U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: EXTENDED RANGE OPERATION WITH TWO-ENGINE AIRPLANES

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Change:

1. PURPOSE. This advisory circular (AC) states an acceptable means but not the only means for obtaining approval under FAR Section 121.161 for two-engine airplanes to operate over a route that contains a point farther than one hour flying time at the normal one-engine inoperative cruise speed (in still air) from an adequate airport.

2. RELATED FAR SECTIONS. Sections 121.161, 121.197, 121.565, 25.1309, 25.901 and 25.903 of the Federal Aviation Regulations (FAR).

3. DEFINITIONS.

a. Airport.

(1) Adequate. For the purpose of this AC an adequate airport is an airport certified as an FAR 139 airport or is found to be equivalent to these safety requirements.

(2) Suitable. For the purpose of this AC, a suitable airport is an adequate airport with weather reports, or forecasts, or any combination thereof, indicating that the weather conditions are at or above operating minima, as specified in the operations specifications, and the field condition reports indicate that a safe landing can be accomplished at the time of the intended operation.

b. Auxiliary Power Units (APU). A gas turbine engine intended for use as a power source for driving generators, hydraulic pumps, and other airplane accessories and equipment and/or to provide compressed air for airplane pneumatic systems.

(1) An essential APU installation provides the bleed air and/or mechanical power, as required, necessary for the dispatch of a transport category airplane for operations other than extended range operations with two-engine airplanes.

(2) An APU installation required for extended range operations provides the bleed air and/or mechanical power necessary for the safe flight of a two-engine transport category airplane approved for extended range operation under a deviation from § 121.161 and is designed and maintained to provide a level of reliability necessary to perform its intended function.

c. Engine. The basic engine assembly plus its essential accessories as supplied by the engine manufacturer.

d. Extended Range Operations. For the purpose of this AC, extended range operations are those operations conducted over a route that contains a point further than one hour flying time at the normal one-engine inoperative cruise speed (in still air) from an adequate airport.

e. Fail-Safe. The design methodology upon which the FAR Part 25 airworthiness standards are based. It requires the effect of failures and combination of failures to be considered in defining a safe design. (Refer to Appendix 2 for a more complete definition of fail-safe design concepts.)

f. Power Unit. A system consisting of an engine and all ancillary parts installed on the engine prior to installation on the airplane to provide and control power/thrust and for the extraction of energy but not including devices which produce thrust for short periods (i.e., Jet Assisted Takeoff (JATO).

g. System. A system includes all elements of equipment necessary for the control and performance of a particular major function. It includes both the equipment specifically provided for the function in question and other basic equipment such as that required to supply power for the equipment operation.

(1) Airframe System. Any system on the airplane that is not a propulsion system.

(2) Propulsion System. The airplane powerplant installation includes each component that is necessary for propulsion; affects the control of the major propulsion units; or affects the safety of the major propulsion units (§ 25.901a).

4. DISCUSSION. To be eligible for extended range operations, the specified airplane-engine combination should have been certificated to the airworthiness standards of transport category airplanes and should be evaluated considering the concepts in paragraph 6, the type design considerations in paragraph 7 and the inservice experience discussed in paragraph 8, as well as, the continuing airworthiness and operational concepts outlined in paragraph 9.

a. General. All two-engine airplanes operated under FAR Part 121 are required to comply with § 121.161. Section 121.161 states, in pertinent part, that "unless otherwise authorized by the Administrator, based on the character of the terrain, the kind of operation, or the performance of the airplane to be used, no certificate holder may operate two-engine or three-engine airplanes (except a three-engine turbine powered airplane) over a route that contains a point farther than 1 hour flying time (in still air at normal cruising speed with one-engine inoperative) from an adequate airport." It is significant to note that this rule is equally applicable to reciprocating, turbopropeller, turbojet, and turbofan airplanes as well as routes transiting oceanic areas or routes entirely over land.

b. Background. The current § 121.161 has an extensive historical basis which began as early as 1936. The rule in effect in 1936 required the applicant to show, prior to obtaining approval for the operation, that intermediate fields, available for safe takeoff and landings, were located at least 100 mile intervals along the proposed route. This restriction applied to all airplanes operating under this rule regardless of the terrain or area overflown. Throughout the evolution of the current § 121.161, the following factors have remained constant:

(1) The rule has always applied to all areas of operation and has not been limited to overwater operation, and

(2) Any additional restrictions imposed or, alternatively, any deviations granted to operate in excess of the basic requirements were based on a finding by the Administrator that adequate safety would be provided in the proposed operation when all factors were considered. This finding was never limited to engine reliability alone, and

(3) The airports used in meeting the provisions of the rule must be adequate for the airplane used (i.e., available for safe landings and takeoff with the weights authorized), and

(4) In granting a deviation for the time restrictions, the Administrator considers the character of the terrain, the kind of operation, the performance of the aircraft, etc.

c. Current Situation (1985). Although the § 121.161 requirements evolved during the era of piston-engined airplanes and these requirements are currently applied to turbine-powered airplanes which have significantly better reliability, experience has shown the present rule to be effective and yet flexible enough in its application to accommodate significant improvements in technology. Until recently, little consideration had been given to reexamining the viability of extending the permissible operating range of two-engine turbine powered airplanes, by granting credit for improved reliability, due to the limited range/payload capabilities of most of the existing generation of two-engine turbine-powered airplanes. However, some of the new generation airplanes have a range/payload capability equivalent to many previous generation three- and four-engine airplanes. The demonstrated range/payload capabilities of the new generation airplanes clearly indicate there is a need to recognize the capabilities of these airplanes and to establish the conditions under which extended range operations with these airplanes can be safely conducted in oceanic and/or desolate land areas.

5. APPLICABILITY. Since large transport category airplanes are certificated in consideration of the operating rule, § 121.161, any consideration for deviation from this operating rule for two-engine airplanes necessitates an evaluation of the type design to determine suitability of that particular airplane/engine combination for the intended operation. This circular provides guidance for obtaining type design, continued airworthiness and/or operations approval for those two-engine transport category airplanes intended for use in

extended range operations. The issuance of this advisory circular is not intended to alter the status of deviations previously approved in accordance with § 121.161. Although many of the criteria in this AC are currently incorporated into an operator's approved program for other airplanes or route structures, the unique nature of extended range operations with two-engine airplanes necessitates an evaluation of these operations to ensure that the approved programs provide a level of safety consistent with that required for current extended range operations with three- and four-engine turbine-powered airplanes. To the extent that changes in the airplane's type design, continued airworthiness, or the operations program are involved as a result of this evaluation, they are approved through the normal approval processes.

