, FAA agreed to accommodate air carrier scheduling practices, by allowing them to exceed flight caps during certain 15- and 30-minute periods—as long as the hourly caps were generally achieved. Figure 4 below shows an example of how Kennedy's operations exceeded flight caps on one summer day in 2008. Even in optimal weather (VFR conditions), these peaks—which in some cases are nearly twice Kennedy's stated capacity—can produce long lines of aircraft waiting to take off and taxi-out times approaching 1 hour, the longest of any airport in the Nation.[22]

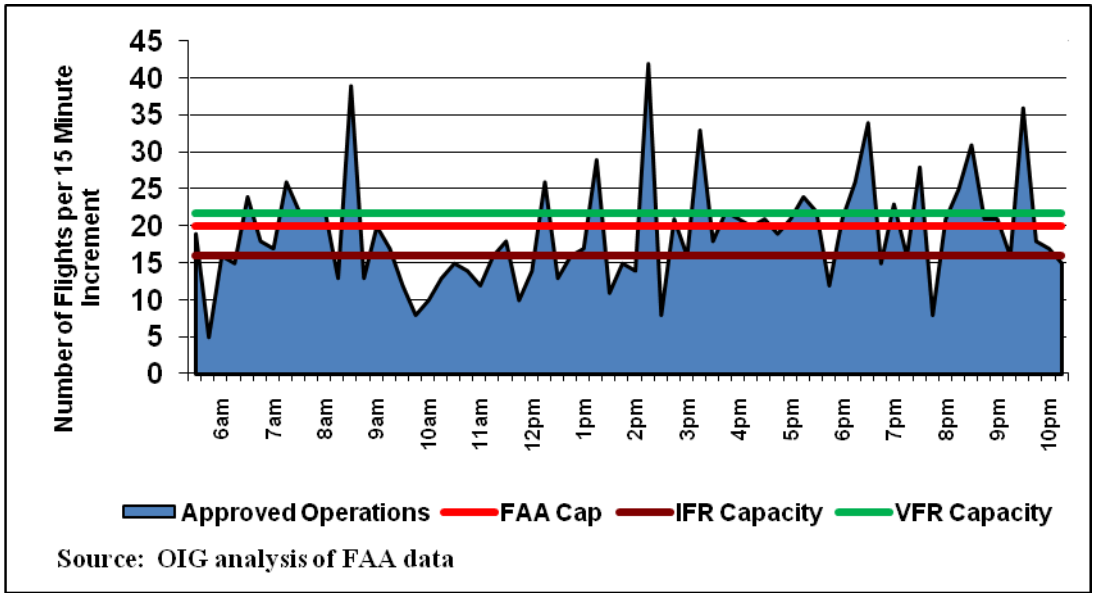
[19] FAA generally allocated 81 operations per hour for scheduled flights at both Kennedy and Newark and 75 at LaGuardia—as well as 2 nonscheduled operations per hour at both Kennedy and Newark and 6 at LaGuardia.

[20] Generally, the number of departures and arrivals an airport can handle are contingent upon weather conditions specified by FAA's Visual Flight Rule (VFR) and Instrument Flight Rule (IFR) capacity rates. If visibility levels fall below the minimum VFR conditions, then IFR conditions govern flight operations, thus reducing airport capacity.

[21] Rather than impose the caps under a lengthy rulemaking process, FAA sought to achieve air carrier acceptance of the caps and ensure the carriers had sufficient time to begin marketing summer flights to the public.

[22] In 2010, FAA continues to allow air carriers to schedule flights in excess of the desired caps, although the excess is slightly below that experienced in 2008.

Figure 4. Comparison of Flight Schedules with Various Capacity Measures at Kennedy (June 18, 2008)



By setting the reimposed caps near the airports' maximum capacity and permitting scheduling peaks, FAA achieved its limited goals for the summer of 2008 with only modest reductions in the both the average length of airport departure delays and in the number of flights delayed by more than 1 hour. However, since FAA's goals did not include improvements in the delay rate and the average duration of delayed flights, New York again experienced severe flight disruptions in the summer of 2008, with more than 40 percent of New York arrivals delayed or cancelled and arrival delays averaging 71 minutes. Although delays have since declined due to a drop in air traffic, once the economy recovers and flight volume returns, delays will likely rise again and increase passenger dissatisfaction with air travel.

