NextGen Avionics Incentive Program

Qualified Equipage

Background

The avionics equipage incentive program aims to equip aircraft with "communications, surveillance, navigation, and other avionics equipment as determined by the Secretary to be in the interest of achieving NextGen capabilities for such aircraft."

The FAA recognizes that there are a variety of aircraft architectures, and that different equipment can be installed to achieve a given capability. Older aircraft have a federated architecture where several different boxes may need to be upgraded or replaced, while newer aircraft tend to have integrated architectures which may involve a software upgrade or the potential installation of a computer card. The FAA is structuring the qualifying equipage under Section 221 of the FAA Modernization and Reform Act of 2012, based on the enabling equipment to achieve a NextGen capability, and does not intend to distinguish between avionics architectures. The installed equipment is an *enabler* of a NextGen capability, recognizing that the capability may also be dependent on flight crew training, ground or satellite system deployment and FAA site-specific implementation.

The basis for identifying qualified avionics enablers for the equipage incentive program is the FAA NextGen Implementation Plan (NGIP). In the NGIP, the FAA provides an annual update of the aircraft capabilities that are part of NextGen, and relates them to the operational initiatives that yield benefits to the operator, the FAA and the public. Additional information concerning the NextGen enablers can be found in Appendix A of the NGIP, or in *NextGen Operator and Airport Enablers*, a supplement to the NGIP that is available at www.faa.gov/nextgen.

Only enablers that are mature can be considered for near-term deployment. The FAA envisions that the qualifying enablers may change over the duration of the avionics incentive program, to include newly available enablers once they become mature.

Bundling Enablers

A major factor affecting the benefits of NextGen is the mixed equipage of the aircraft. Aircraft that possess a capability must be operationally integrated with aircraft that do not in a way that frequently diminishes the benefits to the equipped aircraft. For some capabilities, such as Required Navigation Performance (RNP), a high percentage of operators in the region must be capable for the operational implementation to be viable. Recognizing the importance of a core, common set of NextGen capabilities, the FAA is proposing that a minimum bundle of capabilities will be needed to qualify for the avionics incentive program.

In defining the bundles, we propose the minimum set of enablers that would be required for all aircraft to maximize benefits. We also recognize that there are different needs for

different operators. We are developing one minimum bundle of capabilities that is focused on operators, including the air carriers, flying in and out of our busiest metroplexes. A second minimum bundle is oriented toward operators that fly elsewhere, so that general aviation would not be expected to install capabilities that they may not need. We would give operators flexibility in defining their needs by not restricting these bundles to operator types under the program. For example, general aviation operators who decide they need the metroplex capabilities could participate through the metroplex bundle. The FAA may revise these bundles during the incentive program, with adequate notice to potential new program participants.

The FAA also proposes to include optional enablers in the NextGen avionics incentive program. Operators may equip their aircraft with these optional enablers, provided they either have the minimum bundle or equip to achieve it.

Any equipment required for the operator to implement the first or second bundle of enablers would qualify under the incentive program. If the operator already has the required bundle, they would still qualify for equipment needed to implement one of the optional capabilities.

A description of the bundles, options and their rationale is provided below.

Metroplex Bundle

The metroplex bundle has been selected from the list of mature NextGen avionics enablers. It includes those that provide the greatest positive impact on metroplex operations, and that require high levels of equipage to achieve the operational benefits. The specific enablers are:

RNAV 1, RNAV 2 *AC 20-138B,* ***Airworthiness Approval of Positioning and Navigation Systems****;* *AC 90-100A,* ***U.S. Terminal and En Route Area Navigation (RNAV) Operations***	Through applications of RNAV, the FAA publishes new Q-routes, T-routes, arrival procedures and departure procedures. Also, RNAV is the foundation for metroplex airspace redesign. As of December 2011, the FAA had published 408 RNAV Standard Instrument Departures (SID) and Standard Terminal Arrival Routes (STAR), in addition to 51 RNAV routes. A current inventory summary of RNAV procedures may be found at this url: http://www.faa.gov/air_traffic/flight_info/aeronav/ifpinventorysummary/ *Operational Improvements: Time-based Metering using RNAV and RNP Route Assignments (104123), Increase Capacity and Efficiency using RNAV and RNP (108209), Use Optimized Profile Descent (104124), RNAV SIDs, STARs, and Approaches (107103), Integrated Arrival/Departure Airspace Management (104122), Environmentally and Energy Favorable En Route and Terminal Operations (109311, 109313)*
RNP 1 with curved	This enabler builds on RNAV, increasing the consistency of the aircraft

path *AC 90-105,* ***Approval Guidance for RNP Operations and Barometric Vertical Navigation in the U.S. National Airspace System***	performance and adding the ability to fly precise curved paths (RF legs). RF leg application is an option for SIDs, STARs, RNP approach (APCH) operations and RNP AR APCH operations. However, only RNP AR APCH operations can apply an RF leg segment in the final approach segment. These capabilities can help deconflict arrivals and departures in metroplexes and provide more efficient routing. Potential applications of curved paths exist today at many of our metropolitan areas, including three of our busiest, Chicago (O'Hare and Midway), New York (John F. Kennedy, LaGuardia and Newark) and Dallas/Fort Worth (Dallas/Fort Worth and Love Field). In each case, both commercial carriers and GA operators could benefit. Greater benefits accrue when a large majority of the aircraft in the airspace is capable of curved path operations. *Operational Improvements: RNAV SIDs, STARs, and Approaches (107103), Use Optimized Profile Descents, (104124), Increase Capacity and Efficiency Using RNAV and RNP (108209), Integrated Arrival/Departure Airspace Management (104122)*
VNAV *AC 90-105,* ***Approval Guidance for RNP Operations and Barometric Vertical Navigation in the U.S. National Airspace System****;* *AC 20-138B,* ***Airworthiness Approval of Positioning and Navigation Systems***	Many aircraft are able to use barometric altitude, through a flight management system (FMS), to obtain vertical guidance and fly a defined vertical path. This aircraft capability is called baro-VNAV, and its application gains operational benefit during the final approach segment (FAS) of RNP APCH and RNP AR APCH procedures where suitably equipped and approved operators can use lower approach minimums. Likewise, aircraft with a satellite-based augmentation system (SBAS) of their GNSS, like the FAA's Wide Area Augmentation System (WAAS), qualify for the same operational benefit. Outside the FAS, even more aircraft employ advisory vertical guidance, which helps the pilot maintain an optimum descent profile while complying with an ATC clearance. By accounting for vertical guidance capabilities in the design of arrival and departure procedures, airspace planners can deconflict traffic flows efficiently. We will deploy vertical guidance at major airports as an important component of integrated arrival and departure management. *Operational Improvement: Use Optimized Profile Descents (104124)*
RNP AR Approach *AC 20-138B,* ***Airworthiness Approval of Positioning and Navigation Systems****;* *AC 90-101A,* ***Approval Guidance for RNP Procedures with Authorization Required***	Today, the FAA publishes these unique instrument approach procedures as RNAV (RNP) approaches. The ICAO nomenclature calls them RNP AR APCH. This is the most demanding type of PBN operation, using very precise lateral paths (down to 0.1 nm accuracy), and it can rely on the application of RF Leg segments in the final approach segment. As of 2011, the FAA had published and was maintaining nearly 300 RNP approach procedures. These procedures provide numerous benefits, including safety enhancements at runways in mountainous areas where no other procedure is possible (often offering a straight-in approach in lieu of a circling approach), improved access in reduced visibility due to lower landing minimums, and a sophisticated tool for deconflicting traffic flows by using previously unavailable paths.