6. CONCEPTS. Although it is self-evident that the overall safety of an extended range operation cannot be better than that provided by the reliability of the propulsion systems, some of the factors related to extended range operations are not necessarily obvious. For example, cargo compartment fire suppression/containment capability could be a significant factor or operational/maintenance practices may invalidate certain determinations made during the airplane type design certification, or the probability of system failures could be a more significant problem than the probability of propulsion system failures. Although engine reliability is a critical factor, it is not the only factor which should be seriously considered in evaluating extended range operations. Any decision relating to extended range operations with two-engine airplanes should also consider the probability of occurrence of any condition which would prevent the continued safe flight and landing as well as the probability of occurrence of any condition which would reduce the capability of the airplane or the ability of the crew to cope with adverse operating conditions. The following is provided to define the concepts for evaluating extended range operations with two-engine airplanes. This approach assures that two-engine airplanes are consistent with the level of safety required for current extended range operations with three- and four-engine turbine-powered airplanes without unnecessarily restricting operations.

a. A number of airframe systems have an effect on the safety of extended range operations, therefore, the type design certification of the airplane should be reviewed to ensure that the design of these systems are acceptable for the safe conduct of the intended operation.

b. In order to maintain a level of safety consistent with the overall safety level required of current three- and four-engine turbine-powered airplanes used in air carrier service, it is necessary for two-engine airplanes used in extended range operations to have an acceptably low risk of double propulsion system failure for all design and operations related causes. Additionally, in the event of a single propulsion system failure, the performance and reliability of the airframe systems and the remaining propulsion systems should be sufficiently high to ensure a high probability of continued safe flight and landing at a suitable airport.

c. Since the quality of maintenance programs can have an appreciable effect on the reliability of the propulsion system, and the airframe systems required for extended range operation, an assessment should be made of the proposed maintenance program's ability to maintain a satisfactory level of system reliability for the particular airplane-engine combination.

d. System failures or malfunctions occurring during extended range operations could affect flightcrew workload and procedures. Although the demands on the flightcrew may increase, an assessment should be made to ensure that exceptional piloting skills or crew coordination are not required.

e. Following a determination that the airframe systems and propulsion systems are designed to be suitable for extended range operations, an indepth review of the applicant's training programs, operations, and maintenance programs should be accomplished to determine its ability to maintain an acceptable level of system reliability to safely conduct these operations with the particular airplane-engine combination.

f. Approval Basis. For safe operations of two-engine airplanes in extended range operations, each applicant for extended range approval should show that the configuration of the particular airplane-engine combination is sufficiently reliable. This requires the systems designated for extended range operations, including the propulsion system: first, be shown to be designed to a fail-safe criteria; and, secondly, that these systems can be continuously maintained and operated at levels of reliability appropriate for the intended operation.

(1) Type Design Approval. Evidence that the type design of the airplane is sufficiently reliable for extended range operations is normally reflected by a statement in the FAA-approved Airplane Flight Manual (AFM) and Type Certificate Data Sheet or Supplemental Type Certificate. (See paragraph 7.)

(2) Inservice Experience Approval. In addition to the type design approval, it should be shown that the propulsion systems for that particular airplane-engine combination (world fleet) can achieve a sufficiently high level of reliability inservice so that safe extended range operations may be conducted. The achievement of this level of reliability is determined in accordance with Appendix 1. (See paragraph 8a.) It is also necessary for each operator desiring approval for extended range operations to show that he/she has obtained sufficient maintenance and operations familiarity with that particular airplane-engine combination to safely conduct these operations. (See paragraph 8b.)

(3) Continuing Airworthiness and Operations Approval. Since the type design approval does not reflect a continuing airworthiness or operational approval to conduct extended range operations, each operator should demonstrate the ability to maintain the airplane so as to achieve the required reliability and to train its personnel to achieve competence in extended range operations. The continuing airworthiness and operational approval to conduct extended range operations is made by amendment to the operator's operations specifications. (See paragraph 9.)

7. TYPE DESIGN APPROVAL CONSIDERATION.

a. General. If a new two-engine type design airplane is intended to be used in extended range operations, a determination should be made that the design features are suitable for the intended operation. In the event that an existing airplane's operation is expanded to include extended range operations, a reevaluation of some design features may be necessary because of the greater exposure of the airplane in operations associated with two-engine extended range operation. In this case, modifications to some systems may be necessary to achieve the desired reliability. In either case, the essential systems and the propulsion systems for the particular airplane-engine combination should be shown to be designed to a fail-safe criteria and a level of reliability suitable for the intended maximum range operation of the airplane.

b. Criteria. The evaluation of failures and failure combinations should be based on engineering and operational judgment as well as acceptable fail-safe methodology. The analysis should consider effects of operations with a single engine, including allowance for damage that could result from failure of the first engine. Unless it can be shown that equivalent safety levels are provided or the effects of failure are minor, failure and reliability analysis should be used as guidance in verifying that the proper level of fail-safe design has been provided. The following criteria are applicable to extended range operation of airplanes with two engines:

(1) Airframe systems should be shown to comply with § 25.1309, Amendment 41.

(2) The propulsion systems should be shown to comply with § 25.901, Amendment 40.

(i) Engineering and operational judgment applied in accordance with the assessment conditions outlined in Appendix 1 should be used to show that the probability for total thrust loss on both engines due to design related (chargeable to hardware or software elements) independent failures in the propulsion system is extremely improbable.

(ii) This determination of the propulsion system reliability is derived from a world-fleet data base containing all inflight engine shutdown events, all significant engine reliability problems, and available data on cases of significant loss of thrust, including those where the engine failed or was throttled-back/shut down by the pilot. This determination will take due account of the approved maximum diversion time and rectification of identified engine design problems as well as events where in-flight starting capability may be degraded.

(iii) Contained engine failure, cascading failures, consequential damage or failure of remaining systems or equipment should be assessed in accordance with § 25.901.

(3) The safety impact of an uncontained engine failure should be assessed in accordance with § 25.903.

(4) The APU installation, if required for extended range operations, should meet the applicable FAR Part 25 provisions (Subpart E - Powerplant Provisions, thru Amendment 46) and any additional requirements necessary to demonstrate its ability to perform the intended function as specified by the Propulsion System Reliability Assessment Board, after a review of the applicant's data.

(5) For extended duration, single-engine operations (considering the resulting degradation on the performance of the airplane type), the increased workload, and the adverse effects of malfunctions of remaining systems and equipment on flightcrew procedure should be minimized and should not require exceptional piloting skills and/or crew coordination. Consideration should also be given to the effects of continued flight with an engine and/or airframe systems inoperative on the flightcrew's physiological needs.

(6) It should be demonstrated for extended duration single-engine operation, that the remaining power (electrical, hydraulic, pneumatic), will continue to be available at levels necessary to permit continued safe flight and landing and to provide those services required for the overall safety of the passengers and crew. Unless it can be shown that cabin pressure can be maintained on single-engine operation at the altitude required for continued safe flight to a suitable airport, oxygen should be available to sustain the passengers and crew for the approved maximum diversion time.