FAA Efforts Could Benefit from London's Air Traffic Control Lessons Learned: To gain an international perspective on New York, we observed how flight caps are planned at London's three major airports (Gatwick, Heathrow, and Stansted). These airports together serve a greater number of passengers than the three major New York airports but experience a lower rate of flight delays. In London, airports, air carriers, and the air traffic control organization coordinate to reach consensus on the number of flights that can be accommodated (caps) without exceeding an acceptable delay target. To determine a realistic hourly cap, these organizations also base the capacity of the London metropolitan airports on both winter and summer weather conditions—not year-round optimal conditions as is the practice for New York. By taking these steps, the London airports experience about a 20 percent lower rate of delays than their New York

counterparts by operating 28 percent fewer flights. Yet, London airports handle a greater number of passengers because air carriers are using larger aircraft.

FAA's Ongoing Efforts To Improve Flight Caps: FAA recognizes that its reimposed flight limits at the three New York airports may be set too high and has taken steps to improve them. In January 2009, FAA announced its plan to reduce the number of hourly flights permitted at LaGuardia from 75 to 71 operations, acknowledging that the caps caused significant delays when operating conditions deteriorated (e.g., during poor weather or periods of excess demand). FAA has also been recalling and retaining unused and or voluntarily surrendered slots at Kennedy and Newark where they were negotiated in excess of FAA's desired hourly caps.[23] In October 2009, FAA extended the Kennedy and Newark flight caps for 2 more years and announced that it would reduce flight caps at those airports if conditions warranted. However, further reducing flight caps or restricting scheduling practices to smooth schedule peaking within individual hours will be difficult to achieve due to air carriers' desire for unlimited access to the airports and passenger demands for greater service to and from the New York region. To prevent delay rates from again rising to record levels, FAA will need to reexamine its flight caps, basing them on realistic airport operating conditions, air carrier scheduling practices and an acceptable rate of delay.

FAA LACKS THE ANALYTICAL CAPABILITY TO DETERMINE THE NATIONWIDE EFFECT OF NEW YORK FLIGHT DELAYS

While there is wide agreement within the aviation community that New York delays have a propagation (i.e., ripple) effect on the rest of the Nation, we found the actual extent and nature of this impact remains largely unknown. FAA currently lacks the ability to measure the propagation effect of New York flight delays, and others in the aviation community have only developed fragmentary estimates. Various challenges have hampered FAA and others within the aviation community in measuring this "ripple effect." These include the sheer volume, complexity, and limitations of existing flight data and analytic methods as well as insufficient FAA leadership and coordination of the various groups researching this issue. FAA has initiated two projects to measure delay propagation, although both need further development before they will prove useful in the analysis of delay propagation. Thus, no one fully understands how or to what degree New York delays impact flights nationwide. A complete understanding of the dynamics of flight delays and their nationwide impact would aid FAA in its efforts to manage air traffic, and make sound investment decisions on future aviation infrastructure improvements.

[23] FAA has not forced air carriers to relinquish slots; instead, it is relying on voluntary surrender of slots above the new limits, whereupon they would be retired by the Agency.

Little Is Known as to Actual Nationwide Impact of New York Delays

While it is generally understood that New York delays affect other flights, FAA has not reported on this effect, and researchers in academia and the aviation industry have provided, at best, only limited information on it. For example, in April 2010, the Air Transport Association (ATA) noted that the three New York airports represent nearly half of all flight delays among the Nation's largest airports. However, the ATA analysis only expresses what portion of nationwide delays occur as a result of congestion at the New York airports and airspace (which includes Philadelphia), not their propagation effect. In addition, at a November 2007 White House press conference, then-Secretary Mary Peters stated that "… three-quarters of the flight delays are because the plane went into, out of, or through the New York airspace…." This figure, however, addresses only chronically delayed flights, a small subset of all flight delays.[24] Neither these estimates nor other industry and academic research answers a number of important questions—such as where the delays originated (locally or elsewhere), whether the New York airports absorb or generate delays, what other airports are affected and to what degree, and how air carrier scheduling decisions might cause or alleviate the propagation effect. Any effort to fully understand the propagation effect of New York delays will have to overcome the limitations of earlier efforts as well as a number of other challenges.

Various Factors Hamper Efforts To Measure the Nationwide Effect of New York Flight Delays

In order to understand the propagation effect of flight delays, FAA and other aviation research groups face several key challenges. These include developing analytical methodologies for measuring delay propagation; overcoming limitations in existing delay data sets; and improving coordination between FAA, BTS, and other aviation and research groups. Until these challenges are overcome, no one will fully understand the impact of flight delays on the rest of the Nation.

- *Analytical Complexity.* The sheer volume and complexity of flight delay data pose a significant mathematical and data management challenge. Before an analysis of delay propagation can begin, FAA and others must assemble more than 10 million annual flight records—each with multiple arrival and departure times and causes of delay data elements—into a database of daily aircraft itineraries. In addition, they must develop methods to compile, extract, and analyze the delay characteristics and follow the flow of initial delays to their ripple effect.

[24] The variance in these two estimates is due to the differing methodologies used. For example, the three-quarters figure covered only those flights that were chronically delayed 70 percent or more over a 3-month period—a small subset of all flight delays. In comparison, the ATA study was restricted to those flight delays at the 35 largest U.S. airports and excluded delays caused by air carrier action (e.g., mechanical, customer accommodation, or crew).

- *Data Limitations.* Of the two main databases used by FAA to track flight and delay information, neither provides all the necessary information to fully measure delay propagation.[25] A critical component of determining the delay propagation effect is the ability to track each aircraft's daily movements using its unique tail number. Unfortunately, 1 database, maintained by BTS, only contains aircraft tail numbers for the 19 largest domestic passenger air carriers, representing about two-thirds of the flights that could be analyzed. In contrast, a second database, maintained by FAA, contains more comprehensive information on all passenger and cargo aircraft operating both domestically and trans-border, but has tail numbers for only 40 percent of these aircraft. There are also inaccuracies in the BTS data, though BTS hopes recently implemented validation edits will largely identify and correct air carrier reporting errors.[26]

- *Insufficient Leadership and Coordination.* To date, FAA has not exercised the leadership required for bringing the air carriers, academia, and other aviation research groups together to develop viable analytic methodologies, useful database structures, or common terms of reference. These organizations' input and analytic resources are required to achieve a full understanding of the delay propagation phenomena and to develop workable applications for aviation stakeholders. In the absence of FAA's leadership, these groups have made some individual efforts at measuring delay propagation, but the resulting information has been largely theoretical in nature or of limited application.

FAA Has Only Recently Begun To Examine Delay Propagation Effects

Although FAA has two projects for measuring and tracking delay propagation (both in New York and elsewhere), these efforts will require more work before proving useful in analyzing delay propagation. For example, one project, managed within FAA, is exploring delay propagation as a way to improve FAA's air traffic management nationwide. By analyzing the delay pattern of aircraft as they move about the country, FAA would be able to identify where a delay began and how it impacted later flights. However, the project's methodology may undercount initial delays and overcount delay propagation because it estimates them through mathematical calculation rather than using actual carrier-reported causal information. For example, an aircraft could experience an initial delay on one flight leg due to a mechanical problem and a delay on the next leg due to weather. Under this methodology, FAA could categorize this example as one delay event (first leg) with a propagated delay (second leg), instead of two

[25] Although sufficient data exist for FAA and others to continue the study of delay propagation and apply results, this effort would be improved if existing data limitations were addressed.

[26] Questions regarding the accuracy of air carrier reported causes of delay have caused some FAA officials to be skeptical in accepting the results of delay analysis or reluctant to consider delay propagation in other than theoretical terms.

separate delay events. This project also only measures the minutes of delay propagation, not the number of subsequently delayed flights.

A second project, undertaken by MITRE Corporation[27] under contract to FAA, is exploring delay propagation to help improve calculation of the nationwide benefit from individual airport capital improvement projects. Under this application, delay propagation data could be used to quantify the ripple effect of delays at an airport and, thus, determine the potential national (multiplier) impact of delay-reducing investments at that airport. This second effort also relies on calculating flight delays and contains similar limitations as the first project. Further, FAA would need to expand the scope of this project from identifying a multiplier effect (e.g., minutes of delays) to one that studies the specific characteristics of New York delays and their ripple effect (e.g., causes, duration, and locations).

Unless FAA Develops Viable Methods To Analyze and Understand Delay Propagation, It Will Continue To Miss Opportunities To Improve Air Traffic Management and Investment Decisions

Using detailed and comprehensive information on flight delay propagation would help FAA identify the location of an initial delay and its effect nationwide. Doing so would also help the Agency discern between delays that originate at an airport and those that are merely the ripple effect of delays originating elsewhere. Moreover, a better understanding of New York's impact on the rest of the Nation would help FAA achieve the following specific benefits:

- **Congestion Relief:** Based on information about initial causes, FAA could more accurately identify and then address underlying problems leading to increased congestion. Moreover, it could identify which air carrier practices (e.g., scheduling and turn-around times) contribute to or reduce congestion and delays at specific airport or on specific routes.

- **Improved Air Traffic Management:** FAA could better understand how certain delays affect flights locally and nationwide, as well as the effect of its air traffic management initiatives such as ground stop and ground delay programs.[28]

- **More Informed Investment Decisions:** Propagation data could improve investment decisions by giving FAA and airports more complete information on the potential benefits from delay reduction and/or capital improvement

[27] The MITRE Corporation, a not-for-profit organization, manages the Center for Advanced Aviation System Development, a federally funded research and development center supporting FAA efforts to address various aviation challenges, such as reducing flight delays and managing air traffic.

[28] A ground stop is a halt of departures at origin airports that are destined to a specific, congested airport. A ground delay program holds flight at their origins and delays the departure times to slow the pace of arrivals at a congested airport.

projects. For example, FAA could better prioritize where to deploy new equipment and procedures (e.g., RNAV)[29] that would assist FAA in managing air traffic and help reduce delays. In other cases, understanding the propagation effect of delays would enable FAA to evaluate whether delay-reducing investments at a particular airport would also have an impact in reducing delays elsewhere in the National Airspace System.

CONCLUSION

The New York region serves as the key domestic and international aviation hub for the United States. In 2007, over 1.2 million flights passed through the 3 main airports, transporting 108 million passengers and 2.6 million tons of cargo. Yet, about 35 percent of flights are delayed each year, which cost New York passengers and air carriers an estimated $2.6 billion in 2008.[30] These costs, however, do not stop just in New York, but ripple throughout the Nation. While delays in the New York area have dropped over the last 2 years, given the region's constrained capacity, they are likely to increase again as the global economy improves and air travel demand returns. For flight caps to have any success in helping prevent delays from again rising to record levels, FAA and key aviation stakeholders will need to reexamine flight caps, basing them on more realistic airport operating conditions and acceptable delay rates. Furthermore, gaining a fuller understanding of delay propagation will aid FAA in its efforts to reduce flight delays and congestion, better manage air traffic, and make better investment decisions.

RECOMMENDATIONS

We recommend that FAA:

1. Reexamine flight caps at Kennedy, LaGuardia, and Newark airports, basing the caps on more realistic airport operating conditions, air carrier scheduling practices, and a goal towards reducing delays to an acceptable rate. In considering an acceptable rate and length of delay, FAA should incorporate the views of air carriers, the airport operator, and passenger groups as well as lessons learned from other slot-controlled airports.

2. Establish a working group of air carriers, academia, and other aviation research organizations to enhance the understanding of delay propagation (e.g., develop viable analytic methodologies, useful database structures, and common terms of reference).

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[29] RNAV (Area Navigation) is a satellite-based aircraft navigation system providing more direct airport routings compared to the conventional, ground-based navigation where aircraft are routed from point to point to the airport.

[30] Source: Grounded - The High Cost of Air Traffic Congestion, February, 2009, Partnership for New York City.

3. Enhance existing flight delay data by obtaining aircraft tail numbers for domestic and international flight operations of U.S. air carriers in order to better study and manage the propagation effect of flight delays.

4. Complete development of a viable methodology for measuring the dynamics of flight delays at New York (as well as other U.S. airports) and their propagation nationwide. This methodology should include the ability to measure both the amount of delay time being propagated and the number of subsequent flights being impacted.

AGENCY COMMENTS AND OFFICE OF INSPECTOR GENERAL RESPONSE

We provided FAA a draft copy of this report on August 25, 2010, for comment and received the Agency's response on September 29, 2010. FAA fully concurred with recommendation 2 and partially concurred with recommendations 1, 3, and 4. Overall, FAA's response meets the intent of recommendation 2 but only partially meets the intent of recommendations 1, 3, and 4. Specifically:

- For recommendation 1, FAA stated it had already incorporated many of our recommendations when it established the initial flight caps for Kennedy and Newark. However, this does not address our main points that those flight caps did little to reduce delays and that FAA established them without an on-time performance target. Therefore, FAA must ensure its current evaluation of New York flights caps (a) includes a goal of limiting arrival delays to a more acceptable rate and length (i.e., below those experienced during the summers of 2007 and 2008) and (b) provides passenger groups with greater opportunities to participate in this process.

- For recommendation 2, FAA proposed to host or participate in a forum, within 1 year, to enhance *the Agency's* delay propagation methodologies. While this is an important first step, our report points out that FAA will also need to provide ongoing leadership in developing and coordinating *stakeholders'* (e.g., airlines and academia) research in this field to develop a better understanding of delay propagation and workable applications for the industry.

- For recommendation 3, FAA stated it would pursue data on aircraft tail numbers for international flight records. However, FAA still needs to explain how it will acquire aircraft tail numbers for those domestic airlines that do not currently report this information to the Bureau of Transportation Statistics.

- For recommendation 4, FAA stated it had developed—and would improve—a methodology for measuring delay propagation. We commend FAA's efforts in

this area and recognize that this type of analysis is an evolving science. However, we note that the methodology cited in FAA's response only measures delay propagation to assess the benefits of future airport capital improvement projects—it does not measure the ripple effects of New York delays and their characteristics (e.g., causes, number, duration, and location). We request that FAA clarify how it intends to develop these data and incorporate them in future improvements to its delay propagation methodology.

ACTIONS REQUIRED

FAA provided acceptable actions and timeframes for recommendation 2, and we consider it resolved but open until the planned actions are completed. We request that FAA provide our office with a response clarifying its planned actions and addressing the issues discussed above for recommendations 1, 3, and 4 within 30 days.

We appreciate the courtesies and cooperation of FAA and industry representatives during this audit. If you have any questions concerning this report, please contact me at (202) 366-1427 or Darren Murphy, Program Director, at (206) 220-6503.

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cc: FAA Deputy Administrator
Chief Operating Officer, Air Traffic Organization
Assistant Administrator for Aviation Policy Planning and Environment
Director, Audit and Evaluation
Anthony Williams, AAE-001
Martin Gertel, M-1

EXHIBIT A. SCOPE AND METHODOLOGY

We conducted this performance audit between June 2009 and August 2010 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

To determine the principal causes of flight delays in the New York region, we analyzed data from FAA's Aviation System Performance Metrics (ASPM)[31] database, Flight Schedule Data System (FSDS),[32] and Operations Network (OPSNET)[33] as well as from the Department's Bureau of Transportation Statistics (BTS).[34] Based on our prior assessments and interviews with agency officials, we have concluded that these databases are reliable for the purposes of this audit. In addition, we reviewed the notices and orders that led to the establishment of flight caps at Newark Liberty and John F. Kennedy International Airports and extended the existing flight caps at LaGuardia. We interviewed officials from FAA's Air Traffic Control Command Center, Office of Performance Analysis and Strategy, and Office of Aviation Policy and Plans. We also interviewed officials from the Port Authority of New York and New Jersey as well as JetBlue Airways and Continental Airlines.

To identify the corresponding effect of New York delays, we reviewed reports, studies, and research papers from American Airlines, MITRE Corporation, EUROCONTROL, George Mason University, University of Maryland, and Massachusetts Institute of Technology. We also analyzed the information included in FAA's Delay Propagation database that is currently under development to determine if any data deficiencies existed. Finally, we interviewed officials from MITRE Corporation, EUROCONTROL, National Air Traffic Services for the United Kingdom, BTS, and FAA's Office of Policy and Plans and Air Traffic Organization.

[31] ASPM is an FAA database of air traffic control performance measures that includes flight delays, cancellations, scheduled flights, operations, taxi times, and causes for delays.

[32] FSDS is an FAA database of published air carrier flight schedules.

[33] OPSNET is an FAA database of air traffic control movement operations for all towers, centers, and approach control facilities.

[34] BTS data include information about air carrier on-time performance, flight delays, and cancellations. They are based on data filed each month by the 19 reporting air carriers with the BTS Office of Airline Information as described in 14 CFR Part 234 of DOT's regulations.

EXHIBIT B. OIG REPORTS AND TESTIMONIES ADDRESSING NEW YORK FLIGHT DELAYS

- Air Carrier Flight Delays and Cancellations, Report Number CR-2000-112, July 25, 2000.
- Airline Industry Metrics – *Trends on Demand and Capacity, Aviation System Performance, Airline Finances, and Service to Small Airports*, Correspondence Number CC-2004-006, January 8, 2004.
- Short- and Long-Term Efforts To Mitigate Flight Delays and Congestion, Report Number CR-2004-066, June 17, 2004.
- Airspace Redesign Efforts Are Critical To Enhance Capacity but Need Major Improvements, Report Number AV-2005-059, May 13, 2005.
- Aviation Industry Performance – *Trends in Demand and Capacity, Aviation System Performance, Airline Finances, and Service to Small Airports*, Correspondence Number CC-2005-057, June 30, 2005.
- Aviation Industry Performance – *A Review of Summer 2007 Aviation System Performance*, Correspondence Number CC-2008-039, December 27, 2007.
- Status Report on Actions Underway To Address Flight Delays and Improve Airline Customer Service, Testimony Number CC-2008-058, April 9, 2008.
- Observations on Short-Term Capacity Initiatives, Report Number AV-2008-087, September 26, 2008.
- Aviation Industry Performance – *A Review of the Aviation Industry in 2008*, Correspondence Number CC-2009-039, May 6, 2009.
- Progress and Remaining Challenges in Reducing Flight Delays and Improving Airline Customer Service, Testimony Number CC-2009-067, May 20, 2009.
- Status of the Aviation Rulemaking Committee's 77 Initiatives for Reducing Delays in the New York Area, Report Number AV-2010-003, October 21, 2009.

OIG reports and testimonies are available on our website: www.oig.dot.gov

EXHIBIT C. MAJOR CONTRIBUTORS TO THIS REPORT

Name	Title
Darren Murphy	Program Director
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APPENDIX. AGENCY COMMENTS

Federal Aviation Administration

Memorandum

Date: September 29, 2010

To: Matthew E. Hampton, Deputy Assistant Inspector General for Aviation and Special Program Audits

From: Clay Foushee, Director, Audit and Evaluation

Prepared by: Anthony Williams, x79000

Subject: OIG Draft Report: New York Flight Delays Have Three Main Causes, But More Work Is Needed To Understand Their Nationwide Effect

Both the Department of Transportation (DOT) and Federal Aviation Administration (FAA) continue to work hard to alleviate aviation congestion and delays. Since Fiscal Year (FY) 2000, 22 airfield projects have opened at 19 of the 35 Operational Evolution Plan (OEP) airports. These include 16 new runways, 3 taxiways, 1 runway extension, 1 airfield reconfiguration completed, and 1 airfield reconfiguration two-thirds completed. These projects enable the potential to accommodate more than 2 million annual operations and decrease average delay per operation at these airports by about 5 minutes. Eight other projects (3 airfield reconfigurations, 2 runway extensions, 3 new runways) are in the planning or environmental stage at OEP airports through 2018.

The Next Generation Air Transportation System (NextGen) also is also intended in part, to help communities make better use of their airports by making air travel more predictable, reducing delays and greater flexibility to get around weather problems. The implementation of NextGen technologies is complex and requires investments by both FAA and the industry, who will need to install NextGen avionics in cockpits. By 2018, many NextGen technologies are planned to be operational in various regions of the country and users will begin realizing the benefits of those upgrades.

The economic downturn has resulted in lower passenger demand with a corresponding decline in overall operations and delays. However, in certain congested areas such as New York, travelers may still experience delays. FAA is working aggressively to implement operational and structural improvements so we are prepared to handle the inevitable uptick in traffic in the future.
For example, FAA is continuing work in the New York area to implement precision procedures such as area navigation and required navigation performance (otherwise known as RNAV/RNP),

airspace redesign and the creation of optimal descent procedures - all of which will result in more efficient operations and yield environmental benefits. FAA is also continuing to implement airspace redesign, which will improve the efficiency and reliability of the air traffic operations in the New York, New Jersey and Philadelphia region. The next phase is expected to come on-line late next spring and will focus on New York West departures.

FAA also maintains schedule limits on operations at LaGuardia (LGA), John F. Kennedy (JFK) and Newark airports, and currently has a work group that is reevaluating the current scheduling orders to ensure they effectively limit delays, while also allowing for maximum passenger throughput. FAA has also worked with the air carriers and the Port Authority of New York and New Jersey (Port Authority) to ensure that operations at JFK run as smooth as possible while the airfield and Bay runway are under construction. Specifically, FAA reached agreements with the carriers serving JFK to maintain their winter schedules throughout the four-month runway closure (March-June 2010), which has helped tremendously with the operation of the airport during this construction period.

Recommendations and Responses

OIG Recommendation 1: Reexamine flight caps at Kennedy, LaGuardia, and Newark airports, basing the caps on more realistic airport operating conditions, air carrier scheduling practices, and a goal towards reducing delays to an acceptable rate and length of delay, FAA should incorporate the views of air carriers, the airport operator, and passenger groups as well as lessons learned from other slot-controlled airports.

FAA Response: Partially Concur. Kennedy, LaGuardia and Newark airports are currently operating under short-term orders, which expire in October 2011. As part of our ongoing efforts to address congestion at these airports, FAA currently has an internal workgroup that is evaluating the orders at the three New York airports and any proposed changes would be subject to notice and comment. In particular, the workgroup is evaluating model results, current scheduling practices and re-evaluating policy goals related to acceptable level of delay. We anticipate that any potentially recommended changes to the existing schedule limits would be published for notice and comment by December 2011. The reason for partial concurrence is because FAA already completed many of the Office of Inspector General's recommendations when it established the target operational limits for Kennedy and Newark in 2007/2008. Specifically, the recommendation does not recognize that FAA did use actual airport operating conditions and worked with MITRE Corporation to model capacity at these airports using every hour, of every weekday, over many months at the two airports. FAA modeled the impact of various airline schedules and airport scheduling limits, incorporating variations to the airport capacity due to weather, runway configurations and other operational factors.

In arriving at these flight limits, FAA incorporated the views of air carriers and the airport operator. Notice and comment periods have also been provided on the FAA scheduling orders for the three airports. Establishing scheduling targets requires careful consideration of benefits, costs and tradeoffs. As our stakeholders frequently point out higher limits provide more opportunities for market access but result in more delay and lower on-time performance. Low scheduling targets will improve performance and reduce delays but results in unused capacity and limits access to the airport.

Appendix. Agency Comments

OIG Recommendation 2: Establish a working group of air carriers, academia, and other aviation research organizations to enhance the understanding of delay propagation (e.g., develop viable analytic methodologies, useful database structures, and common terms of reference).

FAA Response: Concur. FAA will continue to work with air carriers, academia, and other aviation research organizations to increase the usefulness of its existing delay propagation models. Given the complexities associated with modeling delay propagation, FAA recognizes that this research is a multi-year effort which will require on-going interaction with industry, academia, and other stakeholders so as to continually improve modeling capabilities in this area. FAA is exploring different avenues to engage stakeholders on this issue. Within one year of this recommendation, FAA will either host or participate in a forum which will focus on enhancing its delay propagation modeling capabilities.

OIG Recommendation 3: Enhance existing flight delay data by obtaining aircraft tail numbers for domestic and international flight operations of U.S. air carriers in order to better study and manage the propagation effect of flight delays.

FAA Response: Partially Concur. From an analytical standpoint, FAA agrees it would be desirable to expand our delay propagation modeling capability, which currently focuses on domestic operations by tail number, to include international flight operations of U.S. air carriers. FAA will work with Bureau of Transportation Statistics (BTS) to determine the feasibility of obtaining the pertinent international flight information for U.S. air carries and whether rulemaking would be required. FAA, working with BTS, will make this determination within one year of this recommendation. If data becomes available, FAA will seek funding to incorporate this information into its delay propagation models. Within one year of receiving necessary funding, we will have incorporated the international flight data into the delay propagation models and will have determined the impact on the published delay propagation multipliers.

OIG Recommendation 4: Complete development of a viable methodology for measuring the dynamics of flight delays at New York (as well as other U.S. airports) and their propagation nationwide. This methodology should include the ability to measure both the amount of delay time being propagated and the number of subsequent flights being impacted.

FAA Response: Partially Concur. FAA has developed a state of the art methodology to measure delay propagation on an airport, regional, and nationwide basis. As previously discussed, the science of modeling this complex phenomenon continues to evolve and FAA continues it work in this area. The report, and these recommendations could better recognize the efforts FAA has pursued in this regard, and the progress achieved. As written it lends the reader to believe that FAA has not progressed in this area. FAA considers flight delay propagation modeling an evolving science, and will pursue improvements continuously.

Flight Delays in the New York Region and Corresponding Effects Nationwide
Section 508 Compliant Presentation

The following pages contains a textual version of Figure 4 of found in this document. These pages were not in the original document but have been added here to accommodate assistive technology.

Figure 4. Comparison of Flight Schedules with Various Capacity Measures at Kennedy (June 18, 2008)

Time Period	Capacity Under Instrument Flight Conditions	Capacity Under Visual Flight Conditions	FAA Target For Caps	FAA Level of Approved Operations
6:00am	16.75	21.75	20	19
6:15am	16.75	21.75	20	5
6:30am	16.75	21.75	20	16
6:45am	16.75	21.75	20	15
7:00am	16.75	21.75	20	24
7:15am	16.75	21.75	20	18
7:30am	16.75	21.75	20	17
7:45am	16.75	21.75	20	26
8:00am	16.75	21.75	20	22
8:15am	16.75	21.75	20	22
8:30am	16.75	21.75	20	22
8:45am	16.75	21.75	20	13
9:00am	16.75	21.75	20	39
9:15am	16.75	21.75	20	13
9:30am	16.75	21.75	20	20
9:45am	16.75	21.75	20	17
10:00am	16.75	21.75	20	12
10:15am	16.75	21.75	20	8
10:30am	16.75	21.75	20	10
10:45am	16.75	21.75	20	13
11:00am	16.75	21.75	20	15
11:15am	16.75	21.75	20	14
11:30am	16.75	21.75	20	12
11:45am	16.75	21.75	20	16
12:00pm	16.75	21.75	20	18
12:15am	16.75	21.75	20	10
12:30am	16.75	21.75	20	14
12:45am	16.75	21.75	20	26

1:00pm	**16.75**	**21.75**	**20**	**13**
1:15pm	**16.75**	**21.75**	**20**	**16**
1:30pm	**16.75**	**21.75**	**20**	**17**
1:45pm	**16.75**	**21.75**	**20**	**29**
2:00pm	**16.75**	**21.75**	**20**	**11**
2:15pm	**16.75**	**21.75**	**20**	**15**
2:30pm	**16.75**	**21.75**	**20**	**14**
2:45pm	**16.75**	**21.75**	**20**	**42**
3:00pm	**16.75**	**21.75**	**20**	**8**
3:15pm	**16.75**	**21.75**	**20**	**21**
3:30pm	**16.75**	**21.75**	**20**	**16**
3:45pm	**16.75**	**21.75**	**20**	**33**
4:00pm	**16.75**	**21.75**	**20**	**18**
4:15pm	**16.75**	**21.75**	**20**	**22**
4:30pm	**16.75**	**21.75**	**20**	**21**
4:45pm	**16.75**	**21.75**	**20**	**20**
5:00pm	**16.75**	**21.75**	**20**	**21**
5:15pm	**16.75**	**21.75**	**20**	**19**
5:30pm	**16.75**	**21.75**	**20**	**21**
5:45pm	**16.75**	**21.75**	**20**	**24**
6:00pm	**16.75**	**21.75**	**20**	**22**
6:15pm	**16.75**	**21.75**	**20**	**12**
6:30pm	**16.75**	**21.75**	**20**	**21**
6:45pm	**16.75**	**21.75**	**20**	**26**
7:00pm	**16.75**	**21.75**	**20**	**34**
7:15pm	**16.75**	**21.75**	**20**	**15**
7:30pm	**16.75**	**21.75**	**20**	**23**
7:45pm	**16.75**	**21.75**	**20**	**16**
8:00pm	**16.75**	**21.75**	**20**	**28**
8:15pm	**16.75**	**21.75**	**20**	**8**
8:30pm	**16.75**	**21.75**	**20**	**21**
8:45pm	**16.75**	**21.75**	**20**	**25**
9:00pm	**16.75**	**21.75**	**20**	**31**
9:15pm	**16.75**	**21.75**	**20**	**21**
9:30pm	**16.75**	**21.75**	**20**	**21**
9:45pm	**16.75**	**21.75**	**20**	**16**
10:00pm	**16.75**	**21.75**	**20**	**36**
10:15pm	**16.75**	**21.75**	**20**	**18**
10:30pm	**16.75**	**21.75**	**20**	**17**
10:45pm	**16.75**	**21.75**	**20**	**15**

Source: OIG Analysis of FAA Data