



SIGNIFICANT CHANGES
COME TO ETOPS WITH THIS
NEW RULE, WHICH
ESTABLISHES OPERATOR AND
AIRPLANE REQUIREMENTS
FOR EXTENDED OPERATIONS.

The New FAA ETOPS Rule

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On January 16, 2007, the U.S. Federal Aviation Administration (FAA) published comprehensive new regulations governing extended operations (ETOPS), which are flight operations on routes that at some point take an airplane far from an airport. This regulatory updating codifies current FAA policy, industry best practices and recommendations, and international standards designed to ensure that long-range flights will continue to operate safely.

The new U.S. ETOPS rule builds further on the success of ETOPS, which is the state-of-the-art in intercontinental air travel. More than 5.5 million ETOPS twinjet flights have been logged worldwide since 1985, and every day some 143 operators perform 1,750 more. These operations set the highest standard for safe, reliable long-range flying.

Significant changes come to ETOPS with this new rule, which updates the requirements for two-engine extended operations and provides a framework under which air carrier operators may safely fly approved twinjets beyond 180 minutes of an airport. As before, ETOPS applies when the twinjet flies beyond 60 minutes of an adequate airport.

For the first time, this new rule also applies ETOPS enhancements and protections to the extended operation of three- and four-engine passenger airplanes. For these "tris and quads," ETOPS applies when the airplane flies beyond 180 minutes of an adequate airport. To ease the

transition to the new rule for all current operators, delayed compliance dates are specified for many of this rule's requirements.

In this regulatory updating, the FAA has recognized the outstanding propulsion reliability and overall safety of long-range twinjets. The new ETOPS rule creates the opportunity for carriers to fly properly configured and approved twinjets on optimal flight routings between virtually any two points on earth.

This article:

- Briefly reviews the collaborative global evolution of the new U.S. ETOPS rule.
- Examines this rule's specific regulatory modifications and additions to show what has changed relative to the previous "twinjet-only ETOPS," with which the industry is so familiar.

Although the new ETOPS rule embraces airplane design, maintenance, and operation, this article focuses primarily on the rule's operational

impacts. Moreover, the discussion is confined to flights conducted under U.S. Code of Federal Regulations 14 CFR Part 121 (scheduled air carrier operations), even though the new rule for the first time also applies ETOPS to flights conducted under 14 CFR Part 135 (commuter and on-demand operations).

EVOLUTION OF THE NEW RULE

Jetliner range capabilities have grown dramatically over the decades. This trend has allowed flight operations to increasingly traverse remote areas of the world where the airplane is at times far from an airport. By the latter 1990s, the global aviation community recognized that the operational protections and reliability enhancements of ETOPS, which then applied just to twinjets, could also further enhance the safety and reliability of three- and

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four-engine airplanes when flying routes with the potential for an extended-duration diversion.

All airplanes flying extended routes contend with similar operating challenges in terms of weather, terrain, and limitations in navigation and communications infrastructure. Thus, the dual ETOPS philosophy of precluding diversions and also protecting them if they do occur is applicable to all extended operations, not just those performed with two-engine airplanes.

Pursuing this higher and more uniform standard, the FAA in June of 2000 created an Aviation Rulemaking Advisory Committee (ARAC) to review the ETOPS record and recommend how ETOPS requirements should be updated, standardized, and codified. Because the ETOPS program was then being administered via FAA advisory circulars, policy letters, and special conditions, this rulemaking would at last formalize extended operations directly in the federal aviation regulations as befits such large-scale operations.

The ARAC is a U.S. framework that relies on international participation. Its ETOPS Working Group gathered together 50 experts drawn from across the global aviation community. After two-and-a-half years of intensive effort, this ARAC delivered its findings and recommendations to the FAA on December 16, 2002. As the FAA noted, its report reflected an extraordinary degree of consensus about needed updates and improvements.

The FAA published a notice of proposed rulemaking (NPRM) on November 14, 2003, that was largely unchanged from the ARAC findings and recommendations. During an extended comment period, some 50 submissions were received from regulatory agencies, operators, manufacturers, and interested nongovernmental associations around the world. The FAA reviewed these public comments, acted on them as it deemed appropriate, and published a final rule on January 16, 2007. This ETOPS rule became effective 30 days later on February 15.

Authorization. Revised regulation 14 CFR 121.161 codifies ETOPS and provides updated requirements for the authorization of extended operations. For twinjets, ETOPS applies when the airplane is more than 60 minutes from an airport. For three- and four-engine passenger airplanes, it applies when the airplane is more than 180 minutes from an airport.

Operators flying three- and four-engine extended passenger operations have a one-year compliance grace period ending February 15, 2008. Three- and four-engine freighters are exempted from the new ETOPS rule.

This regulation also codifies a *polar policy* formalizing requirements for operators whose planned airplane routes traverse the North and South Polar areas. Within these areas, this non-ETOPS policy applies at all times to all airplanes, whether passenger or cargo, regardless of actual diversion time or number of engines.

Cargo fire suppression and other time-limited systems. New regulation 14 CFR 121.633 maintains current standards for up to 180 minutes ETOPS authority. It requires that ETOPS diversion times shall not exceed the time limit, minus 15 minutes, for that airplane type's most time-limited system, which typically is cargo fire suppression.

Beyond 180 minutes,* this rule requires that diversions for cargo fire suppression be calculated at all-engines-operating cruise speed, corrected for wind and temperature, and that diversions for other time-limited ETOPS significant systems be calculated at one-engine-inoperative cruise speed, corrected for wind and temperature. A six-year compliance grace period is provided to bring existing three- and four-engine fleets into compliance for cargo fire suppression.

While the new ETOPS rule closely resembles the ARAC findings and recommendations, there are some differences. One is that three- and four-engine freighters are exempted from the rule because operators contended, and the FAA agreed, that the costs of compliance could not be justified in all-cargo operations.

Another difference is that, while three- and four-engine extended operations with passenger airplanes are subject to the new ETOPS rule, this fleet is exempted from the new rule's maintenance requirements. As explained in the rule's preamble:

"The FAA strongly believes that all operators would benefit from an ETOPS maintenance program. However, the FAA agrees with many of the commenters that the cost of implementing this new requirement for airplanes with more than two engines would be significant. The FAA has determined that this cost cannot be justified based on the current level of safety achieved by the

Communications. New regulations 14 CFR 121.99 and 121.122 require satellite communication (SATCOM) voice communications for all extended operations beyond 180 minutes; another form of communications must also be available in areas where communication is not possible using this technology. A one-year grace period is provided.

Definitions. New regulation 14 CFR 121.7 provides definitions of ETOPS-applicable terms to help ensure proper understanding and compliance.

Design requirements. Regulations governing transport-category airplane (Part 25) and engine design (Part 33) are revised to incorporate ETOPS enhancements that reduce the rate of airplane diversions and protect airplanes if they do divert. For beyond-180-minute ETOPS, new design requirements apply to ETOPS twinjets and three- and four-engine airplanes. Manufacturers have eight years to comply in currently produced three- and four-engine airplanes if these types remain in production past February 17, 2015.

Dispatch. Revised regulation 14 CFR 121.631 specifies ETOPS dispatch or flight-release requirements for weather conditions at ETOPS alternate airports; it also codifies the current requirement that weather information be updated at the start of the ETOPS phase of flight to verify the continuing availability of alternate airports.

Fuel reserve. New regulation 14 CFR 121.646 specifies the amount of reserve fuel to be carried to protect the airplane in the event of a cabin depressurization followed by an extended diversion, at low altitude where fuel consumption is increased, to an alternate airport. Fuel reserve planning assumes this event happens at the most critical point on the flight route.

Maintenance. New regulation 14 CFR 121.374 codifies current ETOPS maintenance practices and applies them to two-engine extended operations. Three- and four-engine passenger planes that fly ETOPS are exempted.

Passenger recovery plan. Revised regulation 14 CFR 121.135 requires all flights on extended routes with diversion times beyond 180 minutes — except those involving three- and four-engine freighters, which are exempted from ETOPS — to prepare a recovery plan for these routes that ensures the well-being of passengers stranded at diversion airports and provides for their safe retrieval without undue delay.

Passenger recovery plans are also required for all polar passenger operations. Moreover, all polar operations and beyond-180-minute ETOPS must comply with the public protection provisions in airport data regulation 14 CFR 121.97.

Performance data. Revised regulation 14 CFR 121.135 requires all ETOPS operators to have the applicable performance data available to support their extended operations.

Rescue and firefighting. Revised regulation 14 CFR 121.106 requires rescue and firefighting equipment to be available at any airport designated as an ETOPS alternate.

Training. Revised regulation 14 CFR 121.415 requires training for crew members and dispatchers for their specific roles and responsibilities in creating and implementing their operator's passenger recovery plans.

Type design. New regulation 14 CFR 121.162 establishes the basis for ETOPS airplane type-design approvals.

* Note that 207-minute ETOPS does not count as "beyond 180 minutes" — the threshold at which most of the new ETOPS requirements apply — because it is a 15 percent operational extension to, and subject to the requirements of, traditional 180-minute ETOPS authority.

combination of engine reliability and the engine redundancy of this fleet of airplanes."¹

The final rule also differs from the NPRM with respect to polar area flight operations. Whereas the ARAC proposed making ETOPS requirements applicable within the North and South Poles (i.e., everything above 78 degrees north latitude and below 60 degrees south latitude), the FAA instead published a non-ETOPS polar policy in the rule-making that formalizes requirements for polar operations and provides a uniform process for operators seeking polar route authority. This approach results in a similar outcome but through a slightly different regulatory mechanism.

REGULATORY MODIFICATIONS AND ADDITIONS

ETOPS authorization. U.S. regulation 14 CFR 121.161 and associated preamble and advisory material have been revised to:

- Establish the basis and requirements for operating two-engine, turbine-powered airplanes beyond 60 minutes flying time (at single-engine cruise speed with no wind and in standard conditions) of an adequate alternate airport.
- Apply this same regulatory framework to the operation of turbine-powered passenger planes with more than two engines beyond 180 minutes (at one-engine-inoperative cruise speed with no wind and in standard conditions) of an adequate alternate airport.
- Make the designed and certified operating capabilities of the airplane type the basis for

determining the maximum diversion authority of that airplane type.

- Use propulsion system reliability levels for two-engine ETOPS to trigger a review of operations and identify common-cause effects and systemic errors.
- Define allowable diversion authorizations and requirements for different regions of the world based on the overall operational needs of each region.

Note that 207-minute ETOPS is not subject to the new ETOPS requirements for "beyond-180-minute flight operations." Flown since 2000, this authority arose as a 15 percent operational extension, for limited use on an exception basis, to 180-minute ETOPS authority. It is thus considered an extension of and subject to the requirements for the traditional 180-minute "twinjet ETOPS" diversion authority.

Cargo fire suppression. To further ensure safety, new regulation 14 CFR 121.633 requires that all time-limited ETOPS significant systems aboard airplanes flying ETOPS shall have sufficient capability to protect the airplane throughout the longest potential diversion for that route. In particular, each flight shall have continuous cargo fire suppression capability for a period equivalent to the maximum planned diversion time plus an additional 15 minutes.

ETOPS twinjets have been required since 1985 to carry sufficient fire suppressant to protect the airplane continuously throughout a maximum-duration diversion. In contrast, although all jetliners have cargo fire suppression systems, airplanes with more than two engines have not previously had to meet this requirement that further protects passengers, crews, and airplanes on extended air routes.

For ETOPS at or below 180 minutes, which only involves twinjets, this cargo fire suppression requirement is based on maximum diversion time in still air plus 15 minutes, as was previously the case. For ETOPS beyond 180 minutes, which

time-limited ETOPS significant systems calculating diversion times at one-engine-inoperative cruise speed, corrected for wind and temperature.

Three- and four-engine ETOPS operators are granted until February 15, 2013, to bring their existing fleets into compliance with the cargo fire suppression requirement. This six-year grace period serves to mitigate operator costs by allowing system upgrades to be performed during regularly scheduled airplane heavy-maintenance cycles. It also provides time for manufacturers to develop and certify this upgraded capability in their airplanes.

Communications. Regulations 14 CFR 121.99 and 121.122 (for supplemental operations) require the adoption of a satellite communication (SATCOM) voice system for ETOPS beyond 180 minutes of an alternate airport. Whereas other communication systems (e.g., VHF, HF, and SATCOM or HF datalink) have limitations that can compromise the reliability of communications during extended operations, SATCOM voice allows clear and immediate conversation that can quickly convey the situation and needs of a flight.

Definitions. Many of the terms used in this ETOPS rule are unique to extended operations and demand precise interpretation to ensure common understanding and proper compliance. New regulation 14 CFR 121.7 provides these definitions.

A noteworthy change is the addition of the term “ETOPS alternate airport,” which is an adequate airport (i.e., one appropriate for the airplane type) that meets the stated requirements for planned diversion use and is listed in the certificate holder’s operations specifications. The weather conditions at these airports are checked at dispatch or flight release, and again in flight, to determine whether they are at or above the operating minimums specified for a safe landing and can thus serve as an alternate for that flight.

“ETOPS alternate” thus replaces the former ETOPS term “suitable airport,” which denoted an alternate airport that was both above required weather minimums and available for diversion use. Under the new ETOPS rule, “suitable” no longer has an ETOPS-specific meaning. Therefore, where it appears in the new ETOPS rule, it is to be interpreted only according to its broadly accepted everyday meaning.

Design requirements. Type-design changes made in Parts 21, 25, and 33 of the U.S. federal aviation regulations codify existing ETOPS policies, practices, and special conditions in a uniform set of regulations for airplanes and engines. The new regulations also extend the existing safety standards to allow for design approvals beyond the previous 180-minute ETOPS diversion authority limit. These extended standards ensure that airplane designs approved for beyond-180-minute ETOPS maintain the same high standards that have exemplified ETOPS experience to date. As the FAA noted in this new rule’s preamble:

“Because of the potential benefits associated with the superior design of airplane-engine combinations demonstrated under the existing [twinjet] ETOPS certification programs, the FAA has decided to extend those requirements to the airplanes with more than two engines should the manufacturer wish to market these airplanes as suitable for ETOPS operation.”²

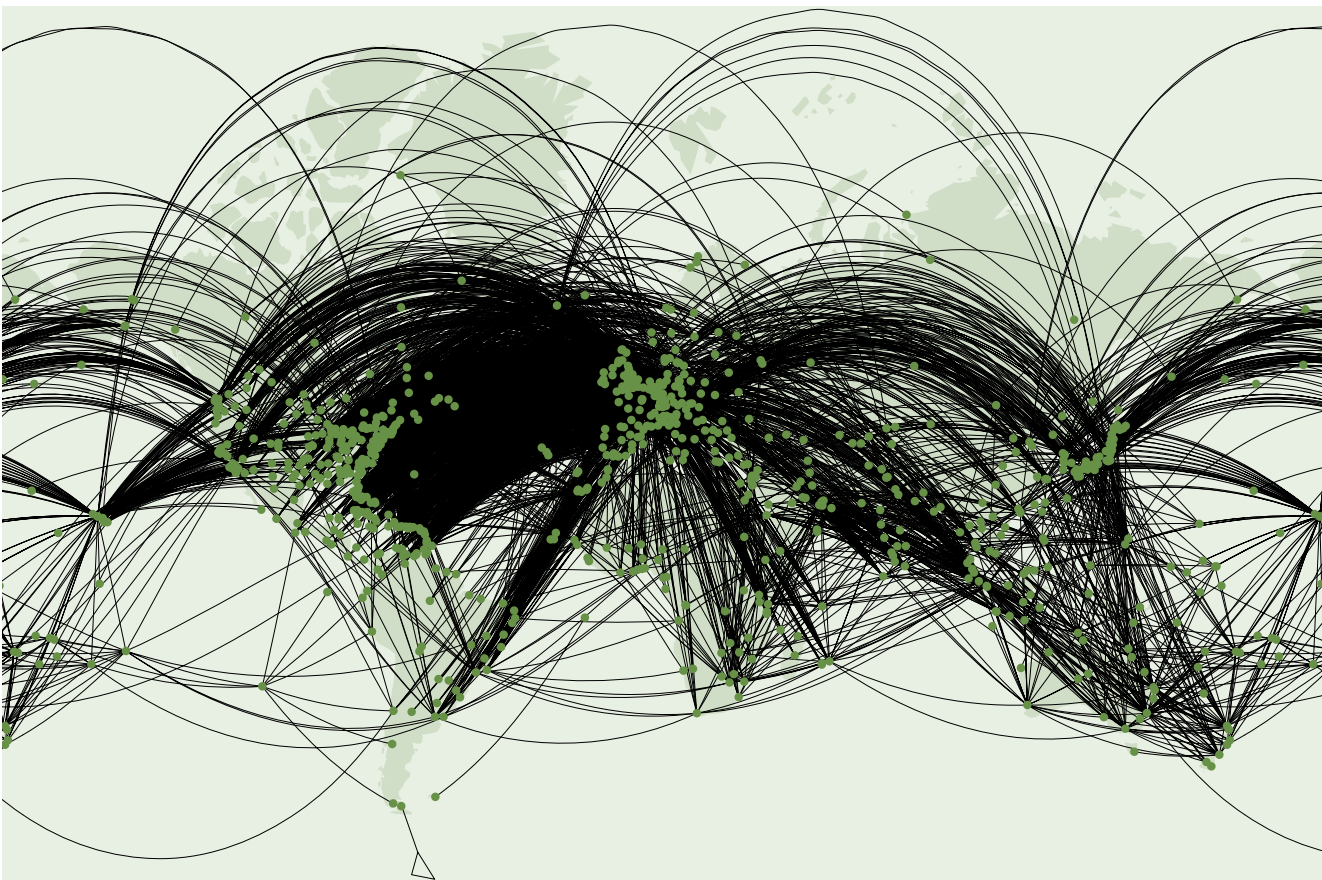
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Boeing plans to certify the long-range versions of the 787 Dreamliner to allow operations up to its design capability. Boeing also plans to extend the diversion capabilities of certain models of the 777, and is looking into extending the cargo fire suppression capabilities of its three- and four-engine models like the new 747-8. These product decisions will be based on customer needs.