(7) In the event of any single failure, or combination of failures not shown to be extremely improbable, it should be shown that electrical power is provided for essential flight instruments, warning systems, avionics, communications, navigation, required route or destination guidance equipment, supportive systems and/or hardware and any other equipment deemed necessary for extended range operation to continue safe flight and landing at a suitable airport. Information provided to the flightcrew should be of sufficient accuracy for the intended operation.

(8) Three or more reliable, independent AC electrical power sources should be available. As a minimum, each electrical source should be capable of powering the items specified in paragraphs 7c(4)and 7c(7). If one or more of the required electrical power sources are powered by an APU, hydraulic system, or ram air turbine, the following criteria apply as appropriate:

(i) The APU when installed, should meet the criteria in paragraph 7b (4).

(ii) The hydraulic power source should be reliable. To achieve this reliability, it may be necessary to provide two or more independent energy sources (e.g., bleed air from two or more pneumatic sources).

(iii) Ram air turbine deployment should be demonstrated to be sufficiently reliable and not require engine dependent power for deployment.

(9) It should be shown that adequate status monitoring information and procedures on all critical systems are available for the flightcrew to make in-flight go/no-go and diversion decisions.

(10) Extended two-engine operations are not permitted with time-related cargo fire limitations less than the most critical diversion time (including an allowance for 15 minutes holding and an approach and landing) determined by considering other relevant failures, such as an engine inoperative, and combinations of failures not shown to be extremely improbable.

(11) If scheduled maintenance, replacement, and/or inspection are utilized to obtain type design approval for extended range operation, then the specified maintenance should be clearly identified in an appropriate maintenance document.

c. Analysis of Failure Effects and Reliability.

(1) General. The analysis and demonstration of airframe and propulsion system failure effects and reliability should be based on the largest diversion time for the extended range routes likely to be flown with the airplane. If it is necessary in certain failure scenarios to consider a lesser time due to time-limited systems or the necessity of an immediate diversion, this lesser time will be established as the approved maximum diversion time.

(2) Propulsion Systems.

(i) An assessment of the propulsion systems reliability for particular airplane-engine combinations will be made in accordance with Appendix 1.

(ii) The analysis will consider the effects of operation with a single propulsion system, including probable damage that could result from failure of the first engine. Effects of failures, external conditions, or crew errors that could jeopardize the operation of the remaining propulsion system under single power unit operating conditions will be examined.

(3) Hydraulic Power and Flight Control. Consideration of these systems may be combined, since many commercial airplanes have full hydraulically-powered controls. For airplanes with all flight controls being hydraulically powered, evaluation of hydraulic system redundancy should show that single failures or failure combinations not shown to be extremely improbable do not preclude continued safe flight and landing at a suitable airport. As part of this evaluation, the loss of any two hydraulic systems and any engine should be assumed to occur unless it is established during failure evaluation that there are no sources of damage or the location of the damage sources are such that this failure condition will not occur.

(4) Electrical Power. Electric power is provided to a small group of instruments and devices required for continued safe flight and landing, and to a much larger group of instruments and devices needed to allow the flightcrew to cope effectively with adverse operating conditions. Multiple sources (engine-driven generators, APU's, etc.) should be provided to meet both the "continued safe flight and landing requirements" and the "adverse conditions requirements." A review should be conducted of fail-safe and redundancy features supported by a statistical analysis considering exposure times established in paragraph 7c(1).

(5) Equipment Cooling. The data should establish that the required electronic equipment for extended range operation has the ability to operate acceptably considering failure modes in the cooling system not shown to be extremely improbable. Adequate indication of the proper functioning of the cooling system should be demonstrated to assure system operation prior to dispatch and during flight.

(6) Cargo Compartment. The cargo compartment design and fire protection system capability (if required) should be consistent with the following:

(i) Design. The cargo compartment fire protection system integrity and reliability should be suitable for the intended operation considering fire detection sensors, liner materials, etc.

(ii) Fire Protection. An analysis or tests should be conducted to show that, considering the time required to terminate an extended range operation, the ability of the system to suppress or extinguish fires is adequate to assure safe flight and landing at a suitable airport.

(7) Communication, Navigation, and Basic Flight Instruments (Altitude, Airspeed, Attitude and Heading). It should be shown that, under all combinations of propulsion and/or airframe system failures which are not extremely improbable, reliable communication, sufficiently accurate navigation, basic flight instruments, and any required route and destination guidance needed to comply with contingency procedures for extended range operation will be available.

(8) Cabin Pressurization. A review of fail-safe and redundancy features should show that the loss of cabin pressure is improbable under single engine operating conditions. Airplane performance data should be provided to verify the ability to continue safe flight and landing after loss of pressure and subsequent operation at a lower altitude.

d. Assessment of Failure Conditions. In assessing the fail-safe features and effects of failure conditions, account should be taken of:

(1) The variations in the performance of the system, the probability of the failure(s), the complexity of the crew action, and the type and frequency of the relevant crew training.

(2) Factors alleviating or aggravating the direct effects of the initial failure condition, including consequential or related conditions existing within the airplane which may affect the ability of the crew to deal with direct effects, such as the presence of smoke, airplane accelerations, interruption of air-to-ground communication, cabin pressurization problems, etc.

e. Type Design Approval. Upon satisfactory completion of an engineering inspection and test program consistent with the type certification procedures of FAR Part 21;

(1) The type design approval is normally reflected in the FAA-approved AFM or supplement, and Type Certificate Data Sheet or Supplemental Type Certificate which contain the following pertinent information, as applicable:

(i) Special limitations (if required), including any limitations associated with a maximum diversion time established in accordance with paragraph 7c(1).

(ii) Markings or placards (if required);

(iii) Revision to the performance section (if required);

(iv) The airborne equipment, installation, and flightcrew procedures required for extended range operations;

(v) Description of the approved airplane configuration.

(vi) A statement to the effect that:

"The type design reliability and performance of this airplane/engine combination has been evaluated in accordance with AC 120-42 and found suitable for extended range operations. This finding does not constitute approval to conduct extended range operations."

f. Type Design Monitoring. The FAA directorate responsible for the certification of the type design will include the consideration of extended range operations in its normal monitoring functions and will identify any significant problems through the normal airworthiness directive process for the approved type design.

8. INSERVICE EXPERIENCE. In addition to substantiating a type design in accordance with paragraph 7 of this AC and as a prerequisite to obtaining any continuing-airworthiness/operational approval, in accordance with the criteria of paragraph 9 of this AC, it should be shown that the necessary level of propulsion system reliability can be achieved in service by the world fleet for that particular airplane-engine combination and that the applicant has obtained sufficient maintenance and operation familiarity with that particular airplane-engine combination.

a. Subsequent to the type design approval, it should be shown that the world fleet of the particular airplane-engine combination for which approval is sought has achieved, as determined by the FAA, an acceptable and reasonably stable level of single propulsion system inflight shutdown (IFSD) rate necessary for extended range operation. Engineering and operational judgment applied in accordance with the assessment considerations outlined in Appendix 1 will be used to determine that the probability of dual engine failure for all independent causes of 10-8 per hour or less can be achieved. This assessment is in addition to the determination in paragraph 7b(2) for type design approval. This determination of propulsion system reliability is derived from a world fleet data base containing all in-flight engine shutdown events, for all design and operations-related causes during all phases of flight, significant engine reliability problems, and the available data on cases of significant loss of thrust including those where the engine failed or was throttled-back/shut down by the pilot. This determination will take due account of the approved maximum diversion time, rectification of identified propulsion system problems, as well as events where inflight starting capability may be degraded.

b. Each operator requesting approval should have twelve consecutive months of operational in-service experience with the specified airplane-engine combination. However, in unique situations, the twelve-month period of operational in-service experience may be reduced following review and concurrence on a case-by-case basis by the Director of Flight Operations and the Director of Airworthiness. Any reduction in the twelve-month period will be based on an evaluation which clearly demonstrates the operator's competence and ability to achieve the necessary reliability for the particular airplane-engine combination in extended range operations (e.g., show extensive in-service experience with a related power unit on another airplane which has achieved good reliability). In contrast, consideration for increasing the amount of time may be given for those cases where heavy maintenance has yet to occur and/or an abnormally low number of takeoffs have occurred.

9. OPERATIONAL APPROVAL CONSIDERATIONS. Any operator requesting approval under § 121.161 for extended range operations with two-engine airplanes (after providing an acceptable evaluation of the considerations in paragraphs 7 and 8) should submit the requests, with the required supporting data, to the certificate-holding office, at least 60 days prior to the proposed start of extended range operation with the specific airplane-engine combination. In considering an application from an operator to conduct extended range operations, an assessment should be made of the operator's overall safety record, past performance, flightcrew training, and maintenance programs. The data provided with the request should substantiate the operator's competence and ability to safely conduct and support these operations and should include the means used to satisfy the considerations outlined in this paragraph. Any reliability assessment obtained, either through analysis or service experience, should be used as guidance in support of operational judgments regarding the suitability of the intended operation.

a. Assessment of the Operator's Propulsion System Reliability. Following the accumulation of adequate operating experience by the world fleet of the specified airplane-engine combination and the establishment of an IFSD rate in accordance with paragraph 8 and approved in accordance with Appendix 1 for use in assuring the propulsion system reliability necessary for extended range operations, an assessment should be made of the applicant's ability to maintain this level of propulsion system reliability. This assessment should include trend comparisons of his/her data with other operators as well as the world fleet average values, and the application of a qualitative judgment that considers all of the relevant factors. The operator's past record of propulsion system reliability with related types of power units should also be reviewed, as well as, his/her record achieved with the airplane-engine combination for which authorization is sought to conduct extended range operations.

b. Engineering Modifications and Maintenance Program Considerations. Although these considerations are normally part of the operator's continuing airworthiness program, the following items will be reviewed to ensure that these programs are adequate for extended range operations.

(1) Engineering Modifications. Titles and numbers of all modifications, additions, and changes which were made to qualify airplane and propulsion systems for extended range operations should be provided to the FAA.

(2) Maintenance Procedures. Any changes to maintenance and training procedures, practices, or limitations established in the qualification for extended range operations should be submitted to the certificate-holding office for acceptance 60 days before such changes are adopted. This includes the type design maintenance requirements identified in paragraph 7b(11).

(3) Reliability Reporting. The reliability reporting program should be implemented prior to approval and continued after approval. Appendix 4 contains additional information concerning propulsion and airframe system reliability monitoring.

(4) Prompt implementation of approved modifications and inspections which would improve propulsion system and airframe system reliability.

(5) Procedures should be established which would preclude an airplane being dispatched for extended range operation after propulsion system shutdown or primary system failure on a previous flight, unless appropriate corrective action has been taken. Confirmation of such action as being appropriate, in some cases, may require the successful completion of a subsequent flight prior to dispatch on an extended range operation.

(6) A program to ensure that the airborne equipment will continue to be maintained at the level of performance and reliability required for extended range operations.

(7) An engine condition monitoring program with hard inspection times for conditions not otherwise inspectable.

(8) An engine oil consumption monitoring program.

c. Flight Dispatch Considerations.

(1) General. The flight dispatch considerations specified herein are in addition to, or amplify, the requirements contained in FAR Part 121 and specifically apply to extended range operations. Although many of the considerations in this AC are currently incorporated into approved programs for other airplanes or route structures, the unique nature of extended range operations with two-engine airplanes necessitates a reexamination of these operations to ensure that the approved programs are adequate for this purpose.

(2) Master Minimum Equipment List (MMEL). Primary system redundancy levels appropriate to extended range operations should be reflected in the MMEL. For airplanes already in operational service, the existing MMEL and the operator's MEL should be reevaluated and adjusted as appropriate in response to primary system redundancy levels necessary for extended range operations. Primary airframe systems are considered to be those systems which have a fundamental influence on flight safety and could be adversely affected by the shutdown of a power unit. Such systems may include, but are not limited to:

(i) Electrical, including battery;

(ii) Hydraulic;

(iii) Pneumatic;

(iv) Flight instrumentation;

(v) Fuel;

(vi) Flight control;

(vii) Ice protection;

(viii) Engine start and ignition;

(ix) Propulsion system instruments;

(x) Navigation and communications;

(xi) Auxiliary power-units;

(xii) Air conditioning and pressurization;

(xiii) Cargo fire suppression;

(xiv) Emergency equipment; and

(xv) Any other equipment necessary for extended range operations.

(3) <u>Communication and Navigation Facilities</u>. An airplane should not be dispatched on an extended range operation unless:

(i) Communications facilities are available to provide, under normal conditions of propagation at the normal one-engine inoperative cruise altitudes, reliable two-way voice communications between the airplane and the appropriate air traffic control unit over the planned route of flight and the routes to any <u>suitable</u> alternate to be used in the event of diversion; and

(ii) Non-visual ground navigation aids are available and located so as to provide, taking account of the navigation equipment installed in the airplane, the navigation accuracy necessary for the planned route and altitude of flight, and the routes to any alternate and altitudes to be used in the event of an engine shutdown; and

(iii) Visual and non-visual aids are available at the specified alternates for the authorized types of approaches and operating minima.

(4) <u>Fuel and Oil Supply</u>.