	A complete listing of all RNAV (GPS) and RNAV (RNP) approaches may be found at the following url: http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/gnss/approaches/ The minimum qualification under the avionics incentive program for the metroplex bundle would be an RNP 0.3 AR approach, with RF leg capability. RNP values below 0.3 NM are optional, as is the capability for missed approaches with RNP < 1 NM. *Operational Improvement: RNAV SIDs, STARs and Approaches (107103)*
ADS-B Out *AC 20-165,* ***Airworthiness Approval of ADS-B Out Systems****;* *TSO-C154c,* ***Universal Access Transceiver (UAT) ADS-B Equipment Operating on Frequency of 978 MHz****;* *TSO-C166b,* ***Extended Squitter ADS-B and Traffic Information Services-Broadcast (TIS-B)****;* *TSO-C145c,* ***Airborne Navigation Sensors Using the Global Positioning System Augmented by the Satellite Based Augmentation System;*** *TSO-C146c,* ***Stand-Alone Airborne Navigation Equipment Using The Global Positioning System Augmented by the Satellite Based Augmentation System****;* *TSO-C196a,* ***Airborne Supplemental Navigation Sensors for Global Positioning System Equipment using Aircraft-Based Augmentation***	ADS-B Out is mandated by rule as of January 1, 2020, for aircraft operating in most airspace classes within the NAS. To comply with the mandate, aircraft operating above Flight Level 180 (18,000 feet above mean sea level) must equip with a Mode S, 1090 Extended Squitter (1090 ES) solution. For aircraft operating below FL180 either 1090 ES or the Universal Access Transceiver (UAT) can satisfy the mandate. The mandate is part of the ADS-B final rule, issued in 2010, to require aircraft to meet ADS-B Out airspace performance requirements. Additionally, the FAA is developing guidance for ADS-B Out equipage for airport-owned ground vehicles operating in the movement area. Expanding radar-like ADS-B surveillance to non-radar airports that are constrained by "one in, one out" operations is expected to improve capacity and safety. In response to a 2009 RTCA NextGen Mid-Term Implementation Task Force recommendation, the FAA is considering state and local cost-sharing initiatives. In addition, the FAA is looking into how to get more coverage out of already planned ADS-B locations, and the potential to deploy additional ADS-B stations in non-radar areas. This enabler is included in the metroplex bundle to promote early compliance to the rule. A WAAS or TSO-C196 GPS receiver is required to participate in the avionics incentive program. TSO-C129 GPS receivers are not eligible for participation. Operators are encouraged to provision their aircraft for ADS-B In, as interval management capability is planned to become part of the metroplex bundle once the standards are complete. *Operational Improvements: Airworthiness operational improvements are under development for ADS-B Separation (102123), Oceanic In-Trail Procedures (102108)*

General Bundle

This bundle targets the minimum NextGen capabilities outside of metroplex areas. It has been selected from the list of mature NextGen avionics enablers, It includes those that provide the greatest positive impact on NAS operations outside metroplexes, and which require high levels of equipage to achieve the operational benefits. The specific enablers are:

RNAV 1, RNAV 2 *AC 20-138B,* ***Airworthiness Approval of Positioning and Navigation Systems****;* *AC 90-100A,* ***U.S. Terminal and En Route Area Navigation (RNAV) Operations***	Through applications of RNAV, the FAA publishes new Q-routes, T-routes, arrival procedures and departure procedures. Also, RNAV is the foundation for metroplex airspace redesign. As of December 2011, the FAA had published 408 RNAV Standard Instrument Departures (SID) and Standard Terminal Arrival Routes (STAR), in addition to 51 RNAV routes. A current inventory summary of RNAV procedures may be found at this url: http://www.faa.gov/air_traffic/flight_info/aeronav/ifpinventorysummary/ *Operational Improvements: Time-based Metering using RNAV and RNP Route Assignments (104123), Increase Capacity and Efficiency using RNAV and RNP (108209), Use Optimized Profile Descent (104124), RNAV SIDs, STARs, and Approaches (107103), Integrated Arrival/Departure Airspace Management (104122), Environmentally and Energy Favorable En Route and Terminal Operations (109311, 109313)*
Localizer Performance with Vertical Guidance (LPV) *AC 20-138B,* ***Airworthiness Approval of Positioning and Navigation Systems****;* *AC 90-107,* ***Guidance for Localizer Performance with Vertical Guidance and Localizer Performance without Vertical Guidance Approach Operations in the U.S. National Airspace System***	An RNAV (GPS) instrument approach offering LPV minimums uses SBAS (WAAS) to provide an instrument approach equivalent to an instrument landing system (ILS). The FAA can, however, publish this approach to airports without incurring the need for an ILS radio-navigation infrastructure and the associated maintenance costs. Likewise, the RNAV (GPS) approach does not present the same challenges an ILS has in sighting the localizer and glideslope antennas. This allows for the publishing of procedures at many locations where an ILS installation is not possible. As a result, today the FAA offers RNAV (GPS) approach procedures with LPV minimums at more than 1,400 airports nationwide. At many of these airports, these instrument approach procedures are the only support for operations in weather conditions requiring flight under instrument flight rules (IFR). As of 2011, RNAV (GPS) approaches with LPV minimums have been published for more than 32 Part 139 and 569 non-Part airports that do not offer ILS approach. Publishing an RNAV (GPS) approach with LPV minimums requires a precision geospatial survey of the airport, but it does not require any ground-based radionavigation equipment at the airport. To achieve the lowest minimums, obstacle clearance requirements must be met and the airport ground infrastructure (e.g., airport lighting, runway markings

	and taxiway placement) must support the lowest minimums. Otherwise, an RNAV (GPS) approach to LPV minimums may be published with higher minimums. Effectively, RNAV (GPS) approaches with LPV minimums enhance IFR approach capabilities through the application of precision vertical guidance offering access to airports ineligible for a traditional ILS installation. RNAV (GPS) approaches with LPV minimums also serve runways with an ILS offering an alternate approach with precision vertical guidance. The FAA plans to publish RNAV (GPS) approaches with LPV minimums for all qualified runway ends in the National Airspace System (NAS) by 2016. *Operational Improvement: RNAV SIDs, STARs and Approaches (107103)*
ADS-B Out *AC 20-165,* ***Airworthiness Approval of ADS-B Out Systems****; TSO-C154c,* ***Universal Access Transceiver (UAT) ADS-B Equipment Operating on Frequency of 978 MHz****; TSO-C166b,* ***Extended Squitter ADS-B and Traffic Information Services-Broadcast (TIS-B)****; TSO-C145c,* ***Airborne Navigation Sensors Using the Global Positioning System Augmented by the Satellite Based Augmentation System;*** *TSO-C146c,* ***Stand-Alone Airborne Navigation Equipment Using The Global Positioning System Augmented by the Satellite Based Augmentation System****; TSO-C196a,* ***Airborne Supplemental Navigation Sensors for Global Positioning System Equipment using Aircraft-Based Augmentation***	ADS-B Out is mandated by rule as of January 1, 2020, for aircraft operating in most airspace classes within the NAS. To comply with the mandate, aircraft operating above Flight Level 180 (18,000 feet above mean sea level) must equip with a Mode S, 1090 Extended Squitter (1090 ES) solution. For aircraft operating below FL180 either 1090 ES or the Universal Access Transceiver (UAT) can satisfy the mandate. The mandate is part of the ADS-B final rule, issued in 2010, to require aircraft to meet ADS-B Out airspace performance requirements. Additionally, the FAA is developing guidance for ADS-B Out equipage for airport-owned ground vehicles operating in the movement area. Expanding radar-like ADS-B surveillance to non-radar airports that are constrained by "one in, one out" operations is expected to improve capacity and safety. In response to a 2009 RTCA NextGen Mid-Term Implementation Task Force recommendation, the FAA is considering state and local cost-sharing initiatives. In addition, the FAA is looking into how to get more coverage out of already planned ADS-B locations, and the potential to deploy additional ADS-B stations in non-radar areas. This enabler is included in the general bundle to promote early compliance with the rule. A WAAS or TSO-C196 GPS receiver is required to participate in the avionics incentive program. TSO-C129 GPS receivers are not eligible for participation. *Operational Improvements: Airworthiness operational improvements are under development for ADS-B Separation (102123), Oceanic In-Trail Procedures (102108)*

Optional capabilities

Any operator participating in the avionics incentive program, who either has the minimum bundle or equips under the program to achieve the minimum bundle, may also elect to equip for additional NextGen enablers under the program.

Operators who fulfill the general bundle may elect to equip for any of the additional enablers listed in the metroplex bundle (RNP 1 with curved path, VNAV, RNP AR Approach). Operators who fulfill the bundle for metroplex may also elect to equip for the general bundle (LPV).

Additional options under the NextGen avionics incentive program are:

Cockpit Display of Traffic Information (CDTI) *TSO-C195a,* ***Avionics Supporting ADS-B Aircraft Surveillance Applications;*** *AC 20-172A,* ***Airworthiness Approval for ADS-B In Systems and Applications***	This ADS-B In enabler provides a graphic display of the relative position of aircraft and ADS-B equipped surface vehicles, mainly on a moving map display. The information that is presented is then used by the pilot to increase situational awareness or to take operational advantage for other defined ADS-B operations. *Operational Improvements: Improved Runway Safety Situational Awareness for Pilots (103208), Provide Full Surface Situation Information (102406), Improved Runway Safety Situational Awareness for Pilots (103208), and Cockpit Display of Traffic Information (CDTI)/Traffic Service-Broadcast (TIS-B) for Surface (103208-12)*
FANS-1/A+ over VDL mode 2 *AC 20-140C,* ***Guidelines for Design Approval of Aircraft Data Communications*** *Systems;* *AC 120-70B,* ***Operational Authorization Process for Use of Data Link Communication System****;* *TSO-160a,* ***VDL Mode 2 Communication Equipment***	Air Traffic Control Data Communications (Data Comm) allows a two-way exchange of digital information between air navigation service providers and the flight crew. This capability has been used in oceanic airspace and will be implemented in the NAS. Data Comm allows some communications to move off the voice channel and provides a record that can be verified, reducing communication errors. It also allows increased air traffic efficiency by reducing the time spent on routine tasks, such as transfer of communications. When it is integrated with the navigation system in the aircraft, Data Comm can enable new and more complex information to be exchanged automatically, such as more specific or frequent position reporting in oceanic airspace or clearances containing multiple fixes/waypoints. This enabler builds on the pre-existing FANS-1/A capabilities, adapting them for domestic operations. Messages are sent over a line-of-sight VHF network (using VDL-2). Equipped aircraft can receive departure clearances and airborne clearances. *Operational Improvements: Enhanced Surface Traffic Operations (104207), Use Optimized Profile Descents (104124), Revised Departure Clearance via*

	Data Comm (104207-11)
Airborne Access to SWIM *AC 20-177,* ***Design and Installation Guidance for an Airborne System for Non-Required Telecommunication Service in Non-Aeronautical Frequency Bands***	Airborne access to System Wide Information Management (SWIM) enables aircraft systems to access the FAA SWIM system to support collaborative decision-making and ensure a common understanding of status of airspace, systems, and weather. Airborne access to SWIM is not specifically listed as an enabler in the 2012 NGIP but will be included in the 2013 Plan. The airborne access may be to an installed system or to an Electronic Flight Bag (EFB). To qualify under the NextGen avionics incentive program, the airborne access to SWIM must be used to support collaborative decision-making. For additional information on EFBs and their capabilities, see AC 120-76B, Guidelines for the Certification, Airworthiness, and Operational Use of Electronic Flight Bags.
HUD/ILS *AC 120-29A,* ***Criteria for Approval of Category I and Category II Weather Minima for Approach****;* *AC 120-28D,* ***Criteria for Approval of Category III Weather Minima for Takeoff, Landing and Roll Out****; Order 8400.13D,* ***Procedures for the Evaluation and Approval of Facilities for Special Authorization Category I Operations and all Category II and III Operations***	A head-up display provides critical flight and navigation data on a transparent screen directly in front of the pilot, allowing simultaneous viewing of primary flight display information, navigation information and the extended scene. When a HUD is integrated with a suitably qualified precision approach system, the FAA has approved operations to 100 feet above the runway before the flight crew acquires the runway environment with natural vision. The use of a suitable HUD when flying to an ILS facility will reduce the required runway visual range (RVR) visibility for the approach and will increase access compared with non-equipped aircraft. The accuracy of these ILS facilities has been verified for this type of operation. In addition, the airport must have the equipment to measure and report the current RVR visibility. The FAA is increasing the number of airports with RVR to expand this capability. *Operational Improvement: Expanded Low-Visibility Operations Using Lower RVR Minima (107119)*
EFVS *AC 20-167,* ***Airworthiness Approval of Enhanced Vision System, Synthetic Vision System, Combined Vision System, and Enhanced Flight Vision System Equipment****;* *AC 90-106,* ***Enhanced Flight Vision Systems***	When a HUD is integrated with suitably qualified precision approach systems, the FAA has approved operations to lower ceilings and visibility minimums before the flight crew acquires the runway environment visually, compared with operations without HUD equipment. With enhanced flight vision, access is allowed that otherwise would be denied due to low-visibility conditions. Existing rules allow approaches to straight-in landing operations below decision height, or minimum descent altitude, using EFVS. The FAA has approved operations to 100 feet above the runway before the flight crew acquires the runway environment with natural vision. EFVS is being evaluated for further capabilities, including potential operational credit for landing in low-visibility conditions.

	Operational Improvements: Improved Safety Situational Awareness for Pilots (103208), Low Visibility/Ceiling Approach Operations (107117), Low Visibility/Ceiling Landing Operations (107118), Low Visibility/Ceiling Take-Off Operations (107115)