involves twinjets and three- and four-engine passenger airplanes, this requirement is to be calculated at all-engines-operating cruise speed, corrected for winds and temperature.

While cargo fire suppression is generally the most time-limited ETOPS significant system, it is just one of many such systems that contribute to safety during flight. For operations beyond 180 minutes, this regulation also requires that airline planning for diversions account for all other

This requirement for satellite-based voice communications will ensure that ETOPS flight crews can communicate emergency situations with air traffic control or their airline throughout a long-range ETOPS flight. Alternative means of communication must also be available in the event that this most reliable means does not work for any reason. To mitigate compliance costs, a one-year grace period ending February 15, 2008, is provided.



Two-engine jetliners have logged more than 5.5 million ETOPS flights since 1985. Boeing twinjets alone perform another 1,400 or so every day.

suppression capabilities of its three- and four-engine models like the new 747-8. These product decisions will be based on customer needs.

At present, it appears that a diversion time limit in the neighborhood of 330 minutes will support optimal flight operations between any two points on earth. Boeing is currently assessing the ability of our current and projected widebody fleet to meet this goal, and will in the very near future define program goals.

Dispatch. Revised regulation 14 CFR 121.631 makes only minor changes to the established ETOPS dispatch and flight-release requirements, which specify requirements for weather conditions at ETOPS alternate airports and require that weather information be updated at the start of the ETOPS phase of flight to verify the continuing availability of diversion airports.

Fuel reserve. New regulation 14 CFR 121.646 requires that all airplanes flown in extended

operations must carry an ETOPS fuel reserve sufficient to allow flight to an ETOPS alternate airport in the event of these three scenarios:

- A rapid loss of cabin pressure at the most critical point followed by a descent to a safe altitude as defined by oxygen availability.
- A rapid loss of cabin pressure and a simultaneous engine failure at the most critical point followed by a descent to a safe altitude as defined by oxygen availability.
- An engine failure at the most critical point and descent to one-engine-inoperative cruise altitude and diversion at one-engine-inoperative cruise speed.

Whichever of the above requires the greatest amount of fuel shall be the basis of computation for this reserve. Because of the increased fuel consumption of turbine engines at low altitudes, and the corresponding reduction in airplane range, the decompression scenarios logically define this reserve, which ensures sufficient fuel for an

extended low-altitude diversion followed by a descent to 1,500 feet at the alternate airport, a 15-minute hold, and an approach and landing. Further allowance is made for possible airframe icing, wind forecasting error, and in-flight use of the auxiliary power unit.

More than two decades of ETOPS twinjet experience have identified areas of excessive conservatism in the original ETOPS fuel reserve requirement. Based on the refinement of models and removal of past uncertainties, this new rule specifies a slightly smaller critical fuel reserve for twinjets. Under the new ETOPS rule, three- and four-engine passenger airplanes flying extended routes will be required to carry an ETOPS fuel reserve.

The FAA has also implemented a non-ETOPS provision, 14 CFR 121.646(a), that addresses an existing concern. This provision requires that all three- and four-engine airplanes carry a decompression fuel reserve whenever they fly beyond 90 minutes of an airport. Although U.S. regulations

Non-ETOPS Provisions Included in This Rulemaking

Polar policy. Regulation 14 CFR 121.161, which authorizes ETOPS, also formalizes requirements for operations north of latitude 78°N (North Pole) and south of latitude 60°S (South Pole). Within these regions, this FAA polar policy applies at all times to all airplanes regardless of actual diversion time or number of engines.

Three- and four-engine airplane fuel reserve. The ETOPS en route fuel supply regulation includes 14 CFR 121.646(a), a general provision that states three- and four-engine airplanes, when flying more than 90 minutes from an airport, shall carry sufficient fuel to safely reach an adequate airport in the event of decompression and diversion at low altitude where fuel consumption is increased.

specify supplemental oxygen in the event that cabin pressure is lost, some operators and flight-plan suppliers have not specified sufficient reserve fuel for the airplane to reach an alternate airport during a low-altitude diversion. It should be noted that many three- and four-engine operators do routinely carry a depressurization fuel reserve as a matter of internal airline policy.

Maintenance. New regulation 14 CFR 121.374 codifies the current ETOPS maintenance practices. These proven practices reduce airplane-related diversions through disciplined procedures like engine condition monitoring, oil consumption monitoring, aggressive resolution of identified reliability issues, and procedures that avoid human error during the maintenance of airplane engines and systems.

The new ETOPS rule makes ETOPS maintenance requirements applicable only to two-engine airplanes that fly extended operations. Because unscheduled landings at alternate airports can be costly and disruptive events for carriers, some three- and four-engine operators have voluntarily raised their maintenance standards to ETOPS levels even though it is not required of them.

Passenger recovery plan. Revised regulation 14 CFR 121.135 requires that for all ETOPS flying beyond 180 minutes (excluding 207-minute ETOPS, as explained above), and for all polar operations, the air carrier must develop a plan to ensure the well-being of passengers and crew members at each approved en route alternate airport listed in this carrier's operations specifications. Because challenging alternate airports tend to be found in the most remote parts of the

world, passenger recovery plans are no longer required for ETOPS below 180 minutes.

This passenger recovery plan must address the safety and comfort, in terms of facilities and accommodations, of stranded passengers at the diversion airport. As its name suggests, it must also address their prompt retrieval from the airport.

Polar operations also require passenger recovery plans, as codified in this rulemaking's polar policy. Initially implemented as an FAA policy letter in 2001, this polar policy also requires diversion airport planning, another key ETOPS concept. Despite these similarities, however, polar operations are distinct from ETOPS because North and South Polar operations entail unique requirements, such as special onboard equipment and a fuel freeze strategy.

Performance data. Revised regulation 14 CFR 121.135 also requires the operator to provide its flight crews and dispatchers with airplane performance data to support all phases of extended operations. This data must describe the specific performance of the airplane in normal and non-normal situations, including those that might arise during an extended-duration diversion to an alternate airport.

Rescue and firefighting service (RFFS). During more than two decades of ETOPS and more than 5.5 million ETOPS twinjet flights around the world, there has never been a landing accident following an extended diversion from the ETOPS phase of flight. However, the fact that RFFS has not been needed in the past does not lessen the importance of this ETOPS operational protection.

New regulation 14 CFR 121.106 formalizes RFFS requirements for alternate airports. For ETOPS up to 180 minutes, each airport listed on the dispatch or flight release as an ETOPS alternate airport must have RFFS capability equivalent to or higher than International Civil Aviation Organization (ICAO) Category 4.³

For ETOPS beyond 180 minutes, ICAO Category 4 is required with at least one adequate airport within the authorized diversion time having ICAO Category 7. This provision allows for optimum route planning while providing the flight crew with available alternate airport options in the event a situation arises requiring a higher RFFS capability.

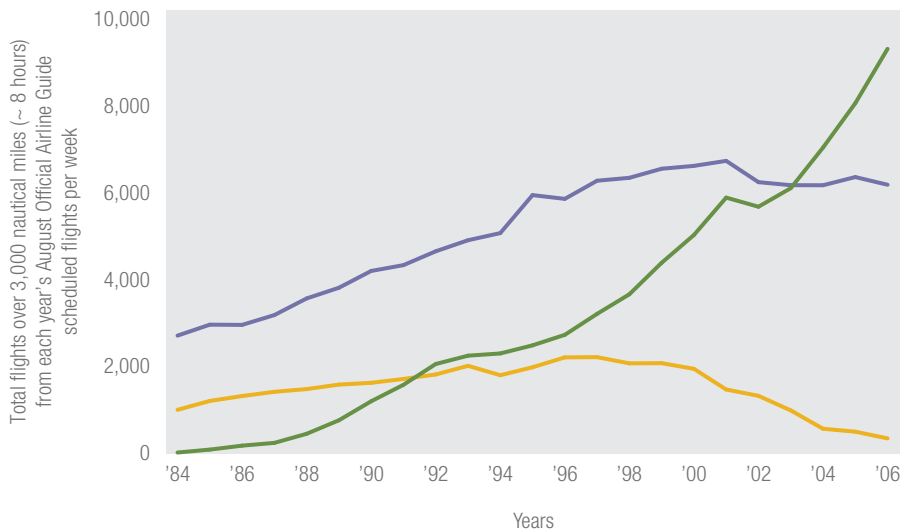
The regulation also makes provision for dispatching even if an otherwise adequate alternate airport lacks sufficient RFFS, provided that local firefighting assets — given 30 minutes notice while the diversion is in progress — can be available to bring the airfield's capability up to the required ICAO standard. There must be a commitment that this supplemental RFFS will be available at arrival and that it will remain at the scene for as long as needed by the diverting airplane.

Training. Revised regulation 14 CFR 121.415 has been modified to require training for crew members and dispatchers for their specific roles and responsibilities in creating and implementing the operator's passenger recovery plans for the alternate airports upon which it relies for its extended operations.

Type design. New regulation 14 CFR 121.162 establishes the basis for ETOPS type-design approvals. This regulation delineates the airworthiness standards required for airplanes to

MOST LONG-RANGE FLYING IS VIA TWINJET

- TWIN TOTAL
includes 737, 757, 767, 777, A300, A310, A320, and A330
- TRI TOTAL
includes DC-10, L1011, MD-11
- QUAD TOTAL
includes 707, 747, DC-8, A340



This new ETOPS rule ensures that air carriers performing twinjet extended operations, or three- and four-engine passenger jet extended operations, will have the requisite experience and ability to maintain and operate these airplanes at the required level of reliability and competence. This rule further provides for ETOPS beyond 180 minutes, and it allows the operators of approved long-range twinjets to fly optimal routings between virtually any two cities on earth.


be used in Part 121 ETOPS and it confirms that current ETOPS-qualified operators can continue operating their ETOPS routes without a new approval process.

This new ETOPS rule's remaining regulatory additions or modifications formalize the requirements for weather minimums at these alternate airports (14 CFR 121.625), ETOPS dispatch or flight release (14 CFR 121.631, § 121.687, § 121.689), and ETOPS alternate airports (14 CFR 121.624). General regulation 14 CFR 121.97, which describes what airport information all operators are to be cognizant of, also applies to the alternate airports on which ETOPS and polar area operations depend. The FAA has also updated existing regulation on flight procedures following in-flight engine failure or shutdown (14 CFR 121.565).

CONCLUSION

This new U.S. ETOPS rule ensures that air carriers performing twinjet extended operations, or three- and four-engine passenger jet extended operations, will have the requisite experience and ability to maintain and operate these airplanes at the required level of reliability and competence. This rule further provides for ETOPS beyond 180 minutes, and it allows the operators of approved long-range twinjets to fly optimal routings between virtually any two cities on earth.

On the operational front, this rulemaking ensures the availability of alternate airports as well as sufficient reserve fuel to reach these airports even under the most challenging circumstances. Furthermore, it ensures the availability of rescue and firefighting services, and requires that operators plan for the safety, comfort, and prompt retrieval of stranded passengers.

On the design front, the new ETOPS rule continues to reduce the rate of airplane propulsion and system failures that might cause a diversion. Moreover, it ensures that all time-limited ETOPS airplane systems will support worst-case scenarios by remaining continuously available throughout a maximum-duration diversion to the limit of that flight's authority. For more information, please contact Mohan Pandey at mohan.r.pandey@boeing.com. 

¹ U.S. Federal Register, Washington, DC, vol. 72, no. 9, January 16, 2007, p. 1836.

² Ibid., p. 1816.

³ ICAO Annex 14, Volume 1, Aerodrome Design and Operations.