(i) <u>General</u>. An airplane should not be dispatched on an extended range operation unless it carries sufficient fuel and oil to meet the requirements of FAR Part 121, and any additional fuel and oil that may be determined in accordance with subparagraph 9c(4)(ii). In computing fuel and oil requirements, advantage may be taken of driftdown and at least the following should be considered as applicable:

(A) Current forecast winds and meteorological conditions along the expected flightpath at one engine inoperative cruising altitude and throughout the approach and landing;

(B) Any necessary operation of ice protection systems and performance loss due to ice accretion on the unheated surfaces of the airplane;

(C) Any necessary operation of auxiliary power units;

(D) Loss of airplane pressurization and air conditioning; consideration should be given to flying at an altitude meeting oxygen requirements in the event of loss of pressurization;

(E) An approach followed by a missed approach and a subsequent approach and landing;

(F) Navigational accuracy necessary; and

(G) Any known Air Traffic Control (ATC) constraints.

(ii) Critical Fuel Reserves. In establishing the critical fuel reserves, the applicant is to determine the fuel required to fly to the most critical point, in terms of overall fuel and oil requirements, for a diversion to a suitable alternate and then complete the critical fuel scenario in subparagraph 9c(4)(iii). These critical fuel reserves should be compared to the normal FAR Part 121 requirements for the flight. If it is determined by this comparison that the fuel to complete the critical fuel scenario exceeds the fuel that would be on board at the most critical point, as determined by FAR Part 121 requirements, additional fuel and oil should be added to the extent necessary to safely complete the critical fuel scenario. In consideration of the items listed in subparagraph 9c(4)(i), the critical fuel scenario should allow for: a contingency figure of 5 percent added to the calculated fuel burn from the critical point to allow for errors in wind forecasts, a 5 percent penalty in fuel mileage**, any CDL items, both airframe and engine anti-icing and account for ice accumulation on unheated surfaces if icing conditions are likely to be encountered during the diversion. If the APU is a required power source, then its fuel consumption should be accounted for during the appropriate phase(s) of flight. (**In lieu of an applicant's established value for inservice deterioration in cruise fuel mileage.)

(iii) Critical Fuel Scenario. The following describes a scenario to be used in determining the critical fuel reserves necessary for a diversion at the most critical point. The applicant should confirm the scenario is operationally the most critical.

(A) At the critical point, consider simultaneous failure of an engine and the pressurization system (critical point based on time to a suitable alternate at the normal one engine inoperative cruise speed).

(B) Immediate descent to and continued cruise at 10,000 feet at the normal one-engine inoperative cruise speed or above 10,000 feet if the airplane is equipped with sufficient supplemental oxygen in accordance with § 121.329.

(C) Upon approaching destination, descend to 1,500 feet above destination, hold for 15 minutes, initiate an approach followed by a missed approach and then continue a normal approach and landing.

(5) Alternate Airports. An airplane should not be dispatched on an extended range operation unless the required takeoff, destination and alternate airports, including suitable en route alternate airports to be used in the event of power-unit shutdown or airframe system failure(s) which require a diversion, are listed in the cockpit documentation (e.g., computerized flight plan). Suitable en route alternates should also be identified and listed in the ATC flight plan and the dispatch release for all cases where the planned route of flight contains a point more than one hour flying time at the one-engine inoperative speed from an adequate airport. Since these suitable en route alternates serve a different purpose than the destination alternate airport and would normally be used only in the event of an engine failure or the loss of

primary airframe systems, an airport should not be listed as a suitable en route alternate unless:

(i) The landing distances required as specified in the AFM for the altitude of the airport, for the runway expected to be used, taking into account wind conditions, runway surface conditions, and airplane handling characteristics, permit the airplane to be stopped within the landing distance available as declared by the airport authorities and computed in accordance with § 121.197.

(ii) The airport services and facilities are adequate for the applicant operator's approved approach procedure(s) and operating minima for the runway expected to be used; and

(iii) The latest available forecast weather conditions for a period commencing one hour before the established earliest time of landing and ending one hour after the established latest time of landing at that airport, equals or exceeds the authorized IFR weather minima for en route alternate airports in Appendix 3. In addition, for the period commencing one hour before the established earliest time of landing, and ending one hour after the established latest time of landing at that airport, the forecast crosswind component, including gusts, for the intended landing runway should be less than the maximum permitted crosswind for landing.

(6) Airplane Performance Data. No airplane should be dispatched on an extended range flight unless the operator's Operations Manual contains:

(i) Detailed one-engine inoperative performance data covering:

(A) Driftdown,

(B) Cruise (altitude coverage including 10,000 feet),

(C) Holding,

(D) Altitude capability, and

(E) Missed approach.

(ii) Details of any other conditions relevant to extended range operations which can cause significant deterioration of performance, such as ice accumulation on the unheated surfaces of the airplane, Ram Air Turbine (RAT) deployment, etc.

d. Flightcrew Training and Evaluation Program. The operator's training program in respect to extended range operations should provide training for flight crewmembers followed by subsequent evaluations and proficiency checks in the following areas:

(1) Performance.

(i) Flight planning, including all contingencies.

(ii) Flight performance progress monitoring.

(2) Procedures.

(i) Diversion procedures.

(ii) Use of appropriate navigation and communication systems.

(iii) Abnormal and emergency procedures to be followed in the event of forseeable failures, including:

(A) Procedures for single and multiple failures inflight that would precipitate go/no-go and diversion decisions.

(B) Operational restrictions associated with these failures including any applicable MEL considerations.

(C) Procedures for air start of the propulsion systems, including the APU, if required.

(D) Crew incapacitation.

(iv) Use of emergency equipment including protective breathing and ditching equipment.

(v) Understanding and effective use of approved additional or modified equipment required for extended range operations.

e. Operational Limitations.

(1) Area of Operation.

(i) An operator may be authorized to conduct extended range operations within an area where the following considerations can be met:

(A) The diversion time, at any point along the proposed route of flight to an adequate airport, is 120 minutes or less at the normal one-engine inoperative cruise speed (under standard conditions in still air), and

(B) At least 50 percent of any route segment, which is considered extended range, is less than 90 minutes diversion time from an adequate airport at the normal one-engine inoperative cruise speed (under standard conditions in still air).

(ii) The area which meets the considerations in subparagraph 9e(1)(i) may be approved for extended range operations with two-engine airplanes and should be specified in the operations specifications as the authorized area of operations.

(2) Flight Dispatch Limitation. The flight dispatch limitation should specify the maximum diversion time from a suitable airport an operator can conduct a particular extended range operation. The maximum diversion time in still air at the normal one-engine inoperative cruise speed should not be any greater than the value established by subparagraphs 9e(2)(i) or 9e(2)(ii). Authorization for operations beyond these values will not be considered until operational experience, in extended range operation with two-engine airplanes, clearly indicates that further credit is appropriate.

(i) Use of Standard Maximum Diversion Time. The flight dispatch considerations should ensure that extended range operation is limited to flight plan routes where a maximum diversion time of 120 minutes or less at the normal one-engine inoperative cruise speed in still air to suitable airports can be met. Operators should provide for:

(A) Compliance with § 121.565 of the FAR whereupon occurrence of an in-flight shutdown of an engine, the pilot should fly to and land at the nearest suitable airport in point of time at which a safe landing can be made; and

(B) A practice to be established such that in the event of a single or multiple primary system failure, the pilot will fly to and land at the nearest suitable airport, unless it has been demonstrated that no substantial degradation of safety results from continuation of the planned flight.

(ii) Increased Maximum Diversion Time. Although still constrained by the area of operation authorized in accordance with subparagraph 9e(1) (i.e., 120 minutes from an adequate airport), those operators who also choose to demonstrate the additional capabilities discussed in this paragraph may be approved, on a case-by-case basis, for an increase in maximum diversion time from a suitable airport. Based upon the approval of the FAA Director of Flight Operations, the operator's Flight Dispatch Considerations could provide for an increase of up to 15 percent in maximum diversion time at the normal one-engine inoperative cruise speed in still air from suitable airports. The operator obtains this additional approval by establishing the following capabilities, practices, and procedures:

(A) Special maintenance practice and procedures which result in the operator's single engine in-flight shutdown rate being significantly below the world fleet average for the particular airplane-engine combination and achieves a very low quantity of continuing noncritical MEL items by thorough and timely action on maintenance discrepancies.

(B) Special operating practices and procedures for use of such items as: Category II/III authorization, special MEL provisions, VHF/HF/ satellite data link for weather dissemination, and preplanned contingency actions for at least the five most probable operating contingencies including engine and airframe system failures.

(C) Special crew training which includes operational procedures for use in operating contingencies and other special qualifications such as Category II/III (AC 90-79, Recommended Practices and Procedures for the Use of Electronic Long-Range Navigation Equipment), point-of-safe-return/radius-of-action, etc.

(D) Special operational control practices and procedures which maintain close contact between flightcrews and the operational control system to provide immediate technical and operational guidance to assist flightcrews in making go/no-go and diversion decisions.

(E) Special equipment which would enhance the capabilities of the airplane and flightcrew in extended range operation, for example: approved Category II/III capability, flight management computers which would provide readily accessible range, performance, and navigation information to all required alternate airports, VHF/HF/satellite data link equipment to enhance reliability and timeliness of communications, automated flight phase status monitoring systems which significantly enhance the flightcrew's ability to make timely go/no-go and diversion decisions, etc.

(3) Contingency procedures or plans should not be interpreted in any way which prejudices the final authority and responsibility of the pilot-in-command for the safe operation of the airplane.

f. Operations Specifications.

(1) An operator's two-engine airplane should not be operated on an extended range flight unless authorized by operations specifications approval (both maintenance and operations).

(2) Operations specifications for extended range operations should specifically include provisions covering at least the following:

(i) Part D should define the particular airplane-engine combinations, including specification of modifications required for extended range operation.

(ii) Authorized area of operation.

(iii) Minimum altitudes to be flown along planned and diversionary routes.

(iv) The maximum diversion time, at the normal one-engine inoperative cruise speed, that any point on the route may be from a suitable airport for landing.

(v) Airports authorized for use, including alternates, and associated instrument approaches and operating minima;

(vi) Maintenance--the approved maintenance program for extended range operations including those items specified in the type design approval.

(vii) Identification of those airplanes designated for extended range operation by make and model as well as serial and registration numbers.

g. Operational Validation Flight. The operator should demonstrate, by means of FAA-witnessed validation flight using the specified airplane-engine combination, that it has the competence and capability to safely conduct and adequately support the intended operation. The following emergency conditions should be demonstrated during the validation flight unless successful demonstration of these conditions has been witnessed by the FAA in an acceptable simulation prior to the validation flight:

(1) Total loss of thrust of one-engine; and

(2) Total loss of engine generated electrical power; or

(3) Any other condition considered to be equivalent in airworthiness, crew workload, or performance risk.

h. Extended Range Operations Approval. Following a type design approval for extended range operations in accordance with paragraph 7 and satisfactory application of the criteria in paragraphs 8 and 9 and prior to the issuance of operations specifications, the operator's application, as well as, the certificate-holding office's principal inspectors' (Principal Maintenance Inspector, Principal Avionics Inspector, Principal Operations Inspector) recommendations and supporting data should be forwarded to the Directors of Flight Operations and Airworthiness for their review and concurrence. Following the review and concurrence from the Director of Flight Operations, the operational validation flight should be conducted in accordance with any additional guidance specified in this review and concurrence. When the data from the operational validation flight has been analyzed and found acceptable, an applicant may be authorized to conduct extended range operations with two-engine airplanes. Approval to conduct extended range operations is made by the issuance of operations specifications containing appropriate limitations.

10. CONTINUING SURVEILLANCE. The fleet average IFSD rate for the specified airplane-engine combination will continue to be monitored in accordance with Appendix 1. As with all other operations, the certificate-holding office should also monitor all aspects of the extended range operations it has authorized to ensure the levels of reliability achieved in extended range operations remain at the necessary levels and that the operation continues to be conducted safely. In the event that an acceptable level of reliability is not maintained, or if significant deficiencies are detected in the type design or the conduct of this operation, the certificate-holding office should assure that the operator takes all necessary action to resolve the problems in a timely manner, or should withdraw the authorization for extended range operations. The certificate-holding office should alert the Type Design Certification Office if the deficiency could involve the type design.

11. FAA ENGINE RELIABILITY REPORT. An FAA propulsion system reliability report will be published providing the results of the assessment of the world fleet engine reliability as it relates to design and operations for a particular airplane-engine combination. This will be done in accordance with Appendix 1.

Anthony J. Broderick
Associate Administrator for Aviation Standards

APPENDIX 1. PROPULSION SYSTEM RELIABILITY ASSESSMENT AND REPORT

1. General. In order to establish if a particular airplane-engine combination has satisfied the propulsion system reliability requirements for extended range operations, a thorough assessment will be conducted by a group of FAA specialists utilizing all the pertinent engine and airplane propulsion system data and information available (includes the APU, if required). Engineering and operational judgment supported by the relevant statistics will be used to determine current propulsion system reliability. The findings of the specialist group will be documented and provided to the Transport Airplane Certification Directorate (FAA Northwest Mountain Region) responsible for the type design certification of that airplane. The findings of the specialist group, as well as the Transport Airplane Certification Directorate's recommendations and supporting data, will be forwarded to the Directors of Flight Operations and Airworthiness for review and concurrence.

a. Assessment. To adequately assess propulsion system reliability for extended range type design, continuing airworthiness and operational approval, certain world-fleet data and information are required. The specialist group intends to maximize the use of existing sources and kinds of data generally available; however, additional data may be required in certain cases. In support of applications for extended range type approval, data should be provided from various sources to ensure completeness, i.e., engine manufacturer, operator, and airplane manufacturer. Data so provided should include all event descriptions, qualifications, and any pertinent details necessary to help determine the impact on propulsion system reliability. To provide a reasonable indication of reliability trends and significant problem areas, accumulation of 250,000 engine hours is normally necessary in the world fleet before the assessment process can produce meaningful results. This number of hours may be reduced if adequate compensating factors are established which give a reasonable equivalent data base. For example, a wide distribution of the total engine hours accumulated by the world fleet may be adequate to show reliability trends and significant problems at total times less than the 250,000 hours, or the use of the same engine model on a different airplane installation, if the experience is extensive and appropriate, may be adequate to establish the necessary reliability prior to attaining 250,000 hours.

b. Report. Once an assessment has been completed and the FAA specialist group has documented its findings, the FAA will publish a report that will declare whether or not the current propulsion system reliability of a particular airplane-engine combination satisfies the relevant considerations of this AC. The report will specify items recommended to qualify the propulsion system suitable for extended range operation, such as, the recommended propulsion system type design configuration, operating conditions, maintenance requirements and limitations. Any questions on the report should be addressed to the Transport Airplane Certification Directorate (FAA Northwest Mountain Region).

2. Concepts. No single parameter by itself, without other data/information, can adequately qualify reliability. There are a number of variables, maintenance and operating statistics and general information about the

operational experience of a particular power unit, which characterize propulsion system reliability. Engineering and operational judgment is utilized to determine the adequacy and applicability of these data and information to extended range operation and to determine the suitability of the airplane for extended range operations. As an aid in making this judgment, statistical analysis will be used to help determine that the desired level of reliability is obtained.

a. Necessary Data. Certain world-fleet data and information are necessary to adequately assess propulsion system reliability for extended range operations. These data include:

(1) A list of all engine shutdown events both ground and inflight for all causes (excluding normal training events) including flameout. The list should provide the following for each event: date, airline, airplane and engine identification (model and serial number), power unit configuration and modification history, engine position, symptoms leading up to the event, phase of flight or ground operation, weather/environmental conditions, and reason for shutdown. In addition, similar information should be provided for all occurrences where achieved thrust was below the intended level, for whatever reason.

(2) Unscheduled engine removal rate and causes.

(3) Dispatch delays, cancellations, and en route diversions chargeable to the propulsion system.

(4) Total engine hours and airplane cycles (if known, include engine-hour distribution, e.g., percent of world fleet of engines at -- 1,000 hours, 2,000 hours, etc.)

(5) Meantime between failure of propulsion system components that affect reliability.

(6) Additional data as specified by the specialist group.

b. Engineering Assessment. The methodology to be used by the FAA in finding adequate propulsion system reliability will be a problem-oriented approach using fail-safe concepts, engineering and operational judgment and reliability analysis, and will consist of:

(1) An analysis, on a case-by-case basis, of all significant failures, defects and malfunctions experienced in service (or during testing) for the airplane/engine combination being addressed. Significant failures are principally those causing or resulting in in-flight shutdown or flameout of the engine(s), but may also include unusual ground failures and/or unscheduled removal of engines from the airplane. In making the assessment, consideration will be given to the following:

(i) The type of power unit, previous experience, whether the power unit is new or a derivative of an existing model, and the engine operating rating limit to be used with one-engine shutdown.

(ii) The trends in cumulative and 6- and 12-month rolling average, updated quarterly, of in-flight shutdown rates versus propulsion system flight hours and cycles.

(iii) The effect of corrective modifications, maintenance, etc., on the possible future reliability of the propulsion system.

(iv) Maintenance actions recommended and performed and its effect on engine and APU failure rates.

(v) The accumulation of operational experience which covers the range of environmental conditions likely to be encountered.

(vi) Intended maximum flight duration, approved maximum diversion and mean diversion time used in extended range operation:

(2) An assessment of the corrective actions taken for each problem identified with the objective of verifying that the action is sufficient to correct the deficiency.

(3) When each identified significant deficiency has a corresponding FAA-approved corrective action and when all corrective actions are satisfactorily incorporated and verified, the FAA determines that an acceptable level of reliability can be achieved. Statistical corroboration will also be utilized. (Note: In the statistical analysis, factors may be applied to establish second engine shutdown rate for determining probability of total thrust loss on both engines. If necessary, the factor will be established using standard engineering practice considering items like the variability of the statistical data, adverse trends, quantity of information, etc.)

(i) Any certification inspections and tests that may be necessary to approve these corrective actions will be the responsibility of the appropriate Aircraft Certification Office.

(ii) The required corrective action and modifications, as specified in the FAA's Report, will be included in the type design standard necessary for final type approval of the airplane for extended range operation.

(4) When foreign manufacturer's and/or operator's data are being evaluated, the respective foreign airworthiness authorities will be offered the opportunity to participate and will be briefed by the FAA during the proceedings and provided a copy of the final report.

(5) Statistical Analysis. As a complement to the engineering and operational judgment, the statistical risk of total or unacceptable thrust loss will be determined. The Propulsion System Reliability Assessment Board will determine the statistical reliability for two categories -- those relating to type design and operations.

(i) Type Design. A determination will be made that the type design of the propulsion system can achieve the desired level of reliability. The FAA will determine if the probability of total/unacceptable thrust loss on both engines due to design--related independent causes is 10^{-9} per hour or less.

(ii) Operation. A determination will be made of the propulsion system's ability to achieve the desired level of operational reliability in extended range operations, the FAA will determine if the probability of total/unacceptable thrust loss on both engines for all independent causes is 10^{-8} per hour or less.

APPENDIX 2. THE FAA FAIL-SAFE DESIGN CONCEPT

1. Fail-Safe is the design methodology upon which FAR Part 25 airworthiness standards are based. It requires the effect of failures and combination of failures be considered in defining a safe design. The following basic rules involving failure events apply:

a. In any system or subsystem a single failure of any element or connection during any one flight (brake release through ground deceleration to stop) must be assumed without consideration as to its probability of failing. This single failure event must not prevent the continued safe flight and landing of the airplane.

b. Additional failure events during any one flight following the first single failure must also be considered when the probability of occurrence is likely (i.e., those combinations of failures not shown to be extremely improbable). The probability of these combined failures includes the probability of occurrence of the first failure event. If a critical failure event cannot readily be detected, it must be counted a latent existing failure in addition to the first failure.

2. The following design principles and techniques are utilized to prevent single failures and combinations of failures from jeopardizing the continued safe flight and landing of the airplane:

a. Redundancy or back up systems that provide system function after the first failure, i.e., two or more engines, two or more hydraulic systems, dual flight controls, etc.

b. Isolation of systems and components so that failure of one element will not cause failure of the other. Sometimes referred to as system independence.

c. Detection of failures or failure indication.

d. Functional verification, the capability for testing or checking the component's condition.

e. Proven reliability and integrity to assure that multiple component or system failures will not occur in the same flight.

f. Damage tolerance that limits the safety impact or effect of the failure.

g. Designed failure path that controls and directs the failure event by design to limit the safety impact.

h. Flightcrew procedures following the failure event designed to assure continued safe flight by specific crew actions.

3. The FAA fail-safe design concept utilizes all of the preceding eight design principles in whatever combination is required to produce a safe design. The employment of only one of the above principles is seldom adequate; generally, two or more are used in the design to satisfy the fail-safe design concept (i.e., assures that catastrophic failures will be extremely improbable).

APPENDIX 3. SUITABLE EN ROUTE ALTERNATE AIRPORTS

1. General.

a. One of the distinguishing features of two-engine extended range operations is the concept of a suitable en route alternate airport being available to which an aircraft can divert after a single failure or failure combinations which require a diversion. Whereas most two-engined airplanes operate in an environment where there is usually a choice of diversion airports available, the extended range airplane may have only one alternate within a range dictated by the endurance of a particular airframe system (e.g., cargo fire suppressant), or by the approved maximum diversion time for that route.

b. It is, therefore, important that any airport designated as an en route alternate has the capabilities, services, and facilities to safely support that particular airplane, and the weather conditions at the time of arrival provide a high assurance that adequate visual references are available upon arrival at decision height (DH) or minimum descent altitude (MDA), and the surface wind conditions and corresponding runway surface conditions are within acceptable limits to permit the approach and landing to be safely completed with an engine and/or systems inoperative.

2. Adequate Airport. As with all other operations, an operator desiring any route approval should show that it is able to satisfactorily conduct scheduled operations between each required airport over that route or route segment. Operators should show that the facilities and services specified in FAR Parts 121.97 through 121.107 for domestic and flag air carriers (FAR Parts 121.113 through 121.127 for supplemental air carriers and commercial operators) are available and adequate for the proposed operation. For the purpose of this advisory circular, in addition to meeting FAR Part 121 requirements, those airports which meet the provisions of FAR Part 139 and those foreign airports which are determined to be equivalent to the provisions of subparts D and E of FAR Part 139 for that particular airplane are considered to be adequate airports.

3. Suitable Airport. For an airport to be suitable for the purpose of this advisory circular, it should have the capabilities, services, and facilities necessary to be designated as an adequate airport and have weather and field conditions at the time of the particular operation which provide a high assurance that an approach and landing can be safely completed with an engine and/or systems inoperative in the event that a diversion to the en route alternate becomes necessary. Due to the natural variability of weather conditions with time as well as the need to determine the suitability of a particular en route airport prior to departure, the en route alternate weather minima for dispatch purposes are generally higher than the weather minima necessary to initiate an instrument approach. This is necessary to assure that the instrument approach can be conducted safely if the flight has to divert to the alternate airport. Additionally, since the visual reference necessary to safely complete an approach and landing is determined, among other things, by the accuracy with which the airplane can be controlled along the approach path

by reference to instruments and the accuracy of the ground-based instrument aids, as well as the tasks the pilot is required to accomplish to maneuver the airplane so as to complete the landing, the weather minima for nonprecision approaches are generally higher than for precision approaches.

4. The following Standard En Route Alternate Airport Weather Minima are established for flight planning and dispatch purposes with two-engine airplanes in extended range operations. These weather minima recognize the benefits of ILS/MLS, as well as the increased assurance of safely completing an instrument approach at airports which are equipped with ILS/MLS approaches to at least two separate runways. A particular airport may be considered to be a suitable airport for flight planning and dispatch purposes for extended range operations if it meets the criteria of paragraph 3 of this appendix and has one of the following combinations of instrument approach capabilities and en route alternate airport weather minima.

a. A single ILS/MLS:

Ceiling of 600 feet and a visibility of 2 statute miles or a ceiling of 400 feet and a visibility of 1 statute mile above the lowest authorized landing minima; whichever is higher.

b. Two or more separate ILS/MLS equipped runways:

Ceiling of 400 feet and a visibility of 1-1/2 statute miles or a ceiling of 200 feet and a visibility of 1 statute mile above the lowest authorized landing minima; whichever is higher.

c. Nonprecision approach(es):

Ceiling of 800 feet and a visibility of 2 statute miles or a ceiling of 400 feet and a visibility of 1 statute mile above the lowest authorized landing minima; whichever is higher.

5. Lower than Standard En Route Alternate Airport Weather Minima may be considered for approval for certain operators on a case-by-case basis by the Director of Flight Operations at suitably equipped airports for certain airplanes which have the certificated capability to safely conduct Category II and/or Category III approach and landing operations after encountering any failure condition in the airframe and/or propulsion systems which would result in a diversion to an en route alternate airport. Subsequent failures during the diversion, which would result in the loss of the capability to safely conduct and complete Category II and/or Category III approach and landing operations, should be shown to be improbable. The certificated capability of the airplane should be evaluated considering the approved maximum diversion time. Although, as of the date of this advisory circular existing airplanes are not certificated to have these capabilities, lower than standard en route alternate weather minima could be considered at suitably equipped airports, in the future

if appropriate, for those airplanes which have these approved capabilities considering the established maximum diversion time.

6. The suitability of an en route alternate airport for an airplane which encounters a situation inflight which necessitates a diversion, including the provisions of § 121.565, while en route on an extended range operation is based on a determination that the airport is still suitable for the circumstances, and the weather and field conditions at that airport will permit an instrument approach to be initiated and a landing completed.

APPENDIX 4. PROPULSION AND AIRFRAME SYSTEMS RELIABILITY MONITORING

1. General. In extended range operations, as well as operations with other airplanes or route structures, it is necessary for an operator to collect and analyze certain data to support its approved maintenance program. Although the means of collecting the data may vary, each operator should have an acceptable method for collecting the data necessary to analyze and track airframe and propulsion system reliability for the airplanes used in extended range operations.

2. Assessment.

a. Each operator approved for extended range operations should have a program to continually assess the propulsion and airframe systems reliability within the extended range fleet which incorporates a data collection and analysis system as outlined in AC 120-17A (or equivalent), Maintenance Control by Reliability Methods, Chapter 2, paragraph 15a and 15b.

b. The operator's assessment of the airplane's reliability for the extended range fleet configuration should be made available to the FAA with the supporting data, as outlined in AC 120-17A (or equivalent), Chapter 2, paragraph 15e, to assure the approved maintenance programs continue to maintain a level of reliability necessary for extended range operations.

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