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AC 120-28D

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CRITERIA FOR APPROVAL OF CATEGORY III WEATHER MINIMA FOR TAKEOFF, LANDING, AND ROLLOUT

1. Purpose. This advisory circular (AC) provides an acceptable means, but not the only means, for obtaining and maintaining approval of operations in Category III Landing Weather Minima and low visibility takeoff including the installation and approval of associated aircraft systems. It includes additional Category III criteria or revised Category III criteria for use in conjunction with Head-up Displays, satellite navigation systems, low visibility takeoff guidance systems, Wide-body Fail Passive operations and use of Category III during certain engine inoperative operations. This revision also updates and incorporates provisions of the former AC 20-57 into AC 120-28.

This revision incorporates changes resulting from the first steps toward international all weather operations (AWO) criteria harmonization taken by the Federal Aviation Administration (FAA), European Joint Aviation Authorities (JAA), and several other regulatory authorities. Subsequent revisions of this AC are planned as additional all weather operations harmonization items (AHI) are agreed and completed by FAA JAA, and other regulatory authorities.

L. Nicholas Lacey
Director, Flight Standards Service

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APPENDIX 7 OPERATIONS SPECIFICATIONS - GENERAL
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1. PURPOSE. This advisory circular (AC) provides an acceptable means, but not the only means, for obtaining and maintaining approval of operations in Category III Landing Weather Minima and low visibility takeoff including the installation and approval of associated airborne systems. This AC is applicable to Title 14 of the Code of Federal Regulations (14 CFR) part 121, 135 and 125 operators. Certain aspects of this AC are applicable to 14 CFR part 129 operators. Many of the principles, concepts and procedures described also may apply to 14 CFR part 91 operations and are recommended for use by those operators when applicable. Mandatory terms used in this AC such as "shall" or "must" are used only in the sense of ensuring applicability of these particular methods of compliance when the acceptable means of compliance described herein is used. This AC does not change, add or delete regulatory requirements or authorize deviations from regulatory requirements.

CANCELLATION. AC 120-28C, dated March 9, 1984, and AC 20-57A dated January 12, 1971, are canceled.

2. RELATED REFERENCES AND DEFINITIONS.

2.1. Related References. Title 14 of the Code of Federal Regulations (14 CFR) part 23, section 23.1309; part 25, sections 25.1309, 25.1322, 25.1581, and 25.1583; part 91, sections 91.175 and 91.189; part 121, sections 121.579, and 121.651; part 125, sections 125.379, and 125.381; part 129, section 129.11; and part 135, section 135.225.

Unless a specific reference is made to a particular version of a rule or AC, current editions of the following AC's should be used:

AC 23.1309-1, Equipment, Systems, and Installation in Part 23 Airplanes

AC 25-7A, Flight Test Guide for Certification of Transport Category Airplanes

AC 25.1309-1, System Design Analysis

AC 120-29, Criteria for Approving Category I and Category II Landing Minima for 14 CFR Part 121 Operators

Standard Operations Specifications Parts A and C,

FAA Order 8400.8, Procedures for Approval of Facilities for FAR Part 121 and Part 135 Category III Operations

FAA Order 8400.10, Air Transportation Operations Inspector's Handbook

2.2. Definitions. A comprehensive set of definitions pertinent to Category III approach and landing and low visibility takeoff is included in Appendix 1.

Within this AC, Runway Visual Range (RVR) values are specified in units of feet (ft.) unless otherwise noted (e.g., meters (m)).

Where visibility minima are stated in both feet and meters (e.g., RVR300 (75m)) using values other than those identified as "equivalent" in standard operations specifications, it is intended that the RVR value in feet apply to minima specified in feet, and the value in meters apply in states specifying their minima in meters.

Minima typically used for low visibility operations including a minima conversion table where applicable are provided in the operations specifications shown in Appendix 7.

In this AC, where the term "RNP Level" is used, it may be considered to be equivalent to the term "RNP Type" typically used in some current ICAO and other authority references. The term "RNP Level" is used in the U.S. to match various RNP approval documents (e.g., AFM's) already in widespread use, and to reserve use of the term "RNP Type" for future anticipated RNP applications.

3. BACKGROUND.

3.1. Major Changes Addressed in this Revision. This AC includes additional Category III criteria or revised Category III criteria for use in conjunction with Head-up Displays, satellite navigation systems, low visibility takeoff guidance systems, Wide-body Fail Passive operations and use of Category III during certain engine inoperative operations.

This revision also updates and incorporates provisions of the former AC 20-57 into AC 120-28, since provisions of the former AC 20-57 are directly related to and dependent on criteria provided in this AC.

This revision incorporates changes resulting from the first steps toward international all weather operations (AWO) criteria harmonization taken by the Federal Aviation Administration (FAA), the European Joint Aviation Authorities (JAA), and several other regulatory authorities. Subsequent revisions of this AC are planned as additional all weather operations harmonization items (AHI) are agreed and completed by FAA and JAA, or internationally.

3.2. Relationship of Operational Authorizations for Category III and Airborne System Demonstrations. Takeoff and landing weather minima are approved through applicable operating rules, use of approved instrument procedures and issuance of operations specifications. Airworthiness demonstration of airborne equipment and systems is usually accomplished in support of operational authorizations on a one time basis at the time of Type Certification (TC) or Supplemental Type Certification (STC). Since operating rules continuously apply over time and may change after airworthiness demonstrations are conducted, or may be updated consistent with safety experience, additional Category III credit or constraints may apply to operators or aircraft as necessary for safe operations. Airworthiness demonstrations are based on the particular operational and airworthiness criteria in effect at the time a type design certification basis is established for a particular TC or STC.

Subsequent operational authorizations may constrain capabilities originally demonstrated based on current operational regulatory policy and experience. The main body of this AC contains criteria related to operational approval and Appendix 2 and Appendix 3 are the primary source of airworthiness criteria. Nothing in this AC is intended to preclude an operator from proposing and demonstrating to the FAA the ability to operate to Category III minima with a different equipment configuration; or alternatively to an RVR minima lower than that presently described in this document.

3.3. Applicable Criteria. AC 120-28C, dated March 9, 1984, and AC 20-57A dated January 12, 1971 are canceled. Except as described below, new airworthiness demonstrations or operational authorizations should use criteria of AC 120-28D. Airworthiness demonstrations may use equivalent JAA criteria where agreed by FAA through the FAA/JAA criteria harmonization process.

In general, the provisions of the main body of this AC outline concepts, objectives, and provisions necessary for operators. The appendices contain definitions, abbreviations, airworthiness demonstration provisions typically applied in conjunction with type certification, technical information necessary for airworthiness or operational assessments (e.g., atmospheric/wind models, obstacle clearance criteria) and examples of operational authorizations (e.g., sample Operations-Specifications (OpSpecs)). Certain criteria related to airworthiness assessment are included in the main body of the AC primarily to address the status and eligibility of previously certificated in-service aircraft for current authorizations (e.g., status of service bulletin compliance for continued or new authorizations, demonstration provisions applicable to "in-service" aircraft).

Operators electing to comply with this AC's revised criteria may receive the applicable additional credit(s). Aircraft manufacturers, operators or modifiers may elect to demonstrate that their aircraft meet the revised criteria to seek additional credit for any particular operation (e.g., HUD installation) or for all operations addressed by this AC (e.g., incorporation of a general compliance statement related to AC 120-28D, instead of reference to the former canceled criteria of AC 120-28C). However, aircraft demonstrated to earlier criteria may continue to be approved for Category III operations in accordance with that earlier criteria, and applicants may continue to make reference to the fact that an earlier demonstration was based on that previous criteria
(e.g., in the AFM). Aircraft manufacturers, modifiers or operators seeking authorization provided for only in this AC must, however, use applicable criteria of this AC (e.g., for RNP based missed approach obstacle criteria, meet pertinent provisions of Appendix 9). To get a particular authorization cited by this AC, the operator need only meet the provision or provisions applicable (e.g., RVR600 fail passive landing minima may be authorized per 4.3.8 for presently authorized airborne systems meeting previous criteria without regard to Appendix 3 criteria).

4. OPERATIONAL CONCEPTS.

4.1. Classification and Applicability of Minima. Landing minima are generally classified by Category I, Category II and Category III (e.g., see ICAO Annex 6 references, and the associated

ICAO Manual of All Weather Operations DOC 9360/AN910, 2nd Edition, 1991). AC 120-29 (as amended) addresses Category I and II. This AC addresses Category III.

Takeoff minima are usually classified by RVR or meteorological visibility, and other factors (e.g., aircraft characteristics).

Although a wide variety of normal and non-normal situations are considered in the design and approval of systems used for Category III, Category III minima are primarily intended to apply to normal operations.

For non-normal operations, flightcrews are expected to take the safest course of action appropriate for the situation, including consideration of normal landing weather minima. When aircraft systems have been demonstrated to account for certain non-normal configurations (e.g., an approach with an engine inoperative) flightcrew may take into account this information in assessing the safest course of action.

4.2. Takeoff. Takeoff minimums are included in standard operations specifications. This AC addresses criteria for takeoff in low visibility conditions where additional aircraft equipment is provided to assist the pilot in a low visibility takeoff, or is required to assure safe operations when using minima below values acceptable for exclusive use of visual reference.

Standard OpSpecs list minima acceptable to FAA for manual control based exclusively on visual reference.

Authorization of takeoff minima below the level supported by use of visual reference alone requires use of a guidance system which has been demonstrated to provide an acceptable level of performance and satisfactory workload for the minima approved, with or without use of visual reference. The performance and workload assessment of such a system must have considered any compensation that may be introduced by the pilot for particular guidance system characteristics (e.g., coping with a slight localizer signal offset during initial runway alignment) or concurrent pilot use of the guidance system with limited or patchy visual references.

Systems intended to be used at or above the minima authorized for visual reference alone (e.g., as a supplement to manual control) may be used if demonstrated to be:

1) Safe in normal use, and

2) If there is no unacceptable increase in pilot workload or significant adverse effect on crew coordination, and

3) If the system is unlikely to introduce a significant hazard if a failure or degradation of the system itself occurs, and

4) If the system is unlikely to introduce a significant additional hazard if other potential failures in the aircraft occur (e.g., engine failure, electrical component failure), and

5) A failure or anomaly in a NAVAID(s) used does not introduce a significant hazard.

Authorized minima for such systems may be no lower than that specified for manual control using visual reference alone.

If low visibility takeoff operations are predicated on the use of RNP, then the provisions applicable to RNP apply only following liftoff, after passing 35 ft. above the published elevation of the runway.

A proof of concept demonstration is necessary for initial authorization of takeoff minima less than RVR300 ft./75m.

Criteria for demonstration of systems eligible for takeoff minima below the level supported by use of visual reference alone are found in section 5.1.3 for operational authorization or Appendix 2 for systems proposed for airworthiness demonstration.

4.3. Landing.

4.3.1. Concepts and Objectives. Category III landing minima are classified as Category IIIa, Category IIIb or Category IIIc. Definitions of these categories are provided in Appendix 1. Visual conditions encountered in Category III operations range from visual references being adequate for manual control during rollout (e.g., Category IIIa) to visual references being inadequate even for taxi operations without special visual reference enhancements or suitable synthetic references. For any Category III operation, the airplane and external system requirements established (e.g., position fixing) should be compatible with any visual reference requirements that are specified.

Category III operations may be conducted manually using Flight Guidance Displays, or automatically using approved autoland system or with Hybrid Systems which employ both automatic and flight guidance elements. If the particular Flight Guidance Display depicts flight director or other command guidance it may be approved in accordance with this AC, or equivalent. Situational Flight Guidance Displays may be used if the Proof of Concept (PoC) is satisfactorily demonstrated. When an automatic system is to be the primary means of control the use of that system should not require pilot intervention. The means for crew intervention must be provided, however, in the unlikely event the pilot detects or strongly suspects inadequate system performance (e.g., the pilot determines that an automatic landing cannot be accomplished within the touchdown zone). If a Hybrid system is employed, then the primary mode of operation must be automatic to touchdown, with manual control used only as an alternate means to complete the operation.

To be approved for Category III operations, the airplane and its associated systems should be shown to be capable of safely completing an approach, touchdown, and rollout and permitting a safe go-around from any altitude to touchdown following any failure condition not shown to be extremely improbable.

Cockpit design, instrumentation, annunciations and warning systems, should be adequate in combination to assure that the pilot can verify that the aircraft should touch down within the touchdown zone and safely rollout if the controlling visibility is reported at or above applicable minima. Systems based on automatic control to touchdown, or touchdown and rollout and manually flown flight guidance system (e.g., HUD), have been approved by FAA. Other concepts may be acceptable if Proof of Concept [PoC] testing can demonstrate an equivalent or greater level of safety as presently specified for approval of automatic systems (e.g., hybrid systems or vision enhancement systems).

To be approved for Category III operations, the airplane and its associated systems should be shown to be able to perform to the necessary level of accuracy, integrity, and availability. This is typically shown initially during airworthiness demonstration, is confirmed during the operational authorization process, and is monitored by the operator on a continuing basis.

Category III operations are predicated on meeting requirements for Category II, or equivalent, for that portion of the approach prior to 100' HAT (see the current version of AC 120-29 for approval of Category II).

If Category III operations are predicated on the use of RNP, then the provisions of this AC or any subsequent current version of AC120-29A, or other suitable FAA criteria for application of RNP are considered to be acceptable to apply to definition of any instrument approach procedure segment down to 100 ft. HAT.

Below 100 ft. HAT, the provisions of this or any subsequent version of AC120-28 are considered to be the applicable criteria to assure the necessary performance for landing, flare and rollout.

For a go-around and missed approach from DA(H), Alert Height (AH), or the end of the touchdown zone for a rejected landing, RNP provisions may be applied from the point of initiation of a go-around to completion of the applicable missed approach procedure, in accordance with provisions of this version of AC 120-29, any subsequent current version, or any other RNP criteria found acceptable to the FAA.

4.3.2. Fail Operational Category III Operations. A Fail Operational System is a system which after failure of any single component, is capable of completing an approach, flare and touchdown, or approach, flare, touchdown and rollout by using the remaining operating elements of the Fail Operational system. The failure effects of single components of the system, airplane or equipment external to the airplane which could have an effect on touchdown or rollout performance must be considered when evaluating Fail Operational systems. Fail Operational systems may be used to touchdown for Category IIIa (e.g., without a rollout system) or Category IIIb through rollout to a full stop. Use of a fail-operational system to touchdown in conjunction with a rollout system that is not fail-operational is acceptable as long as a suitable minimum RVR is specified in the operations specifications, for rollout.

This AC contains criteria for approval of minima as low as RVR150 using a fail-operational system for landing and rollout. Approval of minima less than RVR150 would require a proof of concept [PoC] demonstration.

> Note: A landing system is considered to include each of the elements in the aircraft which are necessary to perform the landing and rollout function (e.g., flight control, hydraulic system(s), electrical system(s), sensors).

The required redundancy may be provided by multiple automatic landing systems, by multiple automatic landing and rollout systems, by redundant manual flight guidance systems, or by suitably redundant hybrid systems.

The reliability and performance of the required operational systems should be such that continued safe operation to landing, or landing and rollout, can be achieved following any failure condition occurring below the Alert Height that is not shown to be extremely improbable. Systems identified below and in 4.3.3 through sections 4.3.8, or equivalent, are considered to meet the intent of this provision.

Failure conditions which result in the loss or disconnect of all the redundant landing, or landing and rollout systems, occurring below the Alert Height, are permissible if the occurrence of these failure conditions is extremely remote and the loss or disconnect is accompanied by acceptable warning indications for the pilots. Airplanes which are demonstrated to meet the airworthiness assessments of Appendix 3 for fail operational systems are considered to meet these reliability and performance criteria.

The following are typical arrangements which may be acceptable for Fail Operational Systems:

1. Two or more monitored fail passive autopilots or integrated autopilot flight director systems each with dual channels making up an automatic fail operational system designed so that at least one autoflight system remains operative after the failure of one system, and the failed system is not used or cannot cause unacceptable autoflight system performance.

> Note: Following a failure with this configuration, it is not intended that a landing be continued with flight director alone, unless a successful Proof of Concept demonstration has been completed.

2. Three autopilots or integrated autopilot flight director systems designed so that at least two remain operative after failure to permit comparison and provide necessary monitoring and protection while continuing to a landing.

3. A monitored fail passive automatic flight control system with automatic landing capability to touchdown and rollout, if applicable, plus an independent and adequately failure protected manual flight guidance system, suitable for landing and rollout with guidance provided for the flying pilot and monitoring displays for the non-flying pilot. A proof of concept demonstration would be necessary for this arrangement.

4. Two independent and adequately monitored manual flight guidance systems with independent displays for the pilot flying and the pilot not flying, each capable of supporting a landing and rollout. A proof of concept demonstration would be necessary for this arrangement.

Aircraft meeting fail-operational requirements of Appendix 3 of this AC, or equivalent, for landing and rollout may be authorized for fail-operational Category III to the lowest currently applicable minima specified in Operations-Specifications for this type of system. As of the publication of this AC, the lowest authorized minima for U.S. operators are Touchdown, Mid, and Rollout RVR of 300ft within the U.S., or 75m internationally.

Aircraft previously demonstrated to meet acceptable fail-operational criteria of earlier AC's or alternate criteria (e.g., suitable JAR criteria) may receive additional credit beyond those already authorized, as specified in provisions of this AC, through appropriate showing of compliance with applicable operational provisions of this AC, and subsequent amendment of applicable operations specifications. An example of aircraft in this category are those B767 or B757 aircraft having statements in the FAA approved AFM indicating they met all fail-op rollout provisions of AC 120-28B or AC 120-28C, except for certain rollout disconnect provisions. Since criteria of AC 120-28D are now revised to alternately address this condition, these aircraft are considered eligible to fully meet Appendix 3 provisions for fail-operational rollout and may be operationally authorized for landing minima accordingly (also see 4.3.8).

Aircraft with a fail operational landing system but without a rollout system, that were originally approved in accordance with AC 120-28, AC 120-28A, AC 120-28B or AC 120-28C, may typically be approved for minima not less than Touchdown Zone, Mid and Rollout RVR600. Eligibility for RVR600 requires compliance with appropriate current service bulletins in accordance with the manufacturer's recommendations, and a determination by FAA that "in-service" operational performance of the system is acceptable.

Aircraft with a fail operational landing system and a rollout system, or a fail operational landing system and a fail passive rollout system originally approved in accordance with FAA "Special Conditions" for a rollout system, or criteria of AC120-28, AC120-28A, or AC120-28B are now considered to have rollout capability equivalent to fail operational and may typically be approved for minima not less than Touchdown Zone, Mid, and Rollout RVR300. Current models in this group found acceptable include the L1011, A300, DC10-30, certain DC10-10s or DC10-40s with suitably upgraded avionics equipment equivalent to currently FAA approved DC10-10s or -30s, and late model B747-200 or -300 aircraft with appropriate versions of the triple channel SPZ-1 autopilot and a rollout system. For these aircraft, appropriate current service bulletin compliance should be reviewed and completed, and line operational performance of the system must be shown to be acceptable. However it is important to note that, as with other aircraft types, Category III authorization for some of these aircraft may be restricted to certain runway facilities since landing or rollout performance may not necessarily be acceptable due to site specific irregular underlying approach terrain, touchdown zone slope, or ILS beam characteristics.

4.3.3. Alert Height. Fail-operational Category III is based on use of an Alert Height (see Appendix I). An Alert Height is the height above a runway based on characteristics of the airplane and its Fail Operational System, above which a Category III approach must be discontinued and a missed approach initiated if a failure occurred in one of the redundant parts of the flight control or related aircraft systems, or if a failure occurred in any one of the relevant ground systems. Use of an Alert Height is consistent with the design philosophy which requires that an aircraft be capable of safely completing a touchdown and rollout (if applicable) following a failure occurring after passing the point at which the Alert Height is specified.

Operational Alert Heights must always be equal to or lower than that specified in the airworthiness demonstration, and may be specified at or below 200 ft. HAT. The Alert Height is specified by an operator of an aircraft and approved by the FAA. The operational Alert Height used must be consistent with the aircraft design, training, ground facilities, and other factors pertinent to the air carriers operation. Typically a minimum usable operational alert height is 50'HAT. However lower Alert Heights may be approved if there is an appropriate reason to do so (e.g., for certain types of hybrid systems).

Airworthiness demonstration of an Alert Height is as specified in Appendix 3. In order to assure the necessary reliability of aircraft systems, airworthiness demonstrations of Alert Height should be from an altitude of at least 200 ft. above the touchdown zone elevation.

4.3.4. Fail Passive Category III Operations. A Fail Passive System is a system which in the event of a failure, causes no significant deviation of aircraft flight path or attitude. The capability to continue the operation may be lost and an alternate course of action (e.g., a missed approach) may be required. A fail-passive system is the minimum capability system acceptable for Category III operation with a Decision Height not less than 50 ft. HAT.

Fail Passive Approach Operations are conducted with a decision height not lower than 50 ft., and are limited to RVR values which provide suitable visual reference to address normal operations as well as failure contingencies. Since a Fail Passive Category III system does not necessarily provide sufficient redundancy to successfully continue the approach and landing to touchdown following any failure in the flight control system not shown to be extremely remote, a DH is specified. A DH is established to assure that prior to passing that point the pilot is able to determine that adequate visual reference exists to allow verification that the aircraft should touchdown in the touchdown zone. If this visual reference is not established prior to passing DH, a missed approach must be initiated. After passing DH, a missed approach will also be initiated if visual cues are lost, or a reduction in visual cues occurs which prevents the pilot from continuing to verify the aircraft is in a position which will permit a landing in the touchdown zone. In the event of a failure of the airborne system at any point in the approach to touchdown, a missed approach is required. However, this provision does not preclude a pilot's authority to continue an approach if continuation of an approach is considered by the pilot to be a safer course of action.

Such a failure however, does not preclude continuation to a Category I or Category II minima if the necessary remaining elements of the aircraft system are operational and if the crew qualification addresses necessary action to continue such an approach are met. Any adjustments to approach minima or procedures made on final approach should be completed at a safe altitude (e.g., above 500 ft. HAT).

The need to initiate a go-around below 100 ft. AGL due to an airplane failure condition should be infrequent. In addition, an aircraft using a Fail Passive system for Category III should be shown to provide the capability to touch down in the touchdown zone or to complete a safe manual or automatic go-around from any altitude to touchdown following any failure condition not shown to be extremely improbable.

Typical arrangements which may be used to meet the requirements for Category III fail passive operations using a 50 ft. Decision Height include the following:

1. A single monitored automatic flight control system with automatic landing capability.

2. A fail operational automatic flight control system with automatic landing which has reverted to a Fail Passive configuration or has been dispatched in a fail-passive configuration.

3. A monitored flight guidance system (e.g., HUD) designed for manual control by the pilot flying, and for monitoring by the pilot not flying. Aircraft intended for Fail Passive Category III operations should have aircraft systems which meet the criteria specified in Appendix 3. Aircraft previously demonstrated to meet earlier Fail Passive criteria may continue to operate using Category III minima in accordance with approved operation specifications.

4.3.5. Decision Altitude (Height). For Category II and certain Category III procedures (e.g., when using a Fail-Passive landing system) a Decision Height (or an equivalent IM position fix) is used as the controlling minima. The "Altitude" value specified is considered as advisory. The altitude value is available for cross reference. Use of a barometrically referenced DA for Category III is not currently authorized for part 121, 129 or 135 operations at U.S. facilities.

A Decision Height is applied to all Fail Passive operations and is specified at certain locations where fail operational minima is authorized. For Category III, a Decision Height is usually based on a specified radio altitude above terrain on the final approach or touchdown zone. The Decision Height is established to assure that prior to passing that point the pilot is able to determine that adequate visual reference exists to allow verification that the aircraft should touch down in the touchdown zone.

For Category I, a DA(H) is specified as the minimum altitude in an approach by which a missed approach must be initiated if the required visual reference to continue the approach has not been established. The "Altitude" value is typically measured by a barometric altimeter or equivalent (e.g., Middle Marker) and is the determining factor for minima for Category I Instrument Approach Procedures. The "Height" value specified in parenthesis is typically a radio altitude equivalent height above the touchdown zone (HAT) used only for advisory reference and does not necessarily reflect actual height above underlying terrain. The DA element of a DA(H) is applicable to Category III only in the event that an approach is considered to revert to Category I or Category II minima following airborne equipment failure, ground facility status, or other similar condition permitting an approach to be conducted to pertinent Category I or II minima.

4.3.6. Go-Around Safety. An aircraft approved for Category III should be capable of safely executing a go-around from any point in an approach prior to touchdown with the aircraft in a normal configuration, or specified non-normal configuration (e.g., engine out if applicable). It is necessary to provide for go-around due to Air Traffic Services contingencies, rejected landings, loss of visual reference, or missed approaches due to other reasons. The evaluation of this capability is based on normal, or specified non-normal, Category III operations at the lowest controlling RVR authorized and should account for factors related to geometric limitations during the transition to go around, limited visual cues, auto-pilot mode switching and other pertinent factors. For aircraft in which a go-around from a very low altitude may result in an inadvertent touchdown, the safety of such a procedure should be established considering its effect on related systems, such as operation of auto spoilers, automatic braking systems, autopilot mode switching, autothrottle mode, reverse thrust initiation and other systems associated with, or affected by, a low altitude go-around.

Except for failure conditions shown to be extremely improbable, a safe go-around must be possible from any point on the approach to touchdown.

If an automatic go-around capability is provided, it should be demonstrated that a go-around can be safely initiated and completed from any altitude to touchdown. If the automatic go-around mode can be engaged at or after touchdown, it should be shown to be safe. The ability to initiate an automatic go-around at or after touchdown is not required.

4.3.7. Category IIIa. In accordance with ICAO definitions of Category III, Category IIIa operations may be conducted with either Fail Operational or Fail Passive systems. The lowest approvable landing minima for Category IIIa is RVR700 or a foreign equivalent of 200 meters.

> Note: For certain Category III operations using fail passive systems that were formerly limited to RVR700, but now are eligible for authorization to RVR600, see paragraph 4.3.8 (Most Category III operations authorized for RVR700 prior to issuance of this AC are now eligible for authorization to RVR600, upon request of the operator for issuance of a revision to that operator's pertinent OpSpecs).

Category IIIa operations with fail passive systems are conducted using a 50 ft. Decision Height.

Category IIIa operations using a fail operational system with a rollout control system are generally conducted using an Alert Height, and not a Decision Height. Visual reference is not a specific requirement for continuation of the approach or touchdown.

Category IIIa operations using a fail operational system without a rollout control system installed require establishment of suitable visual reference with the touchdown zone prior to touchdown.

For any of the above systems there should be a sufficient combination of information from flight instruments, annunciations, and alerting systems to assure that the pilot can verify that the aircraft should touch down within the touchdown zone, and safely initiate rollout.

Unless otherwise specified by FAA, aircraft having operation specifications authorizing RVR700 as of the effective date of this AC, may continue to use those minima without additional demonstration.

Aircraft demonstrated to meet airworthiness provisions of AC 120-28B or AC 120-28C for Fail Passive systems remain eligible for any previously approved operational authorization under provisions of this AC and do not require additional airworthiness demonstration. Aircraft previously having completed an airworthiness demonstration in accordance with AC 120-28C remain eligible for any operational authorization that was permitted by AC 120-28C.

Aircraft demonstrated to meet airworthiness criteria prior to AC 120-28B, and not currently authorized in operations specifications for Category III may be approved for new Fail Passive Category III operations on a case-by-case basis depending on facilities to be used, service bulletin compliance status and other relevant safety factors.

Aircraft, including wide body aircraft such as the DC-10, L1011 and B 747, which are authorized for fail-operational Category III, but have not been demonstrated to meet the provisions for Fail Passive systems shown in Appendix 3, may be approved for Fail Passive operations with landing minima limited to RVR1000 provided the following criteria are met:

1. The aircraft must be shown to be in compliance with relevant service bulletins for the applicable flight control system and displays.

2. An auto throttle system must be installed and operational.

3. The system must be shown to provide reliable auto land performance in line operations.

4. A demonstration using a simulator or aircraft must be completed for that operator and aircraft type, showing that the system and procedures applicable to Fail Passive operations can be practically applied for that air carrier’s operation.

Wide body aircraft types not previously authorized or currently authorized by FAA to use minima less than RVR1000 based on a fail passive system must meet the airworthiness requirements of Appendix 3 or equivalent for any new authorization of minima less than RVR1000.

New aircraft types or derivative aircraft with new flight control system designs should be demonstrated in accordance with Appendix 3 for Fail Passive systems, or equivalent requirements, if fail passive authorization is sought.

4.3.8. Category IIIb. Category IIIb operations are usually conducted with fail operational systems. Fail passive landing systems may be used, but are limited to Category IIIb minima not less than touchdown zone RVR600 (175 m). Airborne systems used for Category IIIb authorized for landing below touchdown zone RVR600 (175 m) must include either a manual flight guidance or automatic rollout or control system for lateral steering which provides the means to control the aircraft until the aircraft slows to a safe taxi speed. Category IIIb operations based on fail operational systems require the use of systems which after passing Alert Height, are capable of the safe completion of the approach, touchdown, and rollout, following any failure conditions not shown to be extremely remote. When fail operational systems are used, they do not necessarily require that operating procedures specify that the approach must necessarily be continued after a failure.

Category IIIb operations based on fail passive landing systems meeting provisions of Appendix 3 of this AC, or equivalent, must use a decision height not less than 50 ft. HAT.

For Category IIIb operations based on fail operational systems, the availability of visual reference is not a specific requirement for continuation of an approach to touchdown. The design of flight instrument systems, annunciations, and alerting systems should be adequate to assure that the pilot can verify the aircraft should touch down within the touchdown zone, and rollout.

Category IIIb operations may be conducted to a touchdown zone RVR and relevant mid or rollout RVR not less than 600 ft. with a fail operational or fail passive landing system without a rollout control system.

Category IIIb operations may be conducted to a touchdown zone RVR of not less than 600 ft. and an relevant mid or rollout RVR not less than RVR400 with a fail operational or fail passive landing system and with any FAA approved rollout control system.

Category IIIb operations may be conducted to a touchdown zone, and relevant mid, and rollout RVR minima not lower than RVR400 (125 m) when using a fail operational landing system and a rollout control system shown to meet Fail Passive criteria of Appendix 3 (or earlier FAA criteria applicable to a rollout system).

Category IIIb operations may be conducted to a touchdown zone RVR, and relevant mid, and rollout RVR minima not less than RVR150 (50 meters) with a fail operational landing system and a rollout control systems shown to meet the Fail Operational criteria of Appendix 3, or earlier equivalent criteria.

See **NOTE** below for criteria, and **Section 4.3.2** above for examples of various aircraft types, systems, and minima which may be authorized.

> **NOTE**: Since amended criteria is specified for fail operational rollout control systems in Appendix 3 of this circular, certain systems previously certificated using earlier criteria of AC120-28C or AC120-28B that at the time of certification were not considered fail operational due to certain conditions that were noted in the AFM as exceptions, but now are considered to meet fail operational criteria, may now be considered as fail operational for the purpose of authorizations under this paragraph.
>
> Accordingly, systems considered to be eligible for this credit are those systems which otherwise previously met all provisions for a fail operational rollout control system as described in Appendix 3 of AC120-28C (or earlier AC 120-28A or B equivalent) except for provisions related to inadvertent control wheel autopilot disconnect and level of redundancy required for nosewheel steering function. Each of these provisions are now revised in Appendix 3.
>
> Operators seeking additional allowable credit for these newly re-classified fail-operational rollout control systems may apply for corresponding minima adjustment through amended operations specifications. "Relevant" or "applicable" mid or rollout RVR is considered to be any transmissiometer report (or equivalent instrumentally derived RVR measurement) considered to be covering a portion of the runway where the aircraft is operating at a speed above a safe taxi speed.

A summary of the minima that may now be authorized based on the above criteria are shown below in table 4.3.8-1.

Landing System Type	Rollout System Type	TDZ RVR (ft)**	Mid RVR (ft)**	Rollout RVR (ft)**
Fail Op or Fail Passive*	No Rollout system	600	600	600
Fail Op or Fail Passive*	Any FAA Approved Rollout System	600	400	400
Fail Op*	Fail Passive*	400	400	400
Fail Op*	Fail Op*	150	150	150

Lowest Minima Authorized for Fail Operational or Fail Passive Landing Systems, or Landing and Rollout Systems
Table 4.3.8 -1

Table 4.3.8-1 Notes:

* Note: Fail Op denotes a Fail Operational Flight Guidance System
Fail Passive denotes Fail Passive Flight Guidance System

** Note: RVR values are shown in U.S. facility units of feet and as Touchdown zone, Mid, and Rollout RVR values, but corresponding metric values or other designated RVR reporting locations may be applied internationally, if acceptable to the State of the Aerodrome.

Equivalent minima may be specified for systems demonstrated to meet earlier airworthiness criteria of AC 120-28B or AC 120-28C. Credit for systems demonstrated prior to AC 120-28B will be as designated in approved operations specifications or as designated by AFS-400 for new Category III applications using such aircraft.

4.3.9. Runway Field-Length.

a. The Runway Field-Length for Category III is as specified by section 121.195 for a wet runway, if each of the following conditions are met:

1. Anti-skid systems are operative (if installed for the aircraft type).

2. The runway surface braking action is expected to be at least "fair" or better (or equivalent Runway Condition Reading, James Brake Devise, or Tapley reading).

In the event that either of the above conditions are not met, the factor to be applied to the section 121.195b distance is 1.3, unless otherwise demonstrated to the FAA that a factor less than 1.3 is acceptable (e.g., due to other factors, such as the required use of an auto brake system).

b. Once airborne, additional consideration of Category III landing field length by the flightcrew is not required for normal operations. In the event of un-forecast adverse weather or if failures occur, the crew and aircraft dispatcher should consider any adverse consequences that may result from a decision to make a Category III landing (e.g., braking action reports). Category III operations should not normally be conducted with braking action less than "fair".

c. When auto brake systems are used for Category III, information must be available to the flightcrew to assist in making the proper selection of a suitable auto brake setting consistent with the field length available for landing and the runway condition, including braking action.

4.3.10. Landing System Sensors (NAVAID's) and Aircraft Position Determination. Various landing system sensors (NAVAID's) or combinations of sensors may be used to provide the necessary position fixing capability to support authorization of Category III landing weather minima. While certain navigation sensors (NAVAID's) are installed and classified primarily based on landing operations, the sensors described in this section may also be used for takeoff, missed approach, or other operations (e.g., RNAV position determination). Regardless of the sensors, NAVAID's, or combination of

NAVAID's used, the NAVAID's and sensors must provide coverage for the intended flight path and for anticipated displacements from that flight path for normal operations, rare normal operations (e.g., winds and wind gradients), and for specified non-normal operations where applicable (e.g., "engine-out go-around" flight path). In addition, Category III authorizations should be consistent with the provisions or characteristics for specific sensors listed below in 4.3.10.1 through 4.3.10.3 unless otherwise accepted or approved by FAA.

4.3.10.1. Instrument Landing System (ILS). The ILS provides a reference signal aligned with the runway centerline and deviation signals when the airplane is displaced left or right of the extended runway centerline. The linear coverage area for this signal is approximately 3 degrees either side of the extended runway centerline from a point emanating at the far end of the runway. The ILS also provides a vertical flight path (nominally 3 degree descent angle) to a point in the landing zone of the runway. The vertical coverage is approximately 0.7 degrees on either side of the vertical reference path. ILS characteristics should be considered as defined in ICAO Annex 10, unless otherwise specified by FAA. U.S. ILS systems are classified by Type, as defined in FAA Order 6750.24 as amended (e.g., II/D/2).

4.3.10.2. Microwave Landing System (MLS). The MLS provides a reference signal aligned with the runway centerline and deviation signals when the airplane is left or right of the extended centerline. The linear coverage area is approximately 40 degrees either side of the extended runway centerline emanating from a point at the far end of the runway. The MLS provides a vertical flight path to the runway similar to ILS. MLS characteristics should be considered as defined in ICAO Annex 10, unless otherwise specified by FAA. U.S. MLS systems are classified by Type, similar to ILS.

4.3.10.3. GPS/GNSS Landing System (GLS). GLS is a landing systems based upon the Global Navigation Satellite System (GNSS). For Category III operations the landing system typically includes a local area differential augmentation system in the vicinity of the runway for which a Category III procedure is specified. The local area system may serve one or more runways, or nearby airports, depending on its classification for each particular runway. The classification of a GLS service may be different for different runway ends (e.g., III/E/3 for Runways 14L and 14R, but I/D/1 for RW 22L). Desired path, centerline, and deviation signals as applicable, are computed by airborne avionics. The coverage area for GLS is typically at least within a 25 mile radius of a primary airport, but extended service volumes are permitted. GLS provides for both vertical and lateral flight path specification to the touchdown zone of the runway(s) served, and a lateral path for rollout or takeoff guidance. GLS characteristics should be considered as defined in ICAO Annex 10, unless otherwise specified by FAA (e.g., FAA accepted references to RTCA SC-159 MASPS).

U.S. GLS systems should be operationally classified by "Type" for each runway end served, similar to ILS (e.g., GLS II/D/2). The operational classification is intended to address at least the service provided in terms of "Type of service or performance level", "area of service" relative to each specific runway served, and level of availability or continuity. As with ILS, the classification schema should not be specified in terms of specific minima Categories (e.g., Category III), since onboard aircraft equipment capability or other factors may determine actual minima to be authorized.

GLS systems are intended to provide equivalent or better service to that provided by a U.S. Type I ILS, including: 1) Adequate guidance over the runway for takeoff or landing rollout (e.g., autoland), and 2) Vertical guidance on approach down to at least 100'HAT. GBAS local area augmentation systems (e.g., LAAS) are usually considered to support this objective. Wide area augmentation systems (e.g., WAAS, EGNOS) are typically considered to be RNAV systems, and are not alone considered to be GLS.

Authorization for use of GLS is for each specific air carrier, aircraft, and GLS system type until pertinent GLS international standards accepted by FAA are promulgated.

4.4. RNAV/Flight Management Systems (FMS). RNAV/Flight Management Systems (FMS) are typically used in conjunction with Category III Instrument Approach Procedures only for initial or intermediate approach segments, or for missed approach.

For departure, RNAV/Flight Management Systems (FMS) may be used for non-visual takeoff guidance after passing the height at which LNAV or VNAV may respectively be engaged or made active, or above 35' AGL, whichever is higher. Other applicable FAA criteria (e.g., section 121.189) must be addressed for takeoff. For development or authorization of departure procedures which follow completion of a low visibility takeoff, FAA Orders 8260.40A, 7100.1, or other applicable RNAV/RNP criteria should be consulted.

Procedures based on 3D or 2D RNAV may or may not include use of RNP. For RNP operations, see section 4.5 below.

4.5. Required Navigation Performance (RNP). A definition for Required Navigation Performance (RNP) is specified in Appendix 1. Standard Levels of RNP typically used for various initial, intermediate approach and missed approach segments for Category III procedures may be based on specific landing systems (e.g., ILS, MLS, or GLS), on multisensor RNAV (e.g., FMS with IRS, VOR, DME inputs), or on other aircraft navigation systems having FMS like capabilities (e.g., GPS Navigation Systems).

RNP applications used for a final approach segment supporting a Category III procedure are typically be based on use of a specific landing system sensor (e.g., ILS, MLS, or GLS), or on multisensor RNAV systems having suitable flight critical performance.

Aircraft/systems RNP capability is typically determined by assessing RNP total system error components, Path Definition Error (PDE), Position Estimation Error (PEE) and Flight Technical Error (FTE). In additional to total system error (TSE) components, associated assurance limits are considered to determine what levels of navigation performance may actually be achieved with integrity. Assessment may specify that certain RNP levels may only be achieved with flight director or autopilot coupled operation, or that for particular applications availability must be based on use of dual independent navigation systems (e.g., as with the/E equipment classification).

4.5.1. Standard RNP Types. Standard values of RNP supporting initial, intermediate, or final approach segments, or missed approach segments applicable to Category III procedures are as specified in Table 4.5.1-1 below.

Table 4.5.1-1
STANDARD RNP TYPES APPLICABLE TO Category III

RNP Type	Applicability/Operation (Approach segment)	Normal Performance (95%)	Containment Value
RNP 1	Initial/Intermediate/ Missed approach	+/- 1 nm	+/- 2 nm
RNP 0.5	Initial/Intermediate/ Missed approach	+/- 0.5 nm	+/- 1 nm
RNP 0.3	Initial/Intermediate/ Missed approach	+/- 0.3 nm	+/- 0.6 nm
RNP levels as specified for lowest Category I	Final approach/ initial missed approach (but not below 200' HAT)	(See AC 120-29, as amended	(See AC 120-29, as amended)
RNP levels as specified for Category II	Final approach/ initial missed approach (but not below 100' HAT)	(See AC 120-29, as amended)	(See AC 120-29, as amended)
RNP 0.003/15	Final approach/ initial missed approach (any altitude)	+/- 0.003 nm +/- 15 ft. (*)	+/- 0.006 nm +/- 30 ft. (*)

(*) Note: vertical accuracy does not apply below 100 ft. HAT - below 100 ft. HAT vertical performance is determined by applicable standards for touchdown performance.

RNP is a required navigation performance level described by the specification of a numeric value indicating the required navigation accuracy for a specific operation, typically specified laterally in nautical miles - e.g., RNP 1 is a Required Navigation Performance of ± 1 nautical mile (95% Probability).

RNP containment is specified as RNP(X) times two (i.e., RNP(X) x 2).

Standard RNP Levels are defined for lateral performance, or lateral and vertical performance, if applicable.

Regarding containment, the probability of exceeding the containment value without annunciation should be assessed by some acceptable method. If assessed during an airworthiness demonstration program during type design or STC, this probability should be considered to be at least remote (e.g., a major failure condition). If based on "fleet qualification" (e.g., use of criteria such as contained in RTCA DO-236 Appendix D for RNP) alternative methods, procedures or buffers may be used to assure protection of containment.

Operationally, containment is typically used in procedures or separation standards in conjunction with other operational verification procedures, other systems (e.g., TCAS, EGPWS), or operational buffers to satisfactorily address assurance of safe operations and contingencies. This is to provide for safety in the unlikely event operation within the containment region cannot be maintained.

In the event that operational procedures or other technical methods are not available to assure safety in the event of loss of containment, then potential for loss of containment situations may need to be addressed in a hazard assessment specifically keyed to an example of the intended application or operation. More demanding uses of containment may require a higher level of assurance or a more complex or comprehensive backup or contingency mechanism (e.g., use of an RNP Level for specification of a lateral path for Category III flare and rollout).

4.5.2. Non-Standard RNP Types. Non-Standard RNP Types are those RNP values other than as specified in paragraph 4.5.1. Non-Standard RNP Types are authorized by FAA on a case by case basis where an applicant has a demonstrated need for such use.

4.6. Flight Path Definition. The following parameters, path points, or definitions may be used as a technical basis for a variety of other references or terms eventually necessary to prepare or implement procedures or development criteria. This section is intended to provide a technical basis for preparation of operational concepts for use with RNAV and RNP based systems (e.g., to serve as a technical basis for preparation of procedures criteria, operations concepts, operational manuals, or operational authorizations). Actual procedural information, manuals, training materials and other documents used by operators, pilots, procedure developers or others who may need to apply this information may use simplified or summarized forms of this information, as necessary, to satisfy their particular operational requirements.

> Note: The path points and segments addressed below are those considered necessary to support definition and operational use of systems intended for Category III. For commonality, their definition and use are intended to be consistent with Category I and Category II. It should be noted, however, that various GNSS or other RNAV applications or criteria currently use or propose use of other similar points or waypoints, use different terminology, or use different definitions for points (e.g., Landing Threshold Waypoint). Accordingly, since U.S. and international terminology and definitions for such points are evolving, it is important to confirm and assure suitability of each point used, for consistency of terminology, suitable definition, and suitable application.

Landing and Rollout Flight Path - The following criteria specifies certain reference points and other criteria necessary to effectively implement landing and rollout operations using a landing system where the required flight path is not inherent in the signal structure of the navigation aid (e.g., satellite systems). The location of points used to describe the landing and rollout flight path are shown in Figure 4.6-1.

Runway Datum Point (RDP) - The RDP is used in conjunction with the FPAP and a vector normal to the WGS-84 ellipsoid at the RDP to define the geodesic plane of a final approach flight path to the runway for touchdown and rollout. It is a point at the designated lateral center of the landing runway defined by latitude, longitude, and ellipsoidal height. The RDP is typically a surveyed reference point used to connect the approach flight path with the runway. The RDP may or may not necessarily be coincident with the designated runway threshold.

Flight Path Alignment Point (FPAP) - The FPAP is used in conjunction with the RDP and a vector normal to the WGS-84 ellipsoid at the RDP to define the geodesic plane of a final approach and landing flight path. The FPAP may be the RDP for the reciprocal runway.

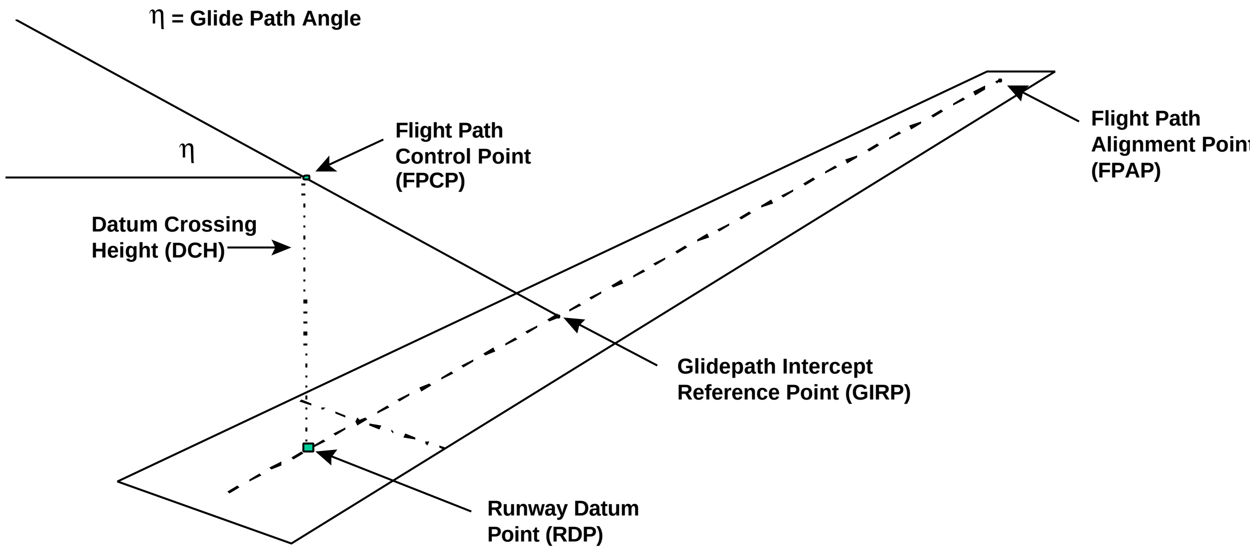
Flight Path Control Point (FPCP) - The FPCP is a calculated point located above the RDP in a direction normal to the WGS-84 ellipsoid. The FPCP is used to relate the vertical descent of the final approach flight path to the landing runway.

Datum Crossing Height [DCH] - The height (feet) of the FPCP above the RDP.

Glide Path Angle [GPA] - The glide path angle is an angle, defined at the FPCP, that establishes the descent gradient for the final approach flight path of an approach procedure. It is measured in the geodesic plane of the approach (defined by the RDP, FPAP, and WGS-84 ellipsoid's center). The vertical and horizontal references for the GPA are a vector normal to the WGS-84 ellipsoid at the RDP and a plane perpendicular to that vector at the FPCP, respectively.

Glidepath Intercept Reference Point [GIRP] - The GIRP is the point at which the extension of the final approach path intercepts the runway.

Figure 4.6-1



The locations established for, and the values assigned to, the **RDP, FPCP, DCH** and **GPA** should be selected based upon the operational need to establish the **GIRP**. Operational considerations include:

1. Path of wheels over threshold,

2. Need for coincidence with other aids and systems - visual and non-visual, or markings

3. Runway characteristics (e.g., local slope in the touchdown zone, general runway upslope or downslope, runway lateral crown),

4. Actual displaced thresholds or multiple runway thresholds,

5. Actual clearways or stopways

6. Construction temporary requirements

Takeoff Flight Path. The flight path for low visibility takeoff (while on the runway) should be defined by the RDP and FPAP.

4.7. Engine Inoperative Category III. The basic concept addressing expected flightcrew response to non-normal situations, such as typically represented by an engine failure, is described in Section 6.1.8.

Engine Inoperative Category III is specifically addressed because for some modern aircraft and systems it is possible to retain and address Category III operating capability, as an alternate configuration. This is to aid operators and pilots in planning for and selecting more desirable and fully considered landing airports that may be closer in distance or time, have less adverse weather in terms of icy or short runways with adverse winds, are better equipped to handle a diversion or emergency, or provide a timely return to land at a takeoff airport or a closer takeoff alternate airport, in the unlikely event of engine failure or other serious problem related to the engine failure.

With pre-planned engine inoperative Category III capability, airports and minima that otherwise may not be considered acceptable for use could be selected by the pilot or operator without having to subsequently justify its use based on emergency authority. This capability also has the advantage of allowing for full pre-assessment of the aircraft capability, and engine inoperative aircraft configurations (e.g., flap settings, electrical system capability, hydraulic system capability), approach procedure characteristics, missed approach performance and other factors that may be difficult to assess in real time if not previously assessed.

This capability also can permit an operator some additional flexibility in selecting alternate airports.

Accordingly Section 5.17 describes aircraft and airborne system criteria for credit for engine inoperative Category III capability. Sections 7.1.3 item 10, and 7.2.6 address crew qualification. Section 10.8 addresses operational authorization and selection and use of alternates.

5. AIRBORNE SYSTEMS.

5.1. General.

5.1.1. Airborne Systems. Airworthiness criteria for airborne systems intended to meet criteria in this AC are specified in paragraph 5.1.3 through 5.19 below for operational authorizations, or Appendix 2 for takeoff, or Appendix 3 for landing and rollout for airworthiness demonstration of new or modified aircraft types or systems.

Aircraft shown to meet provisions of Appendix 2 or 3 respectively, are considered to meet provisions of this section.

For aircraft approved using earlier versions of this AC, airworthiness criteria for airborne systems intended for Category III operations are as specified in criteria referenced by the approved AFM.

Airborne equipment listed in this section needs to be operative for Category III, in accordance with provisions of applicable standard Operations Specifications (OpSpecs) and Operations Specifications for that operator. Airframe manufacturers and individual operators may also include other optional equipment as part of the Category III configuration, however, that equipment does not need to be operative to conduct a Category III approach unless required by that operator's OpSpecs.

Airborne systems making use of RNP capability for approach segments or missed approach segments should be approved in accordance with or consistent with any one or more of the following criteria or processes:

1) FANS I or FANS A systems approved through a certification program acceptable to FAA, or

2) Through reference to an acceptable standard such as RTCA DO-236 for RNP, or

3) Through reference to RTCA DO-236 Appendix D for “fleet qualification” of existing aircraft, or

4) Through other FAA or FAA accepted equivalent criteria for intended for application or approval of RNP (e.g., TERPS or PANS-OPS RNP provisions as adopted).

5.1.2. Non-Airborne Systems. Unless otherwise specified in the Appendices to this AC, NAVAID/landing system characteristics, including facility classification, should be considered as specified in Section 4.3.10 above and AC 120-29 for ILS, MLS or GLS (e.g., U.S. use of ICAO Annex 10 Criteria, FAA Order 6750.24 as amended, and the applicable NAVAID facility classification for Category III). NAVAID facility use is predicated on applicable ILS, MLS, or GLS Type classifications (e.g., ILS III/E/2, GLSII/D/2) or equivalent classification at non-U.S. facilities. Specific Navigation Services are addressed in Section 5.12.

5.1.3. Takeoff Guidance Systems. When takeoff minima are predicated on use of a takeoff guidance system, the takeoff guidance system should be demonstrated to meet provisions of this paragraph or provisions specified in Appendix 2 by an airworthiness demonstration. Takeoff guidance systems which have been shown to meet Appendix 2 by airworthiness demonstration and have a corresponding AFM reference are typically considered to meet requirements of this paragraph.

A takeoff guidance systems shall be demonstrated to show that the airplane will not deviate significantly from the runway centerline during takeoff while the system is being used within the limitations established for it. Compliance may be demonstrated by flight test, or by a combination of flight test and simulation. Flight testing must demonstrate repeatable performance, and cover those factors affecting the behavior of this airplane (e.g., wind conditions, ILS characteristics, weight, center of gravity). Compliance with the performance envelope should be demonstrated with pilots appropriately qualified to use the airborne system, and should not require extraordinary skill, training or proficiency.

Demonstrated winds should be 150% of the winds for which credit is sought, but not less than 15 knots of headwind or crosswind.

In the event that the airplane is displaced from the runway centerline at any point during the takeoff or rejected takeoff, the system must provide sufficient guidance to enable the "pilot flying", or the pilot in command who may assume control and become the "pilot flying", to control the airplane smoothly back to the runway centerline without significant overshoot or any sustained nuisance oscillation.

Figure 5.1.3-1 provides the performance envelope for evaluating takeoff command guidance systems for the following scenarios:

a. Takeoff with all engines operating

b. Engine Failure at V_{ef} - continued takeoff

c. Engine Failure just prior to V_1 - rejected takeoff

d. Engine Failure at a critical speed prior to V_{mcg} rejected takeoff: ($V_{ef} < V_{mcg}$)

Note: For that portion of the flight path following liftoff, the demonstrated lateral path may be adjusted for any effect of wind drift when showing compliance with the performance envelope below.

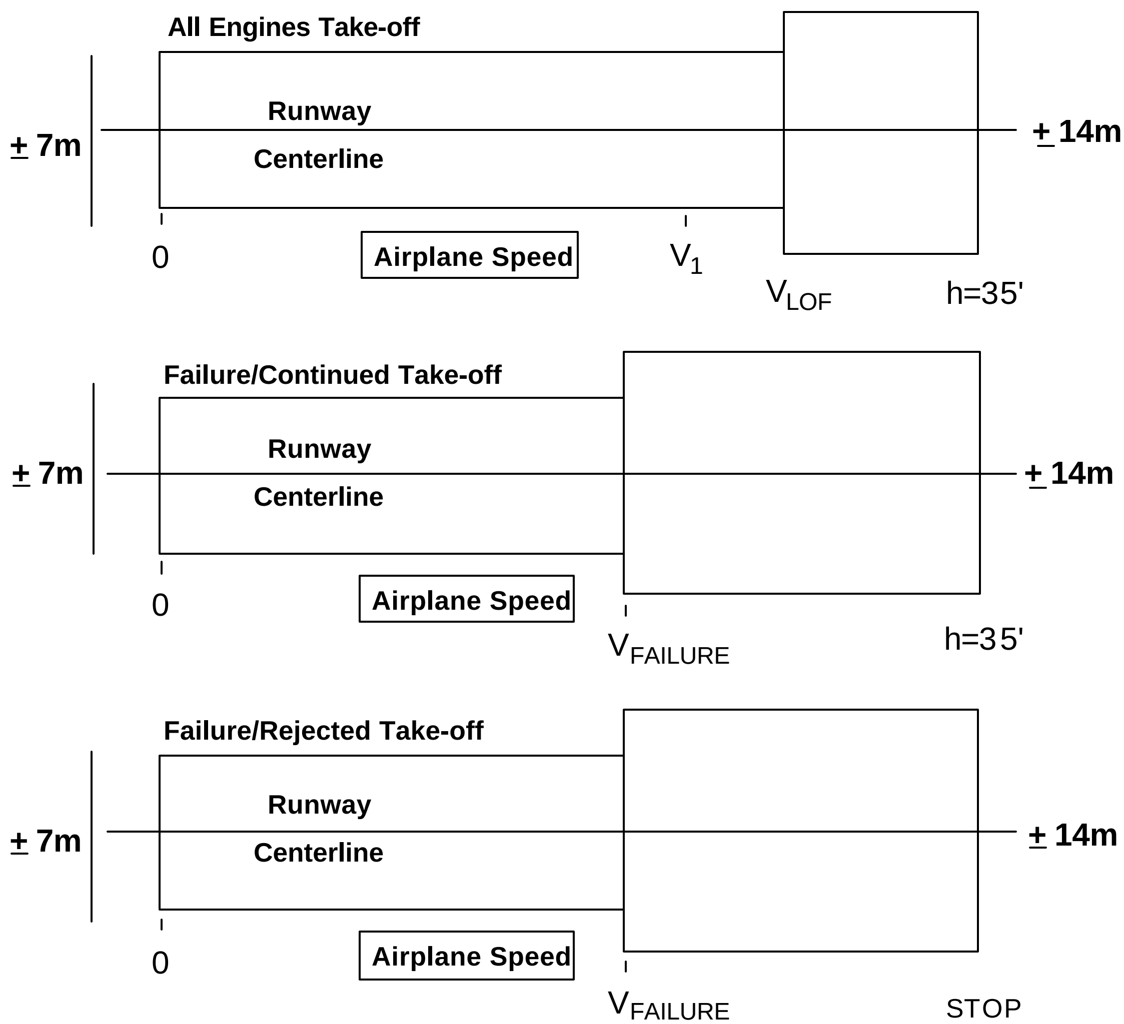


FIGURE 5.1.3-1.

5.2. Airborne Systems for Category III Minima Not Less than RVR600. The following equipment in addition to the instrument and navigation equipment required by 14 CFR part 91 for IFR flight is the minimum aircraft equipment considered necessary for Category III:

1. A redundant flight control or guidance system, demonstrated in accordance with Appendix 3, or for aircraft types previously demonstrated acceptable earlier criteria described in previous versions of AC 120-28 as amended, or acceptable international criteria, such as the JAR AWO.

Acceptable flight guidance or control systems include the following:

a. A Fail Operational or Fail Passive automatic landing system at least to touchdown, or

b. A Fail Operational or Fail Passive manual flight guidance system providing suitable head-up or head-down command guidance, and suitable monitoring capability at least to touchdown, or

c. A hybrid system, using automatic landing capability as the primary means of landing at least to touchdown.

d. Other system which can provide an equivalent level of performance and safety.

NOTE: For system concepts not currently approved by FAA or system concepts not addressed by Appendix 3, a proof of concept demonstration is required prior to either airworthiness or operational consideration for approval.

2. An automatic throttle or automatic thrust control system which meets Appendix 3, or appropriate earlier criteria as specified in an FAA-approved AFM. However, for operations with a 50 foot Decision Height, or other operations that have specifically been evaluated such as for engine inoperative landing capability, automatic throttles may not be required if it has been demonstrated that operations can safely be conducted, with an acceptable work load, without their use.

3. At least two independent navigation receivers/sensors providing lateral and vertical position or displacement information, typically with the first pilot's station receiving information from one and the second pilot's station receiving information from the other. The navigation receivers/sensors must meet the criteria specified in Appendix 3 or equivalent, or must meet an earlier acceptable criteria as specified in an FAA AFM (e.g., 2 ILS localizer and glide slope receivers meeting performance requirements of AC 120-28C; Appendix 1, paragraph 7a & b).

4. At least two approved radio altimeter systems which meet the performance requirements outlined in Appendix 3, or acceptable earlier criteria, as specified in an FAA AFM, typically with the first pilot's station receiving information from one and the second pilot's station receiving information from the other.

5. Failure detection, annunciation, and warning capability, as described in Appendix 3, or as determined acceptable by earlier criteria, such as 120-28C; Appendix 1, paragraph 7c & 7g, and specified in an FAA AFM.

6. Missed approach guidance provided by one or more of the following means:

a. Attitude displays which include suitable pitch attitude markings, or a pre-established computed pitch command display.

b. An approved flight path angle display, or

c. An automatic or flight guidance go-around capability.

7. Suitable forward and side flight deck visibility for each pilot, as specified in 5.13.1.

8. Suitable windshield rain removal, ice protection, or defog capability as specified in 5.13.2.

5.3. Airborne Systems for Category III Minima Less Than RVR600.

5.3.1. Airborne Systems for Category III Minima Not Less than RVR400. The following equipment in addition to the instrument and navigation equipment required by part 91 for IFR flight is the minimum aircraft equipment considered necessary for Category III operations to minima less than RVR600 but not less than RVR400:

1. A redundant flight control or guidance system, demonstrated in accordance with Appendix 3, or for aircraft types previously demonstrated acceptable earlier criteria described in previous versions of AC 120-28 as amended, or acceptable international criteria, such as the JAR AWO.

Acceptable flight guidance or control systems include the following:

a. A Fail Operational landing system with a Fail Operational or Fail Passive automatic rollout system, or

b. A Fail Passive landing system (limited to touchdown zone RVR not less than RVR600) with Fail Passive rollout provided automatically or by a flight guidance system providing suitable head-up or head-down guidance, and suitable monitoring capability, or

c. A Fail Operational hybrid automatic landing and rollout system with compatible manual flight guidance system, using automatic landing capability as the primary means of landing.

d. Other system which can provide an equivalent level of performance and safety.

> NOTE: For system concepts not currently approved by FAA or system concepts not addressed by Appendix 3, a proof of concept demonstration is required prior to either airworthiness or operational consideration for approval.

2. An automatic throttle or automatic thrust control system which meets Appendix 3, or appropriate earlier criteria as specified in an FAA-approved AFM. However, for operations with a 50

foot Decision Height, automatic throttles may not be required if it has been demonstrated that operations can safely be conducted, with an acceptable work load, without their use.

3. At least two independent navigation receivers/sensors providing lateral and vertical position or displacement information, typically with the first pilot's station receiving information from one and the second pilot's station receiving information from the other. The navigation receivers/sensors must meet the criteria specified in Appendix 3 or equivalent, or must meet an earlier acceptable criteria as specified in an FAA AFM (e.g., 2 ILS localizer and glide slope receivers meeting performance contained in AC 120-28C; Appendix 1, paragraph 7a & b).

4. At least two approved radio altimeter systems which meet the performance criteria outlined in Appendix 3, or acceptable earlier criteria, as specified in an FAA AFM, typically with the first pilot's station receiving information from one and the second pilot's station receiving information from the other.

5. Failure detection, annunciation, and warning capability, as described in Appendix 3, or as determined acceptable by earlier criteria, such as 120-28C; Appendix 1, paragraph 7c & 7g, and specified in an FAA AFM.

6. Missed approach guidance provided by one or more of the following means:

a. Attitude displays which include calibrated pitch attitude markings, or a pre-established computed pitch command display,

b. An approved flight path angle display, or

c. An automatic or flight guidance go-around capability.

7. Suitable forward and side flight deck visibility for each pilot, as specified in 5.13.1.

8. Suitable windshield rain removal, ice protection, or defog capability as specified in 5.13.2.

5.3.2. Airborne Systems for Category III Minima Not Less than RVR300 (75 m). Visibility minima of RVR300 is applicable to those facilities reporting RVR in feet and which have appropriate reporting increments in feet. Visibility minima of 75m is applicable to those facilities reporting RVR in meters and which have appropriate reporting increments in meters.

In addition to the aircraft equipment specified in 5.3.1 above, the following equipment is required for Category III minima not less than RVR300 (75m):

1. A Fail Operational Automatic Flight Control System, or manual flight guidance system designed to meet fail operational system criteria, or a hybrid system in which both the fail-passive automatic system and the monitored manual flight guidance components provide approach and flare guidance to touchdown, and in combination provide full fail operational capability, and

2. A fail operational rollout guidance or control system that can assure safe rollout to taxi speed consisting of either:

a. A fail operational automatic rollout control system or fail operational manual flight guidance rollout system, or

b. A hybrid system consisting of at least a fail passive automatic rollout system and a compatible Fail Passive manual flight guidance rollout control system demonstrated in accordance with Appendix 3; (may be approved for operations not less than RVR300), or

3. Suitable flight instruments, annunciations, or crew procedures which can reliably detect and alert the flightcrew to abnormal lateral or vertical flight path performance during an approach to touchdown, or abnormal lateral performance during rollout.

5.3.3. Airborne Systems for Category III Minima Less than RVR300 (75 m). In addition to the aircraft equipment specified in 5.3.2 above, the following equipment is required for Category III minima less than RVR300 (75m):

1. A Fail Operational Automatic Flight Control System, or manual flight guidance system designed to meet fail operational system criteria, or a hybrid system in which both the fail-passive automatic system and the monitored manual flight guidance components provide approach and flare guidance to touchdown, and in combination provide full fail operational capability, and

2. A fail operational automatic, manual, or hybrid rollout control system.

5.4. Automatic Flight Control Systems and Automatic Landing Systems. Automatic Flight Control Systems or Autoland Systems considered acceptable for Category III, include:

1) Those systems meeting pertinent criteria of Appendix 3,

2) Those systems meeting acceptable earlier FAA criteria which have already been and currently are approved for use through operations specifications (whether or not specifically referenced in AFM provisions), or

3) Those systems meeting other equivalent criteria (e.g., JAR AWO), found acceptable to the FAA.

5.5. Flight Director Systems. Characteristics of Flight Director Systems (head down or head up) used for aircraft authorized for Category III should be compatible with any characteristics of the autopilot or autoland system used. Flight control systems which provide both autopilot control and flight director information may or may not display flight director commands as appropriate for the system design and operator requirements. Regardless of whether Flight Director commands are provided, situational information displays of navigation displacement must also be provided to both flightcrew members. To assure that unacceptable deviations and failures can be detected, the displays must be appropriately scaled and readily understandable in the modes or configurations applicable.

"Flight director systems" may be considered as "fail passive" if after a failure, the flight path of the aircraft does not experience a significant immediate deviation due to the pilot following the failed guidance before the pilot detects the failure and discontinues using the guidance.

5.6. Head-up Display Systems. Head-up Display systems used as the basis for a suitable Category III authorization must provide guidance for one or both pilots as appropriate for the system design. If information is provided to only the flying pilot, then appropriate monitoring capability must be established for the non flying pilot. Monitoring tasks must be identified, and the non flying pilot must be able to assume control of the aircraft in the event of system failure or incapacitation of the pilot using the Head-up Display (e.g., for a safe go-around or completion of rollout). Head-up Display Systems acceptable for Category III must meet provisions of Appendix 3, or acceptable earlier criteria specified by the FAA and referenced in an AFM.

"Head-up Display systems" may be considered as "fail passive" if:

1. After a failure, the pilot using the system or pilot monitoring the system is made aware of the failure in a timely manner, and

2. The flight path of the aircraft does not experience a significant immediate deviation from the intended path due to the pilot following the failed guidance before the pilot flying or pilot monitoring detects the failure, and the pilot flying discontinues using the guidance.

5.7. Enhanced/Synthetic Vision Systems. Enhanced/Synthetic Vision Systems based on millimeter wave radar or other such sensors may be used to assure the integrity of other flight guidance or control systems in use during Category III operations. They must be demonstrated to be acceptable to FAA in a proof of concept evaluation and they must otherwise be in accordance with Appendix 3. Use of Enhanced/Synthetic Vision Systems for purposes other than establishing the accuracy or integrity of flight guidance system performance must be demonstrated to be acceptable through proof of concept testing prior to identification of specific airworthiness and operation criteria.

5.8. Hybrid Systems. Hybrid systems (e.g., a fail passive autoland system used in combination with a monitored HUD flight guidance system) may be acceptable for Category III if each element of the system alone is shown to meet its respective suitability for Category III, and if taken together, the components provide the equivalent performance and safety to a non-hybrid system as specified for the minima sought (e.g., fail operational Category IIIb).

Hybrid systems with automatic landing capability should be based on the concept of use of the automatic landing system as the primary means of control, with the manual flight guidance system serving as a backup mode or reversionary mode.

Manual rollout flight guidance capability must be provided for hybrid systems which do not have automatic rollout capability. Such manual rollout capability must have been shown to have performance and reliability at least equivalent to that of a fail passive automatic rollout system.

Any transition between hybrid system elements (e.g., control transition from autoland use to manual control HUD use, or for response to failures) must be acceptable for use by properly qualified flightcrews (e.g., qualified in accordance with part 121, SFAR 58, or equivalent JAA criteria, as applicable, and standard industry practices). Transitions should not require extraordinary skill, training, or proficiency.

For any system which requires a pilot to initiate manual control near or shortly after touchdown, the transition from automatic control prior to touchdown to manual control using the remaining element of the hybrid system (e.g., HUD) after touchdown must be shown to be safe and reliable.

For hybrid systems, operational procedures following failure of the automatic system or flight guidance system prior to touchdown may require that the pilot initiate a go-around, even though the aircraft using a hybrid system must have been demonstrated as being capable of safely completing a landing and rollout following a failure of one of the hybrid system elements below alert height.

A hybrid system may be approved for Category III if it is shown to meet the criteria specified in Appendix 3 when approved through an airworthiness demonstration process. Alternately, a hybrid system may be acceptable for Category III if it is determined to meet applicable airworthiness criteria for each element of the system separately (e.g., separately meets Category III criteria for autoland and HUD), and in addition, a successful operational suitability demonstration is completed using the individual system elements together as a hybrid system. If acceptability is determined through an operational demonstration process, the individual elements of the hybrid system must be shown to be compatible for both normal and non-normal operations, and the combined system must be shown to have the necessary performance, integrity, and availability appropriate for the operations intended.

An operator may receive approval to use an automatic landing system and a manual flight guidance system as a Hybrid System provided, (a) each system individually meets appropriate airworthiness assessments, and (b), that operator conducts a successful operational demonstration showing the hybrid system's capability to meet applicable provisions of this section.

For hybrid systems used for Category III an Alert Height of 50' or higher should be used unless otherwise approved by the FAA AFS-400.

5.9. Instruments and Displays. Flight instrument and display presentations related to Category III, including attitude indicators, EADI’s, primary flight displays, EHSI’s, HIS’s, or other such navigation displays must provide pertinent, reliable and readily understandable information for both normal and non-normal conditions related to Category III landing and missed approach.

Alert Height and/or Decision Height indications must be readily understandable, appropriately highlighted, and not be compromised by effects such as typical underlying terrain on the final approach path, and other annunciations or automatic audio call-outs. In addition, instruments and displays should provide appropriate indications considering terrain characteristics identified in Appendix 3 Section 6.3.4. Controls for altitude or height alerts used for minima determination or alert heights should use standard indications such as RH for radio height (or RA for radio altitude) and BARO for barometric altitude, rather than operational designations such as DH or MDA. Use of the designation RH or RA for height referenced values, or BARO for barometric altitude referenced values for controls or displays do not preclude related use of display symbology color changes or use of flashing alphanumeric symbology as the aircraft descends below a specifically referenced height or altitude value.

Situation information displays of navigation displacement must be available to both flightcrew members, and must be appropriately scaled and readily understandable in presentations or mode of display used. Instrument and panel layouts must follow accepted principles of flight deck design.

5.10. Annunciations. Annunciations must be clear, unambiguous, and appropriately related to the flight control mode in use. The mode annunciation labels should not be identified by landing minima classification. For example, LAND 2, LAND 3, Single Land, Dual Land, etc., are acceptable mode annunciation labels, whereas, Category II, Category III, etc., should not be used. Aircraft previously demonstrated for Category III which do not meet this criteria may require additional operational constraints to assure the correct use of minima suited to the aircraft configuration. In addition, mode annunciation labels must be consistent with other annunciations in the cockpit, and with the airplane documentation.

5.11. Automatic Aural Alerts. Automatic Aural Alerts (e.g., automatic call-outs, voice callouts) of radio altitude, or call-outs approaching landing minimums, or call-outs denoting landing minimums must be consistent with the design philosophy of the aircraft in question. However, any automatic call-outs used should not be of a volume or frequency that interferes with necessary flightcrew communications or normal crew coordination procedures. Recommended automatic call-outs include a suitable alert or tone as follows:

1. At 500 ft. (radio altitude), approaching minimums and at minimums, and

2. Altitude call-outs during flare, such as at "50" ft., "30" ft. and "10" ft., or altitudes appropriate to aircraft flare characteristics. Low altitude radio altitude call-outs, if used, should appropriately address the situation of higher than normal sink rate during flare, or an extended flare which may be progressing beyond the touchdown zone.

5.12. Navigation Sensors. Various navigation sensors may be acceptable to support Category III operations as specified in Section 4.3.10. ILS localizer and glideslope signals are the primary means currently used for the determination of deviation from the desired path for Category III operations. Criteria for acceptable ILS and MLS localizer and glide-slope receivers are included in Appendix 3 or in earlier acceptable criteria used by FAA for previous demonstrations of systems for Category III. Other navigation sensors, such as GNSS, or DGNSS, may be used individually or in combination to satisfy the necessary accuracy, integrity and availability for Category III if proof of concept demonstrations are successfully completed and operational experience at Category I and Category II minimums is acceptable. Navigation sensors other than ILS must meet equivalent ILS performance or appropriate RTCA or EUROCAE criteria, unless otherwise authorized.

Appropriate marker beacon information, or equivalent, must be displayed to each pilot for the outer, middle and inner markers. Appropriate substitutes for marker beacons may be authorized by the FAA for Category III based upon the use of suitable GNSS/DGNSS capabilities, or DME.

5.13. Supporting Systems and Capabilities.

5.13.1. Flight Deck Visibility. Suitable forward and side flight deck visibility for each pilot should be provided as follows:

a. The aircraft should have a suitable visual reference cockpit cutoff angle over the nose for the intended operations, at the intended approach speeds, and for the intended aircraft configurations, as applicable (e.g., flap settings),

b. The aircraft's flight deck forward and side windows should provide suitable visibility for taxi and ground operations in low visibility, and

c. Placement of any devices or structure in the pilots visual field which could significantly affect the pilot's view for low visibility operations must be acceptable (e.g., HUD drive electronics, sunvisor function or mountings).

5.13.2. Rain and Ice Removal. Suitable windshield rain removal, ice protection, or defog capability should be provided as specified below:

a. Installation of rain removal capability is required (e.g., windshield wipers, windshield bleed air).

b. Installation and use of windshield hydrophobic coatings, or use of equivalent rain repellent systems which meet pertinent environmental standards are recommended.

c. Installation of windshield anti-ice or de-ice capability is required for aircraft intended to operate in known icing conditions during approach and landing.

d. Installation of at least forward windshield defog capability is recommended for aircraft subject to obscuration of the pilot's view during humid conditions.

Aircraft subject to obscuration of the windshield due to rain, ice, or fogging of the pilot's view which do not have protection, or which do not have adequate protection may require operational limitations on the conditions in which low visibility operations are conducted.

5.13.3. Miscellaneous Systems. Other supporting systems should meet appropriate criteria compatible with Category III Operational Objectives. Applicable criteria may include criteria as specified in Appendix 3, criteria as specified in basic airworthiness requirements applicable to U.S. certificated aircraft, or equivalent, or operational criteria for IFR flight. Regarding supporting systems, “In-service aircraft” or “new production” aircraft may meet or continue to meet criteria previously found acceptable for Category III operation for supporting systems for those aircraft. Supporting systems for Category III are considered to include, as applicable: Instruments, radar altimeters, air data computers, inertial reference units, attitude and heading gyros, instrument switching, flight deck night lighting, landing lights and taxi lights, position lights, turnoff lights, recognition lights, GPWS or EGPWS, flight data recorders or other low visibility related aircraft systems pertinent to a particular type.

Any GPWS or EGPWS systems interfaces (e.g., glide slope deviation warning) should be compatible with and should not interfere with the Category III Operations to be conducted (e.g., for engine inoperative Category III Configurations). For multimode capable systems for Category III (e.g., MMR), interfaces with GPWS or EGPWS for each MMR mode (e.g., ILS, MLS or GLS) should be consistent.

For Flight Data Recorders (FDR’s) or Quick Access Recorders (QAR’s), it is recommended that operators consider appropriate flight data recorder requirements for incident or event analysis when addressing provisions for Category III. It is recommended that any data recorders installed provide sufficient capability for recording of parameters applicable to flight guidance system performance for use with Category III operations. Typical parameters of interest and appropriate sample rates are those found in Appendix 8 applicable to Irregular Terrain Assessment.

5.14. Go-Around Capability. Regardless of the flight guidance system used an appropriate go-around mode/capability should be provided. A go-around mode/capability must be able to be selected at any time during the approach to touchdown. The go-around mode/capability should provide information for a safe discontinuance of the approach at any point to touchdown, if activated prior to touchdown. If activated at a low altitude where the aircraft inadvertently touches the ground, the go-around mode should provide adequate information to accomplish a safe go around and not exhibit unsafe characteristics as a result of an inadvertent touchdown. Inadvertent selection of go-around after touchdown should have no adverse effect on the ability of the aircraft to safely rollout and stop.

5.15. Excessive Deviation Alerting. An acceptable method should be provided to detect excessive deviation of the aircraft laterally and vertically during approach, and laterally during rollout, as applicable. The method used should not require excessive workload or undue attention. This provision does not require a specified deviation warning method or annunciation, but may be addressed by parameters displayed on the ADI, EADI, or PFD. When a dedicated deviation warning is provided, its use must not cause excessive nuisance alerts.

5.16. Rollout Deceleration Systems or Procedures for Category III.

5.16.1. Stopping Means. A means to determine that an aircraft can be reliably stopped within the available length of the runway is necessary to conduct Category III operations. At least one of the following means to assess stopping performance should be used:

1. An automatic braking system which includes information for the flightcrew about appropriate auto brake settings to be used for landing or which provides landing distance information suitable for use by the flightcrew to determine which auto brake setting may or may not be appropriate.

2. A ground speed indicating system based on inertial information or other equivalent source such as GNSS, together with acceptable procedures for its use.

3. A deceleration display or other indication which can advise the pilot of the adequacy of aircraft deceleration to stop within the available runway length.

4. A runway remaining indicator display reliably showing the length of remaining runway after touchdown.

5. A procedural means to assure a safe stop acceptable to FAA. However, a procedural means to ensure a safe stop is not appropriate for minima less than RVR300 (75 m).

5.16.2. Antiskid Systems. Unless otherwise determined to be acceptable to the FAA, aircraft authorized for Category III should have an operable anti-skid system installed and operative per the applicable FAA MMEL and MEL.

The authorization for aircraft to operate using Category III minima without anti-skid is determined by the POI for each aircraft type, considering the following factors:

1. Extra field length margin of runways to be authorized, compared with field lengths necessary for the aircraft type, and

2. The braking system characteristics of the aircraft regarding susceptibility to tire failure during heavy braking, and susceptibility to tire failure during operations with reduced or patchy runway surface friction.

5.17. Engine Inoperative Category III Capability. The following criteria are applicable to aircraft systems intended to qualify for "engine inoperative Category III" authorizations. Aircraft demonstrated to meet "engine inoperative" provisions of Appendix 3 that have an appropriate reference to engine inoperative Category III capability in the FAA approved AFM are typically considered to meet the provisions listed below.

The AFM or equivalent reference must suitably describe demonstrated approach and missed approach performance for the engine inoperative configuration, and the aircraft must meet pertinent criteria otherwise required for all-engine Category III or equivalent criteria. This performance data should also be available in the automated flight planning, performance and weight and balance systems normally used by the air carrier so as to be readily available to the pilot and, if applicable, the aircraft dispatcher.

Exceptions to all-engine Category III, or equivalent criteria, may be authorized for engine inoperative Category III as follows:

a. The effects of a second engine failure when conducting Category III operations with an engine inoperative need not be considered, except for a demonstration that the airplane remain controllable when the second engine fails,

b. Crew intervention to re-trim the aircraft to address thrust asymmetry following engine loss may be permitted,

c. Alternate electrical and hydraulic system redundancy provisions may be acceptable, as suited to the type design (e.g., bus isolation and electrical generator remaining capability must be suitable for the engine out configuration),

d. Requirements to show acceptable landing performance may be limited to demonstration of acceptable performance during engine out flight demonstrations (e.g., a safe landing on the runway), and

e. Landing system "status" should accurately reflect the aircraft configuration and capability.

2. Suitable information must be available to the flightcrew at any time in flight, and particularly at the time of a "continuation to destination" or "diversion to alternate” decision. This is to determine that the aircraft can have an appropriate Category III approach capability when the approach is initiated (e.g., Non-normal checklist specification of expected configuration during approach, autoland status annunciation of expected capability).

3. Performance should be demonstrated in appropriate weather conditions considering winds and any other relevant factors.

5.18. Airborne System Assessment for Irregular Pre-Threshold Terrain. Not withstanding that airworthiness demonstrations may consider irregular terrain in the pre-threshold area, special operational evaluations are nonetheless required for certain airports having difficult pre-threshold terrain conditions (see Section 6.2.5). Criteria for the operational evaluation of irregular pre-threshold terrain airports is contained in Appendix 8. This criteria may be used both for operational authorizations and in conjunction with airworthiness demonstrations for type certification (TC) or supplemental type certification (STC).

5.19. Airworthiness Demonstrations of Airborne System Capability for Category III. Airworthiness demonstrations of airborne systems not previously approved for Category III should be in accordance with the provisions of Appendices 2 through 6. Aircraft which have previously completed airworthiness demonstrations in accordance with earlier criteria may continue to reference the demonstrations against earlier criteria in their AFM and may elect to continue to use earlier criteria for continued production or demonstration of new production derivative aircraft. The criteria of this AC must be used when seeking credit not provided by the earlier criteria, for new aircraft types, or for significantly modified systems proposed to FAA for derivative aircraft after the date of the issuance of this revised AC. Category III aircraft systems may be evaluated in accordance with the applicable criteria contained in the Appendices of this AC during airworthiness demonstrations, or they may be evaluated in conjunction with an FAA approved program with an operator, for aircraft that are "in service" using the equivalent criteria and evaluation methods, to those specified in the Appendices to this AC. Operational demonstrations will not be conducted based on criteria prior to this AC.

6. PROCEDURES.

6.1. Operational Procedures. Appropriate operational procedures based on the approved operator program should be addressed. Operational procedures should consider the pilot qualification and training program, airplane flight manual, crew coordination, monitoring, appropriate takeoff and landing minima including specification of either a Decision Height or an Alert Height (as applicable) for landing, crew call-outs, and assurance of appropriate aircraft configurations. Suitable operational procedures must be used by the operator and be used by flightcrews prior to conducting low visibility takeoff or Category III landing operations.

6.1.1. Application of AFM Provisions. The operator's procedures for low visibility takeoff or Category III landing should be consistent with any AFM provisions specified in the normal or non-normal procedures sections (e.g., Section 3 of the AFM) during airworthiness demonstrations. Adjustments of procedures consistent with operator requirements are permitted when approved by the POI. Operators should assure that no adjustments to procedures are made which invalidate the applicability of the original airworthiness demonstration.

Where navigation performance for a specific RNP can only be achieved by specific system modes (e.g., coupled flight director or autopilot), the specific modes and associated RNP levels should be applied consistent with the AFM.

Where operations are based on RNP, suitable flight manual provisions for RNP capability and use should be provided. If not available in the AFM or Flight Crew Operating Manual (FCOM), RNP operations may be approved on a case by case basis, consistent with “fleet qualification” for RNP criteria such as found in RTCA DO-236 Appendix D, or equivalent FAA criteria.

6.1.2. Crew Coordination. Appropriate procedures for crew coordination should be established so that each flightcrew member can carry out their assigned responsibilities. Briefings prior to the applicable takeoff or approach should be specified to assure appropriate and necessary crew communications. Responsibilities and assignment of tasks should be clearly understood by crewmembers.

6.1.3. Monitoring. Operators should establish appropriate monitoring procedures for each low visibility takeoff, approach, landing, and missed approach. Procedures should assure that adequate crew attention can be devoted to control of aircraft flight path, displacements from intended path, mode annunciations, failure annunciations and warnings, and adherence to minima associated with DH and AH. Where a "monitored approach" is used, (e.g., where the First Officer is responsible for control of the aircraft flight path by monitoring of the automatic flight system) appropriate procedures should be established for transfer of control to the captain who will be making the decision for continuation of the landing at or prior to Decision Height or Alert Height. Monitoring procedures should not require a transfer of responsibility or transfer of control at a time that could interfere with safe landing of the aircraft. Procedures for calling out failure conditions should be pre-established, and responsibility for alerting other crewmembers to a failure condition should be clearly identified.

6.1.4. Use of the Decision Height or Alert Height. Decision heights are normally used for Fail Passive Category III operations and Alert Heights are used for Fail Operational Category III operations. Certain exceptions are noted elsewhere in this AC (e.g., use of a Decision Height (DH) due to specific fail operational aircraft characteristic at a runway with irregular pre-threshold terrain). When Decision Heights are specified, procedures for setting various reference bugs in the cockpit should be clearly identified, responsibilities for Decision Height call-outs should be clearly defined, and visual reference requirements necessary at Decision Height should be clearly specified so that flightcrews are aware of the necessary visual references that must be established by, and maintained after passing Decision Height.

When Alert Heights are specified, the operator may elect to use an Alert Height at or below 200 ft. HAT as suitable for procedure or procedures identified for use by that operator.

Procedures should be specified for call-out of the Alert Height and if applicable for conversion of the Alert Height to a Decision Height in the event that the aircraft reverts from Fail Operational to Fail Passive flight control.

The operator should assure that at each runway intended for Category III operations, the radar altimeter systems used to define Alert Height or Decision Height provides consistent, reliable, and appropriate readings for determination of Decision Height or Alert Height in the event of irregular terrain underlying the approach path, or an alternate method should be used. Alert Height or DH may be based on other means (e.g., inner marker) only when specifically approved by FAA. Any adjustments to approach minima or procedures made on final approach should be completed at a safe altitude (e.g., above 500 ft. HAT).

6.1.5. Call-outs. Altitude/Height call-outs should be used for Category III. Callouts may be accomplished by the flightcrew or may be automatic (e.g., using synthetic voice call-outs or a tone system). Typical call-outs acceptable for Category III include a combination of the following:

- "1000 ft." above the touchdown zone,
- "500 ft." above the touchdown zone,
- "approaching minimums,"
- "minimums,"
- altitudes during flare, (e.g., 50, 30, 10) or AFGS mode transitions (e.g., flare, rollout), and
- as appropriate, auto spoiler, reverse thrust deployment and autobrake disconnect.

Calls made by the flightcrew should not conflict with the automatic systems or auto call-outs of the aircraft, and conversely the configuration selected for the aircraft should not conflict with expected call-outs to be made by the flightcrew. Compatibility between the automatic call-outs and the crew call-outs must be assured. The number of call-outs made, either automatically, by crew, or in combination, should not be so frequent as to interfere with necessary crew communication for abnormal events.

Also, call-outs should be specified to address any non-normal configurations, mode switches, failed modes, or other failures that could affect safe flight, continuation of the landing, or the accomplish-ment of a safe missed approach. Any use of crew initiated call-outs at altitudes below 100 ft. should assure that the callouts do not require undue concentration of the non-flying pilot on reading of the radar altimeter rather than monitoring the overall configuration of the aircraft, mode switching, and annunciations that might be related to a successful Category III landing. Automatic altitude call-outs or tones are recommended for altitude awareness, at least at and after passing Decision Height or Alert Height.

Operators may make provision for use of crew verbal callouts as a backup, or in lieu of automatic callouts in certain circumstances. It is recommended that operators have a policy addressing procedures to be used when an automatic callout system fails or is inoperative regarding making some or all key callouts manually. Examples of when use of verbal crew callouts may be appropriate instead of or to augment automatic callouts include:

1) When an automatic callout system has failed,

2) When automatic callouts are inoperative through an MEL provision, or

3) When a particular automatic callout is not issued or is masked by another cockpit advisory or crew conversation, or is not heard for some other reason.

6.1.6. Aircraft Configurations. Operational procedures should accommodate any authorized aircraft configurations that might be required for low visibility takeoff or Category III approaches or missed approaches. Examples of configurations that operational procedures may need to accommodate include:

1. Alternate flap settings approved for Category III,

2. Use of alternate AFGS modes or configurations (e.g., Single Land, LAND2),

3. Inoperative equipment provisions related to the minimum equipment list, such as a non-availability of certain electrical system components, inoperative radar altimeter, air data computers, hydraulic systems or instrument switching system components, and

4. Availability and use of alternate electrical power sources (e.g., APU) if required as a standby source.

Procedures required to accommodate various aircraft configurations should be readily available to the flightcrew and the aircraft dispatcher to preclude the inadvertent use of an incorrect procedure or configuration. Acceptable configurations for that operator and aircraft type should be clearly identified so that the pilots can easily determine whether the aircraft is or is not in a configuration to initiate a low visibility takeoff or Category III approach. Configuration provisions must be consistent with, but are not limited to, those provided in the operations specifications for that operator.

6.1.7. Compatibility with Category I and Category II Procedures. The operator should assure that to the greatest extent possible, procedures for Category III are consistent with the procedures for that operator for Category II and Category I to minimize confusion about which procedure should be used or to preclude procedural errors due to pilots reverting to familiar procedures accomplished more frequently such as for Category I. The operator should to the extent practical, minimize the number of procedures that the crew needs to be familiar with for low visibility operations so that, regardless of the landing category necessary for an approach, the correct procedures can be used consistently and reliably.

6.1.8. Flightcrew Response to Non-Normal Events. Takeoff and landing weather minimums are intended for normal operations. When non-normal events occur, flightcrews and aircraft dispatchers are expected to take the safest course of action to assure safe completion of the flight. Using emergency authority, pilots can deviate from rules or polices, to the extent necessary, to minimize the risk of continued flight to a safe landing. In some instances, guidelines are established for particular failure situations, such as failure of required aircraft systems prior to reaching Alert Height.

When procedures or configurations have not been specified, pilots and aircraft dispatchers are expected to use good judgment in making the determination of appropriate configurations or situations to conduct safe Category III operations. The decision to continue an approach or to discontinue an approach must be made considering all relevant factors of the status of the aircraft, fuel on board, seriousness of the emergency, distance away of other available airports, and the likelihood of changing weather conditions, among other factors. It is not the intent of this AC to attempt to define guidelines for circumstances such as in-flight fire, minimum fuel reserves, or other situations requiring complex judgments of skilled crewmembers.

However, in the case of certain well-defined situations that can be addressed before departure, such as contingency planning in the event of an engine failure, guidelines are provided to assist pilots in making safe and consistent judgments about available alternative courses of action. Specific guidelines for initiation for a Category III approach with an inoperative engine are provided in section 5.17. Guidelines for other configuration situations may be provided by the normal or non-normal procedure section of the aircraft flight manual or by the operator. Pilots and aircraft dispatchers are expected to be familiar with these guidelines and apply them to the extent practical but may deviate as necessary from those guidelines, to the extent that they consider necessary to assure safe flight and landing. If doubt exists as to the advisability of continuation of an approach or diversion, it is the flightcrews responsibility to exercise their emergency authority to the extent necessary to assure a safe flight.

6.2. Category III Instrument Approach Procedures and Low Visibility Takeoff.

6.2.1. Takeoff Guidance System Procedures. When takeoff minima are predicated on use of a takeoff guidance system meeting the criteria of Section 5.1.3 or Appendix 2, procedures for use of the takeoff guidance system should be identified consistent with the approved AFM, or applicable operational authorization. Procedures should address at least the following items or factors:

- Setup, test, and initialization of the guidance system and NAVAID's, as applicable
- Roles and responsibilities of the PF and PNF
- Suitable alignment with and tracking of the runway centerline
- Suitable transfer of control between pilots for failures or incapacitation, as applicable
- Suitable response to failures (e.g., engine failure before and after V_1, electrical failure, guidance system alerts, warnings, and failures as applicable)

6.2.2. Acceptable Procedures for Category III Approach. Instrument Approach Procedures for Category III may be conducted in accordance with:

1. published 14 CFR part 97 procedures, or
2. approved operations specifications for special procedures, or

3. published foreign or military procedures approved by the FAA, or

4. foreign or military procedures accepted by FAA for specific foreign airports and runways.

6.2.3. Standard Obstacle clearance for approach and missed approach. Advisory Circular 120-29 as amended provides the standard Category II and III approach and missed approach criteria not otherwise specified in FAA Order 8260.3 (TERP's). The criteria in AC 120-29 should be applied except where acceptable TERP's criteria is provided for Category II and III operations using ILS, MLS, GLS or RNP facilities and equipment. Standard obstacle clearance criteria are typically incorporated with published part 97 procedures. Standard criteria used by several foreign authorities based on ICAO PANS OPS may be used where found to be acceptable to the FAA (e.g., JAA approved procedures). Category II and III procedures developed using criteria other than TERPS or PANS OPS are normally issued through operations specifications as special procedures. (See paragraph 6.2.4.)

6.2.4. Special Obstacle Criteria. In certain instances standard obstacle criteria as specified by TERPS may not be appropriate for particular Category III procedures. In such instances alternate criteria acceptable to the FAA may be used as specified in OpSpecs (e.g., RNP criteria).

6.2.5. Irregular Terrain Airports. Irregular terrain airports identified by a part 97 procedure, or by FAA order 8400.8, as amended, must be evaluated in accordance with FAA approved procedures prior to incorporation in operations specifications for use by air carriers operating to Category III minima.

Irregular terrain airport special evaluations should consider each particular aircraft type, the particular flight control system, and may include consideration of particular system elements such as the type of radar altimeters installed or other equipment.

Procedures for evaluation of these airports are provided in Appendix 8.

6.2.6. Airport Surface Depiction for Category III Operations. A suitable airport surface depiction (e.g., airport diagrams) should be available to flightcrews to assure appropriate identification of visual landmarks or lighting to safely accomplish taxing in Category III conditions from the gate to the runway and from the runway to the gate. The Airport depiction should use an appropriate scale with suitable detailed information on gate locations, parking locations, holding locations, critical areas, obstacle free zones, taxi way identifications, runway identifications, and any applicable taxi way markings for designated holding spots or holding areas. Standard depictions provided by commercial charting services are typically acceptable if they provide sufficient detail to identify suitable routes of taxi to and from the runway and gate positions for departure or arrival.

6.2.7. Continuing Category III Approaches in Deteriorating Weather Conditions. The following procedures are considered acceptable in the event that weather conditions are reported to drop below the applicable Category III minima after an aircraft has passed the final approach point or final approach fix, as applicable. (Reference section 121.651.)

- Operations based on a DA(H) may continue to the DA(H) and then land, if the specified visual reference is subsequently established by the pilot no later than the DA(H).

- Operations based on an Alert Height (AH) may continue to the AH and then land, if weather is reported to be at or above minima before passing the AH, or if suitable visual reference has been established by the pilot.

- Operations based on an AH may continue to land regardless of reported weather conditions if equipped with a fail operational rollout system which did not indicate a malfunction prior to passing alert height, and the pilot considers continuation a safe course of action.

Operators requesting amended operations specifications reflecting the procedures described above may have their current operations specifications amended by making application in accordance with paragraph 10.16. New Category III operators should have operations specifications issued reflecting these provisions in accordance with revised standard operations specifications (see samples provided in Appendix 7).

When wind constraints apply to Category III procedures (e.g., an Operation-Specification 15 knot crosswind component limit) the limit is considered to apply to the point of touchdown. If a report of a crosswind component value greater than the limit is received while on approach, an aircraft may continue an approach, but a subsequent wind report indicating winds are within limits or a pilot determination that actual winds are within limits must be made prior to touchdown. Acceptable methods for such a determination may include ATS reports, reports of other aircraft with reliable means of wind determination (e.g., IRS), pilot use of on board IRS or FMS wind readout capability, data link of recent winds, or pilot confirmation of an acceptable visual indication of winds on the surface by a wind sock, wind indicator or equivalent wind indicating device.

When an Airplane Flight Manual or other manufacturer's reference (e.g., FCOM) references "Maximum wind component speeds when landing weather minima are predicated on autoland operations", or an equivalent statement, an operator or flightcrew may consider those wind values to apply to "steady state" wind components. Any gust values which exceed the steady state wind limit need not be addressed if the flightcrew determines the gust exceedance can be considered insignificant in magnitude, variable in direction, occasional, or otherwise not applicable (e.g., obviously outdated gust report, winds and gusts reported at a location considered far from the runway or touchdown zone and not applicable, or gusts considered not pertinent during the period of touchdown or rollout).

6.2.8. Low Visibility Taxi Procedures. Low visibility taxi procedures should be adopted for each airport having such procedures. The procedures should be available to pilots in chart form, if applicable, and used. In addition to published Surface Movement Guidance and Control System (SMSGS) airport diagrams and information, the operator should provide:

- Any necessary specific gate identification information to find gates, ramp areas, or lead in vehicles,
- Any necessary information about identification of critical area protection zones or areas,
- Any necessary emergency response information for takeoff, landing, or other emergencies that are different for low visibility operations (e.g., markings or other ways to easily find and identify explosive holding areas in low visibility),
- Information on any known characteristics of the airport where aircraft ground vehicle traffic conflicts, taxi speed, or aircraft wing tip clearance pose unusual difficulty,
- Any other information necessary to facilitate safe operations in very low visibility (e.g., visual references that may be used for operations when standard markings may not be visible due to construction, snow cover).

Provision should be made for both day and night operation, unless operations are only conducted during either night or daylight hours.

Low visibility taxi and ground operations and related training and qualification are addressed in Sections 7.1.1 item 3 and 7.1.3 item 5 for ground training, Section 7.2 for flight training, and Section 8.5 for SMGCS Plans.

6.2.9. Navigation Reference Datum Compatibility (e.g.,WGS-84/Other Datum).

Outside the U.S., it is important for operators using FMS, GPS and RNAV to be aware of, and where necessary, take precautions to address potential differences in the Navigation Data Base (NDB) "reference datum" used by their aircraft's navigation system, and the datum used en route and at destination or alternate airports. Some States specify aeronautical data (e.g., NAVAID locations, runway locations, waypoint locations), including data for instrument procedures, using a reference datum other than the standard WGS-84 datum, or equivalent.

Addressing this difference can be important to preclude significant navigation errors. If not appropriately addressed, aircraft actual position may significantly differ from indicated position when flying in these areas. Aircraft may experience navigation difficulty including:

- Incorrect FMS position updating,
- Incorrect navigation to a waypoint, NAVAID, runway, or other geographic location,
- Violation of airspace or obstacle clearance during approach or missed approach,
- Displacement from the desired flight path, or runway misalignment following completion of an instrument approach, or

- Significant map shift, if FMS position is based on updates from NAVAID(s) referenced to a local datum inconsistent with that of the aircraft's navigation data base.

Also, this issue can be important when flying with FMS using a WGS-84 referenced navigation data base with "GPS updating capability" installed, but not operative (e.g., as for an FMS MEL dispatch, with GPS inoperative, GPS updating inoperative; or GPS updating inhibited).

For Category III procedures, the issue of use of an appropriate Navigation "Reference Datum" principally applies to flying RNAV initial or intermediate approach segments, or missed approach segments. Final approach segments of ILS or MLS procedures typically are not adversely affected by a difference in reference datum because of direct use of the localizer course. GLS or RNP procedures, while depending on specification of an appropriate reference datum for final approach, are otherwise protected from this datum difference through other criteria which assures consistent datum use for procedure development.

Information about the navigation reference datum used in particular locations outside of the United States is typically available on the Internet. An example of a commercial web site containing this information may be found at: **http://www.jeppesen.com/wgs84.html**

Accordingly, when operating outside United States airspace and when WGS-84 is not used locally as the reference datum for NAVAID's or procedures, or a reference datum equivalent to WGS-84 is not used, operators should take suitable precautions, as described below. These precautions apply to any RNAV segments flown as part of any instrument approach procedure or missed approach procedure (including Category III procedures, if applicable) for:

- FMS equipped aircraft capable of GPS updating, or
- GPS "stand alone" equipped aircraft, or
- FMS equipped aircraft.

a. Aircraft Equipped With FMS Having GPS Updating Capability, or Equipped With "GPS Stand Alone" Navigation Systems.

For operations outside the United States, where the local datum is not WGS-84, or WGS-84 equivalent, or where the operator is uncertain as to whether the local datum is significantly different than WGS-84, the operator should take one or more of the following precautions, as necessary:

1) Verify that the datum is WGS-84, or equivalent,

2) Conduct an assessment of the difference in the datum used, to determine that any difference is not significant for the procedures to be flown,

3) Develop and use special RNAV procedure segments or aeronautical data referenced to WGS-84 or equivalent, as necessary,

4) Manually inhibit GPS updating of the FMS while flying the approach, or segments of the approach affected by the difference in reference datum,

5) Only use FMS or GPS Stand Alone systems to fly pertinent RNAV segments of the approach where it is possible to use other NAVAID raw data to confirm correct aircraft position along the flight path,

6) Conduct simulation verification, or in-flight verification or confirmation of suitable navigation performance,

7) Preclude FMS or GPS use on segments of the approach affected by the difference in reference datum, or

8) Use any other method proposed by the operator, and found acceptable to FAA, to assure that a difference in the NDB Reference Datum from the local datum does not cause loss of navigation integrity.

For GLS or RNP procedures or procedure segments, since the reference datum is consistent with WGS-84 by procedure design, operators of aircraft using GPS updating of FMS, or "GPS Stand Alone" systems for RNAV need not apply the special precautions listed above, unless otherwise advised (e.g., by NOTAM, or equivalent).

b. FMS Equipped Aircraft That Do Not Have GPS Updating Capability.

While possible, FMS equipped aircraft that do not have GPS updating capability may be less likely to experience this particular datum reference difference issue. This is because navigation data bases, local NAVAID's, and local instrument procedures typically address and resolve datum issues consistently on a local basis, and in a consistent manner within the locally used coordinate frame of reference. However, even though the datum difference issue may be less likely, it nonetheless may occur. Precautions should be applied by operators, as necessary, if there is significant doubt as to Navigation Data Base datum differences.

The precautions listed above in item a. should not be interpreted to discourage GPS installation and use. GPS updating of FMS can significantly increase both navigation accuracy and integrity, and reduce the risk of other types of navigation errors, including map shifts, yielding a significant safety increase.

7. TRAINING AND CREW QUALIFICATION. Training and crew qualification programs pertinent to Category III should include provisions for appropriate ground training, flight training, initial qualification, recurrent qualification, recency of experience, and re-qualification. The operators program should provide appropriate training and qualification for each pilot in command, second in command and any other crewmember expected to have knowledge of or perform duties related to Category III landing or low visibility takeoff operations (e.g., Flight engineer).

Pilots in command are expected to have a comprehensive level of knowledge with respect to each of the ground training subjects and have performed each of the specified maneuvers and demonstrated skill in accomplishing each of the tasks specified for flight training. Second in command pilots should have a comprehensive knowledge of the subjects specified in the ground training program, and are expected to perform those relevant procedures or maneuvers applicable to the second in command is assigned duties during Category III landing operations or for low visibility takeoff. Other crewmembers are expected to have the knowledge required and the demonstrated skills to perform their assigned duties.

7.1. Ground Training.

7.1.1. Ground System and NAVAIDs for Category III. Ground systems and NAVAID's are considered to include characteristics of the airport, electronic navigation aids, lighting, marking and other systems (e.g., RVR) and any other relevant information necessary for safe Category III landing or low visibility takeoff operations.

The training and qualification program should appropriately address the operational characteristics, capabilities and limitations of at least each of the following:

1. NAVAID's. The navigation systems to be used, such as the instrument landing system with its associated critical area protection criteria, marker beacons, distance measuring equipment, compass locators or other relevant systems should be addressed to the extent necessary for safe operations. As applicable, operationally relevant characteristics of NAVAID types to be used should be addressed. For example for ILS or MLS, any characteristics of beam bends, overflight disturbances, beam switchover to secondary transmitters or power sources, flare of the glide slope signal at low altitudes may need to be explained or addressed depending on the characteristics of the particular flight guidance system used. If non ground based systems (e.g., GNSS) are used, any characteristics or constraints regarding that method of navigation, must be addressed (e.g., proper procedure waypoint selection and use, integrity assurance, coping with space vehicle (SV) loss of availability or failure, SV terrain masking).

2. Visual aids. Visual aids include approach lighting system, touchdown zone, centerline lighting, runway edge lighting, taxiway lighting, standby power for lighting and any other lighting systems that might be relevant to a Category III environment, such as the coding of the center line lighting for distance remaining, and lighting for displaced thresholds, stop ways, or other relevant configurations should be addressed.

3. Runway and Taxiways and SMGCS Plans. The runway and taxiway characteristics concerning width, safety areas, obstacle free zones, markings, hold lines, signs, holding spots, or taxi way position markings, runway distance remaining markings and runway distance remaining signs should be addressed. The SMGCS plan use should be addressed as applicable. This should include any

necessary briefings to be conducted and crew coordination, particularly for crash and rescue, evacuation, or other non-normal events, if different for low visibility situations.

4. Weather Reporting. Weather reporting and transmissometer systems, including RVR locations, readout increments, sensitivity to lighting levels set for the runway edge lights, variation in the significance of reported values during international operations, controlling and advisory status of readouts, and requirements when transmissometers become inoperative should be addressed.

5. Facility Status. Facility status, proper interpretation of outage reports for lighting components, standby power, or other factors and proper application of NOTAM's regarding the initiation of Category III approaches or initiation of a low visibility takeoff should be addressed.

7.1.2. The Airborne System. The training and qualification program should address the characteristics, capabilities, limitations, and proper use of each appropriate airborne system element applicable to Category III landing or low visibility takeoff including the following:

1. Flight Guidance. The flight control system, flight guidance system, instruments and displays and annunciation systems including any associated flight director, landing system and roll out system, or takeoff systems, if applicable. For automatic or manual systems which require crew input for parameters such as inbound course or automatic or manually tuned navigation frequencies, the crew should be aware of the importance of checking that proper selections have been made to assure appropriate system performance.

2. Speed Management. The automatic throttle, FMC or other speed management system, if applicable.

3. Instruments. Situation information displays, as applicable.

4. Supporting Systems. Other associated instrumentation and displays, as applicable, including any monitoring displays, status displays, mode annunciation displays, failure or warning annunciations and associated system status displays that may be relevant.

5. Aircraft Characteristics. Any aircraft characteristics that may be relevant to Category III, such as cockpit visibility cutoff angles and the effect on cockpit visibility of proper eye height, seat position or instrument lighting intensities related to transition through areas of varying brightness visual conditions change. Pilots should be aware of the effects on flight visibility related to use of different flap settings, approach speeds, use of various landing or taxi lights and proper procedures for use of windshield wipers and rain repellent. If windshield defog, anti-ice, or de-icing systems affect forward visibility, pilots should be aware of those effects and be familiar with proper settings for use of that equipment related to low visibility landing.

7.1.3. Flight Procedures and Associated Information.

1. Operations Specification. Pilots and aircraft dispatchers should be familiar with, and properly able to apply, operations specifications applicable to Category III landing or low visibility takeoff.

2. Normal and Non-normal Procedures. Pilots should be familiar with appropriate normal and non-normal procedures including crew duties, monitoring assignments, transfer of control during normal operations using a "monitored approach," appropriate automatic or crew initiated call-outs to be used, proper use of standard instrument approach procedures, special instrument approach procedures, applicable minima for normal configurations or for alternate or failure configurations and reversion to higher minima in the event of failures.

3. Weather and RVR. Pilots and aircraft dispatchers should be familiar with weather associated with Category III and proper application of runway visual range, including its use and limitations, the determination of controlling RVR and advisory RVR, required RVR equipment, appropriate light settings for correct RVR readouts and proper determination of RVR values reported at foreign facilities.

4. Use of DA(H) or Alert Height. Pilots should be familiar with the proper application of Decision Height or Alert Height, as applicable, including proper use and setting of radar altimeter bugs, use of the inner marker where authorized or required due to irregular underlying terrain and appropriate altimeter setting procedures for the barometric altimeter consistent with the operators practice of using either QNH or QFE.

5. Use of Visual Reference. Pilots should be familiar with the availability and limitations of visual reference encountered for taxi, takeoff, and approach.

Approach visual reference limitation information should at least address aircraft geometry limitations on visual reference, actions to take with loss or partial loss of visual reference, risks of inappropriate use of visual reference, and necessary visual references for continuation after Decision Height, if a Decision Height is applicable. Issues listed in section 6.2.7 above for continuation or discontinuation of an approach in deteriorating weather conditions should be comprehensively addressed.

Pilots should be familiar with procedures for an unexpected deterioration of conditions to less than the minimum visibility specified for the procedure during an approach, flare or roll out including the proper response to a loss of visual reference or a reduction of visual reference below the specified values when using a Decision Height and prior to the time that the aircraft touches down. The operator should provide some means of demonstrating the expected minimum visual references that occur on approach when the weather is at acceptable minimum conditions, and the expected sequence of visual queues during an approach in which the visibility is at or above the specified landing minimums. This may be done using simulation, video presentation of simulated landings or actual landings, slides or pictures showing expected visual references, computer based reproductions of expected visual references, or other means acceptable to the FAA.

When an alert height is used, pilots should be familiar with the expected visual references sequence likely to be encountered during an approach, even though a specific regulatory visual reference is not established when using an alert height.

When a synthetic reference system such as "synthetic vision" or enhanced vision systems or independent landing monitors are used, pilots should be familiar and current with the interpretation of the displays to assure proper identification of the runway and proper positioning of the aircraft relative to continuation of the approach to a landing. Pilots should be briefed on the limitations of these systems for use in various weather conditions and specific information may need to be provided on a site-specific basis to assure that mis-identification of runways, taxiways or other adjacent runways does not occur when using such systems.

For takeoff, pilots should be aware of the operators policy for responding to loss of suitable visual reference during takeoff, in the low and high speed regime, both before and after V_1 (see FAA AC 120-62 “Takeoff Safety Training Aid” for additional information and recommendations for training).

6. Transfer of Control. Procedures should be addressed for transfer of control and transition from non-visual to visual flight for both the pilot in command, second in command, as well as the pilot flying and pilot not flying during the approach. For systems which include electronic monitoring displays, as described in item 5 above, procedures for transition from those monitoring displays to external visual references should be addressed.

7. Acceptable Flight Path Deviations. Pilots should be familiar with the recognition of the limits of acceptable aircraft position and flight path tracking during approach, flare and if applicable roll out. This should be addressed using appropriate displays or annunciations for either automatic landing systems or for manual landing systems or when using electronic monitoring systems such as an independent landing monitor.

8. Wind Limitations. Environmental effects should be addressed. Environmental effects include appropriate constraints for head winds, tail winds, cross winds, and the effect of vertical and horizontal wind shear on automatic systems, flight directors, or other system (e.g., synthetic vision) performance. For systems such as head-up displays which have a limited field of view or synthetic reference systems pilots should be familiar with the display limitations of these systems and expected pilot actions in the event that the aircraft reaches or exceeds a display limit capability.

9. Contaminated Runways. Pilots and aircraft dispatchers should be familiar with the operator’s policies and procedures concerning constraints applicable to Category III landings or low visibility takeoffs, on contaminated or cluttered runways. Limits should be noted for use of slippery or icy runways as far as directional control or stopping performance is concerned, and crews should be familiar with appropriate constraints related to braking friction reports. Pilots and aircraft dispatchers should be familiar with the method of providing braking friction reports applicable to each airport having Category III landing operations or low visibility takeoff operations.

10. Airborne System Failures. Pilots should be familiar with the recognition and proper reaction to significant airborne system failures experienced prior to and after reaching the final approach fix and experienced prior to and after reaching Alert Height or Decision Height, as applicable. Expected pilot response to failure after touchdown should be addressed, particularly for Category III operations. Engine inoperative Category III provisions should be addressed, if applicable, including identification of acceptable aircraft and system configurations, assurance of adequate obstacle clearance and missed approach performance, and appropriate use of alternates. If applicable, provisions for "engine inoperative Category III" should be addressed.

11. Go-around Provisions. Pilots are expected to appropriately recognize and react to ground or navigation system faults, failures or abnormalities at any point during the approach, before and after passing Alert Height or Decision Height and in the event an abnormality or failure which occurs after touchdown. Pilots should be familiar with appropriate go-around techniques, systems to be used either automatically or manually, consequences of failures on go-around systems which may be used, the expected height loss during a manual or automatic go around considering various initiation altitudes, and appropriate consideration for obstacle clearance in the event that a missed approach must be initiated below Alert Height or Decision Height.

12. Reporting Anomalies. Pilots should be familiar with the need to report navigation system anomalies or discrepancies, or failures of approach lights, runway lights, touchdown zone lights, center line lights or any other discrepancies which could be pertinent to subsequent Category III operations.

7.2. Flight Training (Aircraft or Simulator). Flight training (typically using a simulator) should address the following maneuvers and procedures and may be done individually as Category III maneuvers, or they may be accomplished in appropriate combinations with Category I or Category II maneuvers. When pilots are authorized to use minima for Category I or Category II, as well as Category III, maneuvers may be appropriately combined and done in conjunction with other required approaches necessary for Category I or Category II training and qualification when such combinations are appropriate (e.g., engine-inoperative missed approach). During each of the specified maneuvers or procedures, crewmembers are expected to perform their respective assignments or duties as applicable. In situations where crewmembers are being qualified, other than as part of the complete flightcrew, such as when two pilots in command are being qualified, it may in some cases be necessary to assure that each candidate completes the required maneuvers or procedures involving manual control of the aircraft or other demonstration of proficiency when such demonstration is required for a PIC.

Flight training (typically using a simulator) for Category III approach and landing should address at least the following maneuvers:

1. Normal landings at the lowest applicable Category III minima.

2. A missed approach from the Alert Height or Decision Height (may be combined with other maneuvers).

3. A missed approach from a low altitude that could result in a touchdown during go-around (rejected landing).

4. Appropriate aircraft and ground system failures (may be combined with other maneuvers).

5. Engine failure prior to or during approach (if specific flight characteristics of the aircraft or operational authorizations require this maneuver).

6. Except for aircraft using an automatic Fail Operational roll out system, manual roll out in low visibility at applicable minima (may be combined).

7. Landings at the limiting environmental conditions authorized for Category III for that operator with respect to wind, cross wind components, and runway surface friction characteristics (may be combined).

Flight training (typically using a simulator) for low visibility takeoff (e.g., RVR less than RVR500 ft./150 m), where a flight guidance system is required, should address the following maneuvers and procedures:

1. Normal takeoff,

2. Rejected takeoff from a point prior to V_1 (including an engine failure),

3. Continued takeoff following failures including engine failure, and any critical failures for the aircraft type which could lead to lateral asymmetry during the takeoff, or

4. Rejected takeoff which involve transfer of control from the first officer to the captain, if first officers are authorized to make takeoffs under the specified low visibility conditions (if applicable).

The conditions under which these normal and rejected takeoffs should be demonstrated include appropriate limiting cross winds, winds, gusts and runway surface friction levels authorized. A demonstration should be done at weights or on runways that represent a critical field length. If the flight guidance devices used have not been shown to have failure characteristics which are extremely improbable, a takeoff and rejected takeoff should be demonstrated with failure of the flight guidance device at a critical point of the takeoff.

Training for low visibility taxi and ground operations (e.g., during simulator training, LOFT or other scenarios) are recommended to be conducted to the extent practical and beneficial. If conducted, they should address at least representative items listed in Sections 6.2.8, 7.1.1, and 7.1.3 at typical airports. Alternately, the operator may elect to use airports frequently experiencing low visibility conditions, complex airports on the operator's route system, airports with particular low visibility ground movement difficulties, or rarely used but significant contingency airports (e.g., ETOPS or EROPS diversion airports), as determined appropriate by the operator for that operator's route system, aircraft types, training cycle, LOFT scenarios used, and typical line issues being experienced.

7.2.1. Initial Qualification.

1. Ground Training. Initial ground training should cover the subjects specified in 7.1 for each pilot in command and second in command and appropriate subjects from 7.1 relevant to other crewmembers when they have assigned responsibilities for Category III landing or low visibility takeoff.

2. Flight Training. Flight training should be conducted using an approved simulator capable of performing the appropriate maneuvers specified, and which can appropriately represent the limiting visual conditions related to the minima which are applicable. Where simulation is not available, an aircraft with suitable view limiting device may be used if authorized by the assigned principal operations inspector. While the number of simulator periods, training flights, or length of simulator periods is not specified, the operator is expected to provide sufficient training to assure that crewmembers can competently perform each of the maneuvers or procedures specified in 7.2 to an acceptable degree of proficiency. When Category III minima are based on manual operations using systems like head-up displays or flight directors, a number of repetitions of the maneuvers specified in paragraph 7.2 above may be necessary to assure that each of the required maneuvers can be properly and reliably performed. Guidance for acceptable programs can be found in FAA, FSB reports for specific aircraft types. Operators should adhere to FSB guidelines when published, unless otherwise authorized by AFS-400.

7.2.2. Recurrent Qualification.

1. Recurrent Ground Training. Recurrent ground training should provide any necessary review of topics specified in 7.1 to assure continued familiarity with those topics. Emphasis should be place on any program modifications, changes to aircraft equipment or procedures, review of any occurrences or incidents that may be pertinent, and finally emphasis may be placed on re-familiarization with topics such as mode annunciations for failure conditions or other information which the pilots may not routinely see during normal line operations. Topics to be addressed for each pilot in command, second in command other crewmember or aircraft dispatchers are those topics necessary for the performance of the assigned duties for each respective crewmember.

2. Recurrent Flight Training. Recurrent flight training should be conducted using an approved simulator with an appropriate visual system. In the event that simulation is not available, recurrent flight training may be accomplished in the aircraft using suitable view limiting devices, if approved by the principal operations inspector. Recurrent flight training should include at least one Category III approach to a landing if the pilot has not had recent Category III or simulated Category III experience, and one approach requiring a go-around from a low altitude below Alert Height or Decision Height prior to touchdown.

When takeoff minimums below RVR500 are approved, recurrent flight training must include at least one rejected takeoff at the lowest approvable minima, with an engine failure near but prior to V_1. For both Category III landings and low visibility takeoffs, sufficient training should be provided to assure competency in each of the maneuvers or procedures listed in 7.2.

Recurrent flight training maneuvers may be accomplished individually or may be integrated with other maneuvers required during proficiency training or during proficiency checking. If minima are authorized using several methods of flight control such as both automatic landing and head-up display, then the training program should assure an appropriate level of proficiency using each authorized mode or system. Where Category III minima are based on manual control using flight guidance such as provided by a head-up flight guidance system, appropriate emphasis should be placed on failure conditions which a pilot does not normally experience in line operations.

7.2.3. Recency of Experience. Recency of experience requirements specified by section 121.439 or in accordance with AC 120-53 normally provide an assurance of the necessary level of experience for Category III landing or low visibility takeoff operations. In the event that special circumstances exist where crewmembers may not have exposure to the automatic landing system or manual systems such as head-up flight guidance for long periods of time beyond that permitted by section 121.439 or AC 120-53, then the operator should assure that the necessary recency of experience is addressed prior to pilots conducting Category III landings, or low visibility takeoff operations below RVR500.

For automatic landing systems, as a minimum, pilots should be exposed to automatic landing system operation and procedures during training or checking in either the aircraft or in a simulator at least annually, if the crew has not otherwise conducted line landings using an automatic system within the previous 12 months. For manual flight guidance landing or takeoff systems the pilot flying (PF) should be exposed to system operation, procedures, and use during training or checking at least once each 90 days, if the pilot has not otherwise conducted line landings using the manual flight guidance system within the previous 90 days.

7.2.4. Re-qualification. Credit for previous Category III qualification in a different aircraft type or variant, or previous qualification in the same type or variant at an earlier time may be considered in determining the type of program, length of program, required maneuvers to be completed or the repetition of maneuvers for re-qualification for Category III operations. Any re-qualification program should assure that the pilots have the necessary knowledge of the topics specified in section 7.1 and are able to perform their assigned duties for Category III or low visibility takeoff considering the maneuvers or procedures identified in section 7.2.

For programs which credit previous Category III qualification in a different type aircraft, the transition program should assure that any subtle differences between aircraft types which could lead to pilot misunderstanding of appropriate characteristics or procedures in the new type must be suitably addressed.

7.2.5. Cockpit or Aircraft System Differences. For Category III programs using aircraft which have several variants, training programs should assure that pilots are aware of any differences which exist and appropriately understand the consequences of those differences. Guidelines for addressing differences can be found in FAA AC 120-53 and FSB reports applicable to a particular type.

7.2.6. Category III Operations with an Inoperative Engine. For air carriers authorized to initiate a Category III approach with an inoperative engine either through Category III dispatch or equivalent procedures or for engine failures which occur en route, appropriate training should be completed to assure that pilots and aircraft dispatchers can properly apply the provisions of section 10.8. For airlines that do not authorize the initiation of a Category III approach with an engine inoperative as an approved procedure, pilots should at least be familiar with the provisions of sections 10.8.4 and 10.8.5 regarding an engine failure after passing the final approach fix. Additionally, pilots should be made aware of the engine inoperative capabilities of the aircraft by reference to the AFM.

7.2.7. Training in Conjunction with Advanced Qualification Programs (AQP) or Exemptions for "Single Visit Training." Appropriate re-qualification or recurrent qualification programs may be adjusted as necessary when incorporated in AQP or other single visit training programs. With such programs, however, each of the areas of knowledge specified by section 7 of this AC must be assured.

7.2.8. Credit for "High Limit Captains" (Reference section 121.562). When authorized by the POI, credit for high landing weather minimum limits and required turbojet experience may be authorized consistent with provisions of exemptions authorized for Category III qualification credit.

7.2.9. Enhanced or Synthetic Vision Systems (Independent Landing Monitor). Training required for enhanced or synthetic vision systems may be as specified by FAA based on successful completion of proof of concept testing.

7.3. Checking or Evaluations. For both initial qualification and recurrent qualification, crewmembers should demonstrate proper use of aircraft systems and correct procedures as follows, unless otherwise specified by an applicable FSB report.

1. For automatic systems, for landing at least one automatic landing to a full stop, and one go-around from a low approach at, or after, decision or Alert Height. The automatic landing to a full stop may be waived for recurrent qualification if the crewmember has accomplished an automatic landing within a period for autoland currency for that operation and aircraft type.

2. For manual systems one landing to a complete stop at the lowest applicable minima and one go-around from low altitude below Alert Height or Decision Height and at least one response to a failure condition during the approach to a landing or a missed approach should be demonstrated.

3. For takeoff below RVR500, pilots should successfully demonstrate one takeoff in the event of an engine failure at, or after, V_1 and one rejected takeoff with an engine failure or other appropriate failure near but prior to, V_1.

7.4. Experience with Line Landings. When a qualification program has been completed using only a simulator program, at least the following experience should be required before initiating Category III operations, unless otherwise specified by an applicable FSB report.

1. For automatic systems at least one line landing using the auto flight system approved for Category III minima should be accomplished in weather conditions at or better than Category II, unless a pilot's qualification has been completed in a Level C or D simulator found acceptable for that autoland system.

2. For manual systems such as head-up flight guidance system, the pilot in command must have completed at least ten line landings, using the approved flight guidance system in the configuration specified for Category III and at suitable facilities (e.g., facilities having appropriate ground facilities for the lowest minima authorized, or equivalent).

7.5. Crew Records. The operator should assure that records suitably identify initial and continued eligibility of pilots for Category III operations. Records should note the appropriate completion of training for both ground qualification, flight qualification, and initial training, recurrent training, or re-qualification training, as applicable.

7.6. Dual Qualification. In the event that crewmembers are dual qualified as either captain or first officer for checking and performing the duties of the second in command or for crewmembers dual qualified between several aircraft types or variants, appropriate training and qualification must be completed to assure that each crewmember can perform the assigned duties for each seat position and each aircraft type or variant.

For programs involving dual qualification, principal inspectors should approve the particular operators program considering the degree of differences involved in the Category III aircraft systems, the assigned duties for each crew position and criteria such as AC 120-53 related to differences. If a pilot serving as second in command is not expressly restricted from performing the duties of the pilot in command during Category III approaches or low visibility takeoffs below RVR500, then that pilot must satisfactorily complete the requirements for a pilot in command regarding maneuvers specified in section 7.2.

7.7. Interchange. When aircraft interchange is involved between operators, flightcrew members and aircraft dispatchers must receive sufficient ground and flight training to assure familiarity and competency with respect to the particular aircraft system or systems of the interchange aircraft. Guidelines for differences should be consistent with those specified in AC 120-53 and FSB reports.

7.8. Training For Use of Foreign Airports for Category III Operations or Low Visibility Takeoff. Operators authorized to conduct Category III operations or low visibility takeoffs below RVR600 at foreign airports, which require procedures or limitations different than those applicable within the United States, should assure that flightcrew members and aircraft dispatchers are familiar with any differences appropriate to operations at those foreign airports.

7.9. Line Checks. Operators should include assessments of Category III procedures and practices as necessary during line checks when operations are conducted at facilities appropriate for Category III or at facilities appropriate for simulating Category III operations.

8. AIRPORTS, NAVIGATION FACILITIES AND METEOROLOGICAL CRITERIA. United States and non-United States airports and runways for Category III are those either having published part 97 SIAPS, or as otherwise specified on the FAA AFS-400 "Category II/Category III status checklist" (FAA Order 8400.8). Requests for authorization to use other airports/runways should be coordinated with AFS-400, through the operator's Certificate Holding District Office (CHDO).

8.1. Use of Standard Navigation Facilities. Category III operations may be approved on standard United States or ICAO navigation facilities as follows:

United States Type 3 ILS facilities for which part 97 Category III procedures are published;

United States Type 2 ILS facilities for which a published part 97 Category III procedure has been established;

Other United States Type 3 or Type 2 ILS facilities determined acceptable by AFS-400 for the type of aircraft equipment and minima sought; and

Non-United States facilities meeting ICAO criteria (ICAO Annex 10, ICAO Manual of All Weather Operations DOC 9365/AN910, etc.) and which are promulgated for use for Category III by the "State of the Aerodrome."

8.2. Use of Other Navigation Facilities or Methods. Category III operations may be approved using other types of navigation facilities than ILS or using other acceptable position fixing and integrity assurance methods, if proof of concept demonstrations acceptable to FAA are successfully completed:

Other United States facilities approvable for Category III (MLS, GLS, DGPS, or a Type I ILS used in conjunction with an acceptable aircraft integrity assurance system, etc.) are as determined acceptable by AFS-400, and

Non-United States ILS facilities meeting acceptable criteria other than ICAO (e.g., JAA), may be used as determined to be acceptable by AFS-400.

8.3. Lighting Systems. Lighting used for Category III must include the following systems, or ICAO equivalent systems, unless approved by AFS-400 (e.g., for Non-United States airports):

United States Standard ALSF1 or ALSF2 approach lights;

United States Standard Touchdown Zone Lights;

United States Standard Runway Centerline Lights;

United States Standard High Intensity Runway Lights;

United States Standard taxiway centerline lights (for any areas of the airport determined to be critical in an FAA accepted Surface Movement Guidance and Control (SMGC) plan), or equivalent;

United States Standard taxiway edge lights (for taxiways not requiring centerline lights);

Suitable ramp and gate area lighting for low visibility operations (for night operations); and

Runway Hold line/Stop Bar lights (if applicable to a FAA approved SMGC plan).

Exceptions to the above lighting criteria may be authorized only if equivalent safety can be demonstrated by an alternate means (e.g., substitution for required approach lighting components due to an approved aircraft system providing equivalent information or performance [such as radar based EVS], or redundant, high integrity, computed runway centerline information, displayed on a HUD).

8.4. Marking and Signs. Airports approved for Category III operations must include the following runway and taxiway markings and airport surface signs, or ICAO equivalent, unless approved by AFS-400 (e.g., for Non-United States airports):

United States Standard Precision Instrument Runway Markings.

United States Standard Taxiway edge and centerline Markings.

Runway signs, taxiway signs, hold line signs, taxiway reference point markings (if required by SMGC), and NAVAID (ILS) critical area signs and markings.

Markings and signs must be in serviceable condition, as determined by the operator or FAA Certificate Holding District Office (CHDO). Markings or signs found in an unacceptable condition by an operator should be reported to the appropriate airport authority and CHDO. Operators should discontinue Category II use of those areas of airport facilities or runways where unsafe conditions are known to exist due to markings or signs being inadequate, until remedial actions are taken by the airport authority (e.g., snow removal, rubber deposit removal on runway touchdown zone markings or centerline markings, critical area hold line or runway centerline marking repainting, runway hold line sign snow removal).

8.5. Low Visibility Surface Movement Guidance and Control (SMGC) Plans. United States airports conducting takeoff or landing operations below RVR1200 are required to develop a Surface Movement Guidance and Control System (SMGCS) plan. SMGCS operations facilitate low visibility takeoffs and landings and surface traffic movement by providing procedures and visual aids for taxiing aircraft between the runway(s) and apron(s). Specific low visibility taxi routes are provided on a separate SMGCS airport chart. SMGCS operations also facilitate the safety of vehicle movements that directly support aircraft operations, such as aircraft rescue and fire fighting (ARFF) and follow-me services, towing and marshaling.

Advisory Circular 120-57 as amended describes the standards and provides guidance in implementing SMGCS operations such as aircrew training, etc. An operator intending authorization for Category III operations should coordinate with the airport authority regarding their SMGCS plan. Equivalent coordination is also applicable at non-U.S. airports if such a plan is used by that airport.

8.6. Meteorological Services and RVR Availability and Use.

8.6.1. Meteorological Services. Appropriate meteorological service (e.g., RVR, Altitude Settings, METAR’s, TAF’s, Braking Action, NOTAM’s, reports) are necessary for each airport/runway intended for use by an operator for Category II, unless otherwise approved by AFS-400. Non-United States facilities should meet criteria of ICAO Doc 9365/AN910, second edition, or later, as amended. This information must be readily available to both the crew and the aircraft dispatcher.

8.6.2. RVR Availability and Use.

8.6.2.1. RVR Availability. RVR availability for touchdown zone (TDZ), mid runway (MID), and ROLLOUT RVR (or a corresponding international equivalent location) are as follows. RVR should be provided for any runway over 8000 ft. in length. TDZ and ROLLOUT RVR should be provided for runways less than 8000 ft. Exceptions to this availability for United States operators at international locations may be approved on a case by case basis, by AFS-400, if equivalent safety can be established. Factors considered due to local circumstances at non-United States airports may include such issues as minima requested, characteristics of prevailing local weather conditions, location of RVR sites or RVR calibration, availability of other supporting weather reports on nearby runways, etc.

8.6.2.2. RVR Use. RVR use by operators and pilots is as specified in standard operations specifications Part C (see Appendix 7).

However, when approved as an exception in operations specifications, aircraft capable of certificated landing or takeoff distance of less than 4000 ft. may be approved to use a single TDZ, MID, or ROLLOUT transmissiometer as applicable to the part of the runway used (e.g., "Relevant" RVR). For such operations, transmissiometers not used are considered to be optional and advisory, unless the aircraft operation is planned to take place at a speed above safe taxi speed on the part of the runway where the MID or ROLLOUT transmissiometer is located.

For operations in the U.S., RVR must be instrumentally derived. At non-U.S. airports, RVR reports that are not instrumentally derived may be used if their basis is determined to be reliable and accurate by the operator and CHDO/POI.

For operations outside the U.S., operators and pilots should be familiar with any application and unique use of RVR at the airports to be used. This should include any differences is standard reporting, calibration, or RVR readings related to lighting step settings used, and any conversions necessary to be made (e.g., meteorological visibility to RVR conversion).

For meteorological visibility to RVR conversion, when operating at foreign airports where the landing minimums are specified only in RVR, and meteorological visibility is provided, the certificate holder or pilot should convert meteorological visibility to RVR by multiplying the reported visibility by an appropriate factor, as shown in Standard Operations Specifications (see Appendix 7, Part C, Paragraph C051 for use of an appropriate conversion table). However, the conversion of reported Meteorological Visibility to RVR provided in paragraph C051 should not be used for takeoff minima or Category III minima, or when a reported RVR is available.

8.6.3. Pilot Assessment of Takeoff Visibility Equivalent to RVR. In special circumstances, provision may be made for pilot assessment of takeoff visibility equivalent to RVR to determine compliance with takeoff minima. Authorization for pilot assessment is provided through operations specifications paragraph C078 (see Appendix 7) when a satisfactory procedure is provided to the flightcrew. A pilot may assess visibility at the take off position in lieu of reported TDZ RVR (or equivalent) in accordance with the following:

1. TDZ RVR is inoperative, or is not reported (e.g., ATS facility is closed), or

2. local visibility conditions as determined by the pilot indicate that a significantly different visibility exists than the reported RVR (e.g., patchy fog, blowing snow, RVR believed to be inaccurate due to snow cover or ice), and

3. pertinent markings, lighting, and electronic aids are clearly visible and in service (e.g., no obscuring clutter), and

4. a pilot assessment is made using an accepted method regarding identification of an appropriate number of centerline lights, or markings, of known spacing visible to the pilot when viewed from the flight deck when the aircraft is at the take-off point, and

5. pilot assessment of visibility as a substitute for TDZ (takeoff) RVR is approved for the operator, and observed visibility is determined to be greater than the equivalent of RVR300 (75m), and

6. a report of the pilot's determination of visibility (PIREP) is forwarded to a suitable ATS facility, and if applicable, dispatch facility prior to departure (e.g., if an ATS facility or dispatch facility is

applicable, available, pertinent, and is providing services relevant to the pilot report). A report of pilot visibility is intended to provide information for other operations.

8.7. Critical Area Protection. Airports and runways used for Category II or III must have suitable NAVAID (e.g., ILS) critical area protection, as applicable to the ground and aircraft systems used. Procedures equivalent or more stringent than those specified in the Air Traffic Control Handbook (FAA Order 7110.65) as amended, are required. Procedures consistent with ICAO DOC 9365/AN910 are acceptable for non-United States facilities. Where uncertainty regarding acceptability of non-United States airport procedures is a factor, operators or CHDOs should contact AFS-400 (e.g., for non United States airports and runways listed on the FAA Category II/Category III status checklist where doubt exists regarding adequacy of procedures encountered in routine operations) for follow up.

8.8. Operational Facilities, Outages, Airport Construction, and NOTAM's. For operations to be initially authorized, operations to continue to be authorized, for an aircraft to be dispatched with the intention of using a facility described above, or for an aircraft to continue to its destination or an alternate with the intent of completing a Category III instrument approach procedure, each of the applicable necessary components or services identified in 8.1 through 8.7 above must be operating, available, or normal as intended for Category III (e.g., NAVAID's, standby power, lighting systems) except as specified below.

Outer, Middle, or Inner Marker beacons may be inoperative unless a Category III operation is predicated on their use (e.g., an AH is predicated on use of an Inner Marker due to irregular terrain, or the aircraft system requires use of a marker beacon for proper flight guidance function).

Lighting systems are in normal status except that isolated lights of an approach light, or runway light system may be inoperative; approach light components not necessary for the particular operation (such as REIL, VASI, RAIL, or SFL) may be inoperative; lights may not be completely obscured by snow or other such contaminants if necessary for the operation (e.g., night); Taxiway, ramp, and gate area lighting components may be inoperative if not essential for the operation to be conducted.

Ground facility standby power capability for the landing airport or alternate (if applicable) must be operative at the time of the aircraft's departure to a Category III destination or alternate.

Category III operations may be continued at airports at which construction projects affect runways, taxiways, signs, markings, lighting, or ramp areas only if the operator has determined that low visibility operations may be safely conducted with the altered or temporary facilities that are provided. In the event of uncertainty as to the suitability of facilities, the operator should consult with their CHDO.

Operators may make the determination as to the suitability of the above facilities regarding unusual weather or failure conditions unless otherwise specified by the airport authority, or FAA.

NOTAM's for NAVAID's, facilities, lighting, marking, or other capabilities must be appropriately considered for both dispatch, and for continued flight operations intending to use a Category III procedure. Operators, aircraft dispatchers, and pilots must appropriately respond to NOTAM's potentially adversely affecting the aircraft system operation, or the availability or suitability of Category III procedures at the airport of landing, or any alternate airport intended for Category III.

An operator may make the determination that a NOTAM does not apply to the aircraft system and procedures being used for a particular flight if the safety of the operation can be ensured, considering the NOTAM and situation (e.g., a NOTAM specifying Category III Not Available due to the ALS inoperative, for an aircraft that had previously been dispatched based on a Category III ETOPS or EROPS alternate airport flight plan, and no other suitable airport facility is available). In such instances, pilots must be advised of any relevant information to the decision, and any precautions to be taken.

8.9. Use of Military Facilities. Military facilities may be used for Category III if authorized by DoD, and if equivalent criteria are met as applicable to United States civil airports.

8.10. Special Provisions for Facilities Used for ETOPS or EROPS Alternates. ETOPS operations are extended range operations with twin-engine aircraft, typically conducted over oceanic or remote areas (see Appendix 1 for definitions, or see a current version of AC 120-42 and 14 CFR section 121.161 for requirements or criteria). EROPS operations are those “extended range operations” typically conducted in oceanic or remote areas, regardless of the number of installed engines.

An airport used as an ETOPS or EROPS alternate based on having available Category III engine-inoperative capability should meet at least the following criteria:

Sufficient information about pre-threshold terrain, missed approach path terrain, and obstructions should be available so that an operator can assure that a safe Category III landing can be completed, and that an engine-inoperative missed approach can be completed from AH or DH as applicable, or at any time after passing the AH or DH at least to a point at the end of the landing touchdown zone (TDZ).

Sufficient meteorological and facility status information should be available so that a diverting flightcrew and the aircraft dispatcher can receive timely status updates on facility capability, weather/RVR, wind components, and braking action reports (if applicable), if conditions could or would adversely affect a planned Category III landing during the period of a diversion.

For any alternate airports not routinely used by that operator as a regular destination airport (e.g., EGCC as an alternate for EGLL; BIKF as a North Atlantic alternate), sufficient information should be provided for aircraft dispatchers and pilots to be familiar with relevant low visibility and adverse weather characteristics of that airport that might have relevance to an engine-inoperative operation (e.g., unique lighting or markings, any nearby obstructions or frequently encountered local wind shear or turbulence characteristics, meteorological reports, braking reports, and NOTAM interpretation, appropriate ground taxi route and gate location information, emergency services available).

8.11. Alternate Minima. Use of alternate minima are specified in Standard OpSpecs Part C paragraph C055. For applicability of "engine inoperative Category III" capability see section 10.8, and in particular, 10.8.2 items (10) and (11).

Paragraph C055 is issued to all part 121 and part 135 operators who conduct IFR operations with airplanes. This paragraph provides a three-part table from which the operator, during the initial dispatch or flight release planning segment of a flight, determines applicable alternate airport IFR weather minimums for those cases where it has been determined that an alternate airport is required.

a. Standard Provisions. Standard provisions of the Part C paragraph C055 operation-specification are applicable to airports with at least one operational navigational facility, or for multiple navigation facilities providing straight-in instrument approach procedures other than precision, or a straight-in precision approach procedure, or a circling maneuver from an instrument approach procedure. The required ceiling and visibility is obtained by adding an increment to the landing minima (e.g., adding 400 ft. to the Category I HAT or, as applicable, the authorized HAA, and by adding 1 statute mile to the authorized landing visibility.

b. Special Engine Inoperative Provisions. Special provisions for Category II and Category III engine-out capability are listed in the third part of the table for airports with at least two operational navigational facilities, each providing a straight-in precision approach, including a precision approach procedure to Category II or Category III minima. The required ceiling and visibility for this operational credit is obtained by adding 300 ft. or 200 ft. to the respective lowest Category II or Category III touchdown zone elevation of the two approaches considered, and by adding 1200 ft. to the lowest authorized RVR minimum (see Appendix 7 Part C paragraph C055).

8.12. Flight Planning to Airports That Have Weather Conditions Below Landing Minima. In certain instances an operator may flight plan (e.g., dispatch) an aircraft to a destination airport even though current weather is reported to be below, or may be forecast to be below landing minima. This is to permit aircraft to begin a flight if there is a reasonable expectation that at or near the expected time of arrival at the destination airport, weather conditions are expected to permit a landing at or above landing minima.

Flight Planning (e.g., dispatch) to such airports typically is considered acceptable if the following conditions are met:

1) All requirements are met to use the landing minima at the destination and at each alternate airport on which the flight plan (e.g., dispatch) is predicated (e.g., aircraft, crew, airport facilities, NAVAID’s).

2) If Alternate minima credit is applied based on availability of Category III capability, or Engine inoperative Category III capability, then each of the airborne systems otherwise applicable to use of that capability must be available at the time of flight planning (e.g., flight guidance system, anti skid, thrust reverse capability, as applicable to the aircraft type and Category III authorization for that operator)

3) ETA at the destination airport considers any necessary holding fuel that may be required while the aircraft waits for weather improvement.

4) Air Traffic conditions are considered for potential delay due to other aircraft arrivals or departures at the destination and at each alternate airport.

5) At least two qualifying alternates are available, the first of which considers the aircraft flying to the below minima intended destination, then holding for a time as determined by the operator awaiting approach or weather improvement, then flying to the closest alternate, then completing an approach and missed approach at that airport, and then flying to the second alternate and landing with appropriate reserve fuel.

9. CONTINUING AIRWORTHINESS/MAINTENANCE.

9.1. Maintenance Program. Unless otherwise approved by FAA, each operator should have an approved continuous airworthiness maintenance program (CAMP). The approved continuous airworthiness maintenance program should typically include any necessary provisions to address lower landing minima (LLM) or low visibility takeoff in accordance with the operator's intended operation and the manufacturers recommended maintenance program, MRB requirements or equivalent requirements, or any subsequent FAA designated requirements (e.g., AD's, mandatory service bulletins). Emphasis should be on maintaining and ensuring total system performance, accuracy, availability, reliability, and integrity for the intended operations.

9.2. Maintenance Program Provisions. The maintenance program should be compatible with an operator's organization and ability to implement and supervise the program. Maintenance personnel should be familiar with the operators approved program, their individual responsibilities in accomplishing that program, and availability of any resources within or outside of the maintenance organization that may be necessary to assure program effectiveness (e.g., getting applicable information related to the manufacturer's recommended maintenance program, getting information referenced in this AC such as service bulletin information).

Provision for low visibility operations may be addressed as a specific program or may be integrated with the general maintenance program.

Regardless whether the maintenance program is integrated or is designated as a specific program for Lower Landing Minima (LLM), the maintenance program should at least address the following:

1) Maintenance procedures necessary to ensure continued airworthiness relative to low visibility operations.

2) A procedure to revise and update the maintenance program.

3) A method to identify, record or designate personnel currently assigned responsibility in managing the program, performing the program, maintaining the program, or performing quality assurance for the program. This includes identification of any contractor or sub-contractor organizations, or where applicable, their personnel.

4) Verification should be made of the lower landing minima systems and configuration status for each aircraft brought into the maintenance or lower minimum program. Unless otherwise accepted by FAA, each aircraft should meet relevant criteria specified by the applicable aircraft manufacturer or avionics manufacturer for associated systems and equipment (e.g., Valid U.S. TC, appropriate STC records and compliance, assessment of status of any engineering orders, AD's, service bulletins or other compliance).

5) Identification of modifications, additions, and changes which were made to qualify aircraft systems for the intended operation or minima, if other than as specified in the AFM, TC or STC.

6) Identification of additional maintenance requirements and log entries necessary to change minima status.

7) Any discrepancy reporting procedures that may be unique to the low visibility program. If applicable, such procedures should be compatibly described in maintenance documents and operations documents.

8) Procedures which identify, monitor and report lower minimum system and component discrepancies for the purpose of quality control and analysis.

9) Procedures which define, monitor and report chronic and repetitive discrepancies.

10) Procedures which ensure aircraft remain out of lower minimum status until successful corrective action has been verified for chronic and repetitive discrepancies.

11) Procedures which ensure the aircraft system status is placarded properly and clearly documented in the aircraft log book, in coordination with maintenance control, engineering, flight operations, and dispatch, or equivalent.

12) Procedures to ensure the downgrade of an aircraft low visibility capability status, if applicable, when maintenance has been performed by persons other than those trained, qualified, or authorized to use or approve procedures related to low visibility operations.

13) Procedures for periodic maintenance of systems ground check, and systems flight check, as applicable. For example, following a heavy maintenance, suitable checks may need to be performed prior to return to service.

14) Provisions for an aircraft to remain in a specific low visibility capability status (e.g., Category II, Category III, Fail-Operational, Fail Passive) or other designated operational status used by the operator.

15) Provision should be made for periodic operational sampling of suitable performance. Typically, at least one satisfactory approach should have been accomplished within a specified period approved for that operator, unless a satisfactory systems ground check has been accomplished. A recording procedure for both satisfactory and unsatisfactory results should be included. Fleet sampling is not typically acceptable in lieu of specific aircraft assessment. Typically at least one satisfactory low visibility system operational use, or a satisfactory systems ground check, should be accomplished within 30 days, for an aircraft to remain in Category III status. Any extension to an aircraft sampling period limit beyond 30 days, or use of statistical fleet sampling should be consistent with the manufacturer's current sampling recommendations and be based on the demonstrated reliability of that operator's aircraft flight guidance system performance in service. Failure of an operator to maintain an acceptable reliability record should result in timely and appropriate remedial action, and should lead to reconsideration of suitability of any sampling period extensions or fleet statistical sampling authorizations.

9.3. Initial And Recurrent Maintenance Training. Operator and contract maintenance personnel including mechanics, maintenance controllers, avionics technicians, personnel performing maintenance inspection or quality assurance, or other engineering personnel if applicable, should receive initial and recurrent training as necessary for an effective program. The training curriculum should include specific aircraft systems and operator policies and procedures applicable to low visibility operations. Recurrent training should typically be accomplished at least annually, or when a person has not been involved in the maintenance of the specified aircraft or systems for an extended period (e.g., greater than 6 months). Training may lead to a certification or qualification (e.g., for lower landing minima "LLM") if the operator so designates such qualification in that operator's approved program.

The training should at least include, as applicable:

1) An initial and recurrent training program for appropriate operator and contract personnel. Personnel considered to be included are maintenance personnel, quality and reliability groups, maintenance control, and incoming inspection and stores, or equivalent organizations. Training should include both classroom and at least some "hands-on" aircraft training for those personnel who are assigned aircraft maintenance duties. Otherwise, training may be performed in a classroom, by computer based training, in simulators, in an airplane or in any other effective combination of the above consistent with the approved program, and considered acceptable to FAA.

2) Subject areas for training should include: Operational concepts, aircraft types and systems affected, aircraft variants and differences where applicable, procedures to be used, manual or technical reference availability and use, processes, tools or test equipment to be used, quality control, methods for testing and return to service, signoffs required, proper Minimum Equipment List (MEL) application, general information about where to get technical assistance as necessary, necessary coordination with

other parts of the operator's organization (e.g., flight operations, dispatch), and any other maintenance program requirements unique to the operator or the aircraft types or variants flown (e.g., human factors considerations, problem reporting).

3) Procedures for the use of outside vendors or vendor's parts that ensures compatibility to program requirements and for establishing measures to control and account for parts overall quality assurance.

4) Procedures to ensure tracking and control of components that are "swapped" between systems for trouble shooting when systems discrepancies can not be duplicated. These procedures should provide for total system testing and/or removal of aircraft from lower minimum status.

5) Procedures to assess, track and control the accomplishment of changes to components or systems pertinent to low visibility operations (e.g., AD's, service bulletins, engineering orders, FAR requirements).

6) Procedures to record and report lower minimum operation(s) that are discontinued/ interrupted because of system(s) malfunction.

7) Procedures to install, evaluate, control, and test system and component software changes, updates, or periodic updates.

8) Procedures related to the minimum equipment list (MEL) remarks section use which identify low visibility related systems and components, specifying limitations, upgrading and downgrading.

9) Procedures for identifying low visibility related components and systems as "required inspection items" (RII), to provide quality assurance whether performed in-house or by contract vendors.

9.4. Test Equipment/Calibration Standards. Test equipment may require periodic re-evaluation to ensure it has the required accuracy and reliability to return systems and components to service following maintenance. A listing of primary and secondary standards used to maintain test equipment which relate to low visibility operations should be maintained. It is the operator's responsibility to ensure these standards are adhered to by contract maintenance organizations. Traceability to a national standard or the manufacturer's calibration standards should be maintained.

9.5. Return To Service Procedures. Procedures should be included to upgrade or downgrade systems status concerning low visibility operations capability. The method for controlling operational status of the aircraft should ensure that flightcrews, maintenance and inspection departments, dispatch, and other administrative personnel as necessary are appropriately aware of aircraft and system status.

The appropriate level of testing should be specified for each component or system. The manufacturer's recommended maintenance program or maintenance instructions should be considered when determining the role built-in-test-equipment (BITE) should play for return to service (RTS) procedures, or for use as a method for low visibility status upgrade or downgrade.

Contract facilities or personnel should follow the operator's FAA approved maintenance program to approve an aircraft for return to service. The operator is responsible for ensuring that contract organizations and personnel are appropriately trained, qualified, and authorized.

9.6. Periodic Aircraft System Evaluations. The operator should provide a method to continuously assess or periodically evaluate aircraft system performance to ensure satisfactory operation for those systems applicable to Category II or III. An acceptable method for assuring satisfactory performance of a low visibility flight guidance system (e.g., autoland or HUD) is to periodically use the system and note satisfactory performance. A reliable record such as a logbook entry or computer ACARS record showing satisfactory performance within the previous 6 months for Category II, or previous 30 days for Category III, is typically an acceptable method for assuring satisfactory system operation (see Section 9.2 item 15).

Periodic flight guidance system/autoland system checks should be conducted in accordance with procedures recommended by the airframe or avionics manufacturer, or by an alternate procedure approved by the FAA. For periodic assessment, a record should be established to show when and where the flight guidance/autoland system was satisfactorily used, and if performance was not satisfactory, to describe any remedial action taken.

Use of the flight guidance/automatic landing system should be encouraged to assist in maintaining its availability and reliability.

9.7. Reliability Reporting And Quality Control. For a period of 1 year after an applicant has been authorized reduced minima, a monthly summary should be submitted to the certificate holding office. The following information should be reported:

a. The total number of approaches tracked, the number of satisfactory approaches tracked, by aircraft/system type, and visibility(RVR), if known or recorded.

b. The total number of unsatisfactory approaches, and reasons for unsatisfactory performance, if known, listed by appropriate category(e.g., poor system performance, aircraft equipment problem/failure; ground facility problem, ATS handling, lack of critical area protection, or other).

c. The total number of unscheduled removals of components of the related avionics systems.

d. Reporting after the initial period should be in accordance with the operators established reliability and reporting requirements.

9.8. Configuration Control/System Modifications. The operator should ensure that any modification to systems and components approved for low visibility operations are not adversely affected when incorporating software changes, service bulletins, hardware additions or modifications. Any changes to system components should be consistent with the aircraft manufacturer's, avionics manufacturer's, industry or FAA accepted criteria or processes.

9.9. Records. The operator should keep suitable records (e.g., both the operator's own records and access to records of any applicable contract maintenance organization). This is to ensure that both the operator and FAA can determine the appropriate airworthiness configuration and status of each aircraft intended for Category III operation.

Contract maintenance organizations should have appropriate records and instructions for coordination of records with the operator.

9.10. FAR 129 Foreign Operator Maintenance Programs.

9.10.1. Maintenance of FAR 129 Foreign Registered Aircraft. For part 129 operators of Foreign registered aircraft (e.g., section 129.14 is not applicable), the cognizant CAA is the CAA of the operator. For those situations, FAA may implicitly accept that the maintenance program is considered to be acceptable if the cognizant CAA has approved it, and if the operator or CAA indicates that the program meets U.S. criteria, U.S. equivalent criteria (e.g., criteria such as JAA criteria), or ICAO criteria (e.g., Annex 6 and Doc 9365/AN910 "Manual of All Weather Operations"), and the cognizant CAA has authorized Category II or Category III U.S. operations. FAA then issues the pertinent part 129 Category II/III OpSpec based on the other CAA's approval for that operator. However, FAA reserves the prerogative to assure competence of both the operator and authorizing and supervising CAA, depending on whether the CAA or operator are considered to be from a category 1, 2, or 3 country (safety classification not a low visibility landing classification), and if there have been any reported problems with the operator or CAA. Evidence of the operator satisfying or being consistent with the manufacturer's recommended maintenance program should serve as evidence of an acceptable maintenance program, regardless of the capability of the CAA or the operator, unless FAA has specifically addressed maintenance requirements beyond those of the manufacturer for that aircraft type (e.g., required service bulletin compliance or Airworthiness Directive compliance related to the flight guidance system).

9.10.2. Maintenance of FAR 129 Foreign Operated U.S. "N" Registered Aircraft. Foreign operators of U.S. "N" Registered Aircraft (e.g., those operators to which section 129.14 is applicable) should have maintenance programs equivalent to that required for a U.S. part 121 operator. Use of the part 91 provisions for General Aviation are not applicable or appropriate. Principal Operations Inspector Approval of Category II/III OpSpecs for a part 129.14 operator may implicitly be considered to also accept the maintenance program adequacy. Accordingly, coordination between the applicable POI and PMI is necessary before part 129 OpSpec authorization is completed. The FAA is ultimately the cognizant CAA for the maintenance program in this instance, if the aircraft is N registered. The FAA may however, accept the oversight of the operators CAA if that CAA is judged by FAA to have equivalent processes, criteria and procedures for oversight of maintenance programs (e.g., JAA countries). The basis for any such maintenance program should be the recommended airframe manufacturer (or avionics vendor) program, considering any adjusted MRB requirements.

10. APPROVAL OF UNITED STATES OPERATORS.

Approval for Category I, II and III is through issuance of or amendments to Operations Specifications (OpSpecs). The authorizations, limitations, and provisions applicable to Category I, Category II or Category III are specified in Part C of the OpSpecs. Sample OpSpecs are provided in Appendix 7.

Operations specifications authorizing Category I operations that use ICAO standard NAVAID's are normally approved by the certificate holding district office or regional flight standards office without further review and concurrence. All Category II or Category III operations normally require both regional flight standards and AFS-400 review and concurrence before approval.

10.1. Operations Manuals and Procedures.

a. Manuals. Prior to Category approval, appropriate flightcrew operating manuals, flight manuals, airline policy manuals, maintenance manuals, training manuals, and related aircraft checklists, quick reference handbooks, or other equivalent operator information, should satisfactorily incorporate pertinent Category III provisions.

Information covered in ground training, and procedures addressed in flight training should be available to pilots in an appropriate form for reference use.

b. Procedures. Prior to Category approval, provisions of section 6 of this AC for procedures, duties, instructions, or any other necessary information to be used by flightcrews and aircraft dispatchers should be implemented by the operator.

Crew member duties during the approach, flare, rollout, or missed approach should be described. Duties should at least address responsibilities, tasks of the pilot flying the aircraft and the pilot not flying the aircraft during all stages of the approach, landing, rollout and missed approach. The duties of additional crewmembers, if required, should also be explicitly defined.

Specification of crewmember duties should address any needed interaction with the aircraft dispatcher or maintenance (e.g., addressing resolution of aircraft discrepancies and return to service).

The applicant's qualification program should incorporate specific Category II/III procedural responsibilities for the pilot in command and second in command in each of the ground training subject areas listed in paragraph 7.1, and each of the flight training subject areas listed in paragraph 7.2.

10.2. Training Programs and Crew Qualification. Training programs, AQP programs (if applicable), crew qualification and checking provisions and standards, differences qualification (AC 120-53) if applicable, check airmen qualification, line check, route check, and IOE programs should each satisfactorily incorporate necessary Category III provisions, as applicable (see sections 7.2 through 7.4). An acceptable method to track pertinent crewmember Category III qualification and recency should be established (see section 7.5).

For manually flown Category III systems (e.g., HUD FD's, Hybrid HUD/Autoland) ensure that provisions are made for each flightcrew member to receive the appropriate training, qualification, and line experience before that particular crewmember is authorized to use the pertinent Category III minima.

10.3. Flight Planning (e.g., Dispatch, MEL, Alternate Airports, ETOPS or EROPS). MEL and CDL provisions should be addressed, as necessary, for Category III operations. The flight planning (e.g., pilot or aircraft dispatcher) should ensure appropriate consideration of reported and forecast weather, field conditions, facility status, NOTAM information, alternate airport designation, engine-inoperative missed approach performance, crew qualification, airborne system status, and fuel planning. For ETOPS or EROPS operations, a satisfactory method to address item 8.10 above should be demonstrated.

10.4. Formulation of Operations Specification (e.g., RVR limits, DH or AH, equipment, field lengths). Proposed OpSpecs should list pertinent approved RVR limits, DH or AH use provisions, "Inner Marker based DH or AH" provisions (if applicable), required transmissiometers, airports/runways, aircraft equipment provisions for "normal" and, if applicable, "engine-inoperative" operations, landing field length provisions, and any other special requirements identified by the CHDO or AFS-400 (e.g., ETOPS or EROPS Category III). The operator's manuals, procedures, checklists, QRH's, MEL's, dispatch procedures and other related flightcrew information should be shown to be consistent with the proposed OpSpecs.

10.5. Operational/Airworthiness Demonstrations. Appropriate "airborne system suitability" and "operational use suitability" demonstrations must be completed as described in sections 10.5.1 and 10.5.2, unless otherwise specified by AFS-400. The purpose of these operational demonstrations is to determine or validate the use and effectiveness of the applicable aircraft flight guidance systems, training, flightcrew procedures, maintenance program, and manuals applicable to the Category III program being approved. Operators of aircraft having FAA approved AFM's referencing AC 120-28D as the criteria used as the basis for Category III airworthiness demonstration already are considered to meet provisions of section 10.5.1, and typically need only address provisions of section 10.5.2. for verification of operational use suitability.

10.5.1. Airborne System Suitability Demonstration. Low visibility takeoff and landing requirements for Category I, Category II, and Category III are related to operating rules addressed by Standard OpSpecs and 14 CFR parts 1, 61, 91, 97, 121, 125, and 135. These provisions apply continuously, as defined at the time of a particular Category I, II, or III operation. Airworthiness rules (14 CFR parts 23, 25, etc.,) primarily apply at the time a "certification basis" is established for type certificate (TC) or supplemental type certificate (STC) and do not necessarily reflect "present" requirements, except through issuance of AD's updated with an amended type certificate or new STC application. Accordingly, operationally acceptable demonstrations addressing suitability of airborne systems for Category III, as applicable, must be successfully completed initially, and acceptable system status must be maintained by an operator to reflect compliance with current operating rules and airworthiness requirements, to initially operate or continue to operate to Category III minima.

To minimize the need for repeating initial airborne system operational suitability demonstrations for each operator, airborne system suitability is usually demonstrated in conjunction with airworthiness approval (TC or STC) of airborne system components such as flight guidance systems, autoland, flight directors, HUD's, flight instrument and alerting systems, radio altimeters, inertial systems, and air data systems. This approach to determination of airborne system suitability is taken to optimize use of analysis and flight demonstration resources for operators, aircraft manufacturers, avionics manufacturers, and the FAA. Accordingly, airborne system suitability is normally demonstrated through an initial airworthiness demonstration meeting applicable provisions of Appendices to this AC (or combined airworthiness/operational evaluation for new systems or concepts, or where otherwise necessary).

Demonstration to an acceptable earlier version of AC 120-28 or equivalent criteria may continue to be used for demonstration of aircraft/airborne systems initially type certificated prior to issuance of this AC 120-28D revision as applicable to the particular aircraft or airborne system (e.g., current production aircraft using earlier AC's 120-28/A/B/C.)

However, previously demonstrated aircraft or airborne systems seeking Category III credits specified only in provisions of revised AC 120-28D (e.g., Hybrid Autoland/HUD Category III) must meet criteria specified in this AC.

Acceptable results of such airworthiness evaluations are usually described in section 3 (Normal and Non-Normal Procedures) of the FAA approved AFM or AFM Supplement. Certificate Holding District Offices should ensure that aircraft proposed for Category III have completed such an appropriate airborne system operational suitability demonstration, and that result should normally be reflected in the approved AFM or AFM Supplement, unless otherwise specified by AFS-400.

For aircraft certified by FAA through section 21.29 (Certain Non-United States manufactured aircraft), AFM provisions applicable to Category III may vary. In certain instances AFM provisions may not be consistent with United States policy or rules applicable to Category III. In such instances, CHDO prior coordination with AFS-400 is appropriate to provide appropriate guidance to operators regarding applicability of various AFM provisions (e.g., DH and RVR limitations, acceptable NAVAID use, alerting system use, and required versus recommended crew procedures).

In the event of special circumstances such as FAA Category III acceptance of an aircraft certificated by a Non-United States airworthiness authority which has only foreign AFM Category III approval, or acceptance of additional credit for existing systems, operational assessments in accordance with criteria in this AC, or equivalent criteria, may be necessary. In such instances, AFS-400 specifies applicable criteria.

10.5.2. "Operator Use Suitability" Demonstration. At least one-hundred (100) successful landings should be accomplished in line operations using the low visibility landing system installed in each aircraft type applicable to the Category III authorization. Demonstrations may be conducted in line operations, during training flights, or during aircraft type or route proving runs.

If an excessive number of failures (e.g., unsatisfactory landings, system disconnects) occur during the landing demonstration program, a determination should be made for the need for additional demonstration landings, or for consideration of other remedial action (e.g., procedures adjustment, wind constraints, or system modifications).

The system should demonstrate reliability and performance in line operations consistent with the operational concepts specified in section 4. In unique situations where the completion of 100 successful landings could take an unreasonably long period of time due to factors such as a small number of aircraft in the fleet, limited opportunity to use runways having Category II/III procedures, or inability to obtain ATS critical area protection during good weather conditions, and equivalent reliability assurance can be achieved, a reduction in the required number of landings may be considered on a case-by-case basis. Reduction of the number of landings to be demonstrated requires a justification for the reduction, and prior approval from the Technical Programs Division (AFS-400).

Landing demonstrations should be accomplished on U.S. facilities or international facilities acceptable to FAA which have Category II or III procedures. However, at the operator's option, demonstrations may be made on other runways and facilities if sufficient information is collected to determine the cause of any unsatisfactory performance (e.g., critical area was not protected). No more than 50 percent of the demonstrations may be made on such facilities.

If an operator has different models of the same type of aircraft using the same basic flight control and display systems, or different basic flight control and display systems on the same type of aircraft, the operator should show that the various models have satisfactory performance, but the operator need not conduct a full operational demonstration for each model or variant.

10.5.2.1. Data Collection For Airborne System Demonstrations. Each applicant should develop a data collection method (e.g., form to be used by flightcrew) to record approach and landing performance. Data should be collected whenever an approach and landing is attempted using the Category III system, regardless of whether the approach is abandoned, unsatisfactory, or is concluded successfully. The resulting data and a summary of the demonstration data should be made available to the CHDO for evaluation. The data should, as a minimum, include the following information:

1. Inability to Initiate an Approach. Identify deficiencies related to airborne equipment which preclude initiation of a Category III approach.

2. Abandoned Approaches. Give the reasons and altitude above the runway at which approach was discontinued or the automatic landing system was disengaged.

3. Touchdown or Touchdown and Rollout Performance. Describe whether or not the aircraft landed satisfactorily (within the desired touchdown area) with lateral velocity or crosstrack error which could be corrected by the pilot or automatic system so as to remain within the lateral confines of the runway without unusual pilot skill or technique. The approximate lateral and longitudinal position of the actual touchdown point in relation to the runway centerline and the runway threshold, respectively, should be indicated in the report. This report should also include any Category III system abnormalities which required manual intervention by the pilot to ensure a safe touchdown or touchdown and rollout, as appropriate.

10.5.2.2. Data Analysis. Unsatisfactory approaches using facilities approved for Category II or III where landing system signal protection was provided should be fully documented. The following factors should be considered:

1. ATS Factors. ATS factors which result in unsuccessful approaches should be reported. Examples include situations in which a flight is vectored too close to the final approach fix/point for adequate localizer and glide slope capture, lack of protection of ILS critical areas, or ATS requests the flight to discontinue the approach.

2. Faulty NAVAID Signals. NAVAID (e.g., ILS localizer) irregularities, such as those caused by other aircraft taxiing, over-flying the NAVAID (antenna), or where a pattern of such faulty performance can be established should be reported.

3. Other Factors. Any other specific factors affecting the success of Category III operations that are clearly discernible to the flightcrew should be reported. An evaluation of reports discussed in subparagraphs 10.5.2.1 (1), (2), and (3) will be made to determine system suitability for further Category III operations.

10.5.2.3. Approval of Landing Minima. When the data from the operational demonstration has been analyzed and found acceptable, an applicant may be authorized the lowest requested minima consistent with this AC and applicable standard operations specifications. Several examples are provided below.

For Category III, fail passive operations where the operator was initially authorized RVR1000 (300 m) to begin a demonstration program, following successful demonstration that operator may be authorized to operate to minima of RVR600 (175 m).

For Category III fail operational operations, where the operator was initially authorized RVR1000 (300 m) to begin a demonstration program, following successful demonstration that operator may be authorized to operate to minima of RVR600 (175 m) or RVR300 (75 m) as applicable.

If the Category III rollout control system has been shown to meet the appropriate provisions of Appendix 3, and the airborne and ground systems including applicable ILS, GLS or MLS (e.g., xLS), Surface Movement Guidance and Control (SMGCS), and weather reporting (e.g., RVR) are each suitable, then operations approvals for operations below RVR300 (75 m) may be authorized. Such authorizations are considered only for specific facilities on a case by case basis, based on suitable and successful operational experience for each particular operator and aircraft type, and must have included actual operations in weather conditions at or below RVR600, using minima of RVR300.

For additional examples of minima step down provisions acceptable to FAA see paragraphs 10.9 and 10.10.

10.6. Eligible Airports and Runways. An assessment of eligible airports, runways, and airborne systems must be made in order to list appropriate runways on OpSpecs. Runways authorized for particular aircraft in accordance with existing operations listed on the AFS-400 Category II/Category III status checklist may be directly incorporated in OpSpecs, or incorporated by reference if published part 97 SIAPS are available. Aircraft type/runway combinations not shown should be verified by airborne system use in line operations at Category II or better minima, prior to authorization for Category III. Airports/aircraft types restricted due to special conditions (e.g., irregular underlying terrain) must be evaluated in accordance with Appendix 8, prior to OpSpecs authorization.

If applicable, the operator should identify any necessary provisions for periodic demonstration of the airborne system on runways other than those having Category II or III procedures (e.g., periodic autoland performance verification, using runways served only by a Category I procedure).

A status checklist for facilities which have published Category II or III procedures can be viewed on the Internet using the following address to access the FAA's Flight Standards Service home page:

FAA Category II/Category III Status Checklist
http://www.faa.gov/avr/afshome.htm

To access this list, search the menu for Air Transportation and select All Weather Operations. The desired section can then be selected from the All Weather Operations home page menu.

10.7. Irregular Pre-Threshold Terrain and Other Restricted Runways. Airports/runways with irregular pre-threshold terrain, or runways restricted due to NAVAID or facility characteristics (see FAA Category II/Category III Status Checklist in section 10.6) may require special evaluation, or limitations. Certificate Holding District Offices (CHDO's) of operators desiring operations on these runways should contact AFS-400 to identify pertinent criteria and evaluation requirements. Various procedures used by FAA to assess irregular pre-threshold terrain are described in Appendix 8.

10.8. Engine-Inoperative Operations and ETOPS or EROPS Alternates based on Category III. Low visibility landing minima are typically based on normal operations. For non-normal operations, flightcrews and aircraft dispatchers are expected to take the safest course of action to resolve the non-normal condition. The low weather minima capability of the aircraft must be known and available to the flightcrew and aircraft dispatcher.

In certain instances, sufficient airborne system redundancy may be included in the aircraft design to permit use of an alternate configuration such as “engine inoperative capability” for initiation of a Category III approach. Use of an engine inoperative configuration is based on the premise that the engine non-normal condition is an engine failure that has not adversely affected other airborne systems. Systems which should be considered include systems such as hydraulic systems, electrical systems or other relevant systems for Category III that are necessary to establish the appropriate flight guidance configuration.

An alternate engine inoperative configuration also is based on the premise that catastrophic engine failure has not occurred which may have caused uncertain, or unsafe collateral damage to the airframe, or aerodynamic configuration.

In instances when AFM or operational criteria is not met, and a Category III approach is necessary, because it is the safest course of action, (e.g., in flight fire), the flightcrew may use emergency authority. The flightcrew should determine to the extent necessary the state of the aircraft and other diversion options to ensure that an approach in weather conditions less than Category II is the safest course of action.

Four cases are useful in considering engine inoperative Category III capability, and engine inoperative approach authorization:

1. Flight planning (e.g., Dispatch) is based on aircraft configuration, reliability, and capability for "engine inoperative Category III" (see Section 10.8.2).

2. An engine fails en route, but prior to final approach (see Section 10.8.3).

3. An engine fails during the approach after passing the final approach fix, but prior to reaching the Alert Height or Decision Height (see Section 10.8.4).

4. An engine fails during approach after passing the Alert Height or Decision Height (see Section 10.8.5).

Section 5.17 provides airworthiness criteria for demonstration of Category III engine out capability. Sections 10.8.1 through 10.8.5 below address criteria for use of aircraft with "engine inoperative Category III" capability.

10.8.1. General Criteria for Engine-Inoperative Category III Authorization. Aircraft capability for "engine-inoperative Category III" should be approved in accordance with the provisions of paragraph 5.17, and Appendix 3.

Regardless of whether an operator is or is not operationally authorized for "engine inoperative Category III", it must be clear that having this aircraft capability should not be interpreted as requiring a Category

III landing at the "nearest suitable" airport in time (e.g., does not require landing at the nearest suitable Category III qualified airport - section 121.565).

POI’s should ensure that the following conditions are met:

1. Operations must be in accordance with the "engine inoperative Category III" AFM provisions (e.g., within demonstrated wind limits, using appropriate crew procedures).

2. Demonstrated/acceptable configurations must be used (e.g., AFDS modes, flap settings, electrical power sources, MEL provisions).

3. WAT limits must be established, and Engine-inoperative Missed Approach obstacle clearance from the TDZ must be ensured. This data should be readily available for flight planning (e.g., to the aircraft dispatcher) either by pre-determined certification listing or through appropriate engine-inoperative programming in automated flight planning and performance systems.

4. Appropriate training program provisions for engine inoperative approaches must be provided (see paragraph 7.2.6).

5. Pilots must be aware that they are expected to take the safest course of action, in their judgment, in the event that unforeseen circumstances or unusual conditions occur that are not addressed by the "engine-inoperative" Category III demonstrated configuration (e.g., uncertain aircraft damage, possible fire, weather deterioration).

6. Operations Specifications must identify the type of "engine-inoperative" Category III operations authorized. Types of operations are described in sections 10.8.2 through 10.8.5 below.

10.8.2. Engine Inoperative "Flight Planning." The operator (e.g., aircraft dispatcher) may consider "engine inoperative Category III" capability in planning flights for a takeoff alternate, en route (ETOPS or EROPS) alternate, re-dispatch alternate, destination, or destination alternate only if each of the following conditions are met:

1. The operator (e.g., aircraft dispatcher) has determined that the aircraft is capable of engine inoperative Category III.

2. Appropriate procedures, performance, and obstacle clearance information must be provided to the crew to be able to safely accomplish an engine inoperative missed approach at any point in the approach. If applicable, similar information must also be readily available to the aircraft dispatcher.

3. Appropriate operational weather constraints must be considered and specified as necessary regarding cross wind, head wind, tail wind limits considering the demonstrated capability specified in the AFM.

4. Weather reports or forecast must indicate that specified alternate minimums or landing minimums will be available for the runway equipped with approved Category III systems and procedures. The operators use of engine inoperative capability credit should consider both the availability and reliability of meteorological reports and forecasts, the time factors involved in potential forecast accuracy, the potential for variability in the weather at each pertinent airport, and the ability for the crew and, if applicable, aircraft dispatcher to obtain timely weather reports and forecast updates during the time the flight is en route. Flight planning considerations must account for any expected ATS delays that might be experienced during arrival due to weather, snow removal, or other factors.

5. Notices to airmen or equivalent information for airport and facility status should be reviewed to ensure that they do not preclude the accomplishment of a safe engine inoperative approach on the designated runway using approved Category III procedures (e.g., temporary obstructions). Any change in NOTAM status of facilities related to use of landing minima or alternate minima must be provided to the crew in a timely manner while en route.

6. If the engine inoperative configuration is different than a normal landing configuration, a means to determine the landing distance of the section 121.195(b) distance must be available for the pertinent engine inoperative aircraft configuration (e.g., landing flap setting). This distance is to ensure sufficient runway to provide for any limitations on the use of reverse thrust or other factors that could pertain to an inoperative engine landing (e.g., reduced flap settings used for an engine inoperative approach). This data may be based on basic aircraft data otherwise available and need not be redemonstrated for "engine-out' cases.

7. The expectation for runway surface condition based on pilot and operator (e.g., aircraft dispatcher) interpretation of the available weather reports, field conditions, and forecasts is that the applicable runway is likely to be free from standing water, snow, slush, ice, or other contaminants at the time of landing. The flightcrew must be advised of any adverse change in this expectation while en route.

8. Criteria otherwise applicable to "all engine" Category III, such as flightcrew or dispatcher training, crew qualification, and availability of suitable procedures must also be addressed for the engine inoperative landing case, if they are not the same as for the “all engine” case.

9. The operator is approved for operations based on engine inoperative Category III capability. In addition, operator responsibilities for engine inoperative credit should be equivalent to that of current normal operations when an en route landing system failure causes degraded landing capability. If an inflight failure causes further degradation of engine inoperative landing capability, the flightcrew (if applicable, in conjunction with the aircraft dispatcher) should determine an acceptable alternative course of action (e.g., specification of different en route diversion options, revised fuel reserves plan, or revised flight plan routing).

10. When engine inoperative Category III provisions are applied to identification of any destination or destination alternate, more than one qualifying destination alternate is required. This is to

provide for the possibility of adverse area wide weather phenomena, or unexpected loss of landing capability at the first designated alternate airport.

11. An appropriate ceiling and visibility increment is added to the lowest authorized minimums when credit for an alternate airport or airports is sought (e.g., 200 ft. DH additive and appropriate RVR additive; see Appendix 7 - Operations Specification Example).

12. The airborne system should be shown through "in-service" performance that for fail-operational systems, landing system availability is at least 99% from takeoff to 500’ HAT on approach, and for fail-passive systems, system availability is at least 95% from takeoff to 500’ HAT on approach (see Appendix 3 section 6.5.1).

It should be noted that even if the aircraft, flightcrews, and operator are authorized for engine inoperative Category III, flightcrews are not required to use a Category III approach to satisfy requirements of section 121.565. Not withstanding section 121.565, pilots may elect to take a safe course of action by landing at a more distant airport than one at which a Category III approach may be required. Conversely, pilots may elect to conduct the Category III approach as the safest or a safe course of action.

10.8.3. Engine Inoperative En Route. For engine failure en route, a pilot may initiate an "engine inoperative" Category III approach under the following conditions:

1. The airplane flight manual normal or non-normal sections specify that engine inoperative approach capability has been demonstrated and procedures are available.

2. The pilot and, if applicable, aircraft dispatcher have taken into account the landing runway length needed for the inoperative engine configuration and corresponding approach speeds, and obstacle clearance can be maintained in the event of a missed approach.

3. The pilot and, if applicable, aircraft dispatcher have determined that the approach can be conducted within the wind, weather, configuration, or other relevant constraints demonstrated for the configuration.

4. The pilot and, if applicable, aircraft dispatcher have determined from interpretation of the best available information that the runway is expected to be free from standing water, snow, slush, ice, or other contaminants.

5. The pilot is confident that the aircraft has not experienced damage related to the engine failure that would make an engine inoperative Category III approach unsuccessful, or unsafe.

6. The operator is approved and the pilot is qualified to conduct a Category III engine inoperative approach.

7. The pilot and, if applicable, aircraft dispatcher consider that conducting a Category III approach is a safe and appropriate course of action.

10.8.4. Engine Failure During Approach, Prior to Alert Height or Decision Height. If the aircraft, operator, and crew meet paragraphs 5.17 for the aircraft and sections 10.8.2 or 10.8.3 for operational use, a Category III approach may be continued if an engine failure is experienced after passing the final approach fix.

In the event that an aircraft has not been demonstrated for engine inoperative Category III approach capability, or the operator or crew have not been authorized for Category III engine inoperative approaches, then, regardless of flight phase, continuation of an approach in the event of an engine failure is permitted only in accordance with the emergency authority of the pilot to select the safest course of action.

NOTE: For some aircraft configurations, it may be necessary to discontinue the approach after passing the final approach fix or final approach point; re-trim the aircraft for an inoperative engine, and then re-initiate the approach in order to be able to appropriately complete a satisfactory Category III landing.

10.8.5. Engine Failure After Passing Alert Height or Decision Height. If an engine fails after passing the Alert Height or Decision Height, the procedure specified in the airplane flight manual for normal or non-normal operations should be followed. All Category III approvals must consider the case of engine failure at, or after, DH or AH. Standard operations specifications are considered to address this case. "Engine inoperative Category III capability" is not specifically a factor in determining response to this situation.

10.9. New Category III Operators. New operators should follow demonstration period provisions of section 10.5.2. Additionally, typical acceptable minima step down provisions approvable by FAA are as follows:

Starting from Category I	
Fail - Passive Landing System	100 ft. DH/RVR1000 then 50 ft. DH/RVR600
Fail - Operational Landing System	100 ft. DH/RVR1000 then RVR600, then RVR300
Starting from Category II	
Fail - Passive Landing System	50 ft. DH/RVR600
Fail - Operational Landing System	RVR600 then RVR300

Each runway/procedure not already being used by any operator of a similar type aircraft must be successfully demonstrated by a line service or an evaluation landing using the Category III system and procedures, in Category II or better conditions, for each aircraft/system type (e.g., B767, L1011). Once this capability has been successfully demonstrated by any operator for a particular runway and aircraft type, subsequent operators may take credit for that demonstration and need not re-demonstrate suitable performance. However, the operator must appropriately address special airports/runways as noted in section 10.7 and the FAA Category II/Category III Status Checklist.

10.10. Credit for Experienced Category III Operators for New Authorizations. Experienced operators are considered to be those operators having successfully completed their initial 6 month/ 100 Category III landing demonstration period, and have current operations specifications authorizing use of lowest applicable or intended Category III minima. Sections 10.10.1 through 10.10.3 below address examples of Category III program changes where "experienced operator" credit may apply.

Operators authorized for Category III using one class of system (e.g., autoland) but who are introducing a significantly different class of system as the basis for a Category III authorization (e.g., manually flown Category III approaches using a HUD) are typically considered to be "New Category III operators" for the purposes of demonstration period provisions and acceptable minima "step down" provisions for that class of system (see section 10.9).

10.10.1. New Airports/Runways. New airports/runways may be added to an experienced Category III operators OpSpecs without further demonstration, if the same or equivalent aircraft/airborne system for the approach are shown on the Category II/III status checklist.

Otherwise, the operator needs to accomplish a line service landing at Category II or better weather conditions to ensure satisfactory performance. Special runways on the FAA Category II/Category III Status Checklist (e.g., irregular terrain runways) may still require special evaluation.

Prior to approval of Category III minima for a particular aircraft type on any facility not formerly approved for Category III use for that type of aircraft, acceptable flight guidance (e.g., autoland, or autoland and rollout) performance if applicable, should be verified. This verification may be made by airline and/or FAA observation of automatic landings during line operations or training flights in weather conditions at or above Category II minima to determine adequacy of the facility for that type aircraft. In certain special cases, as designated by the FAA, where the characteristics of the pre-threshold terrain may induce abnormal performance in certain automatic flight control systems, additional analysis or flight demonstrations in line service may be required for each aircraft type prior to approval of Category III minima.

10.10.2. New or Upgraded Airborne System Capability. Unless otherwise specified by AFS-400, experienced Category III operators may initially use new or upgraded airborne system capabilities/components to the lowest authorized minima established for those systems or components, consistent with the examples provided below. Operators may also request reduced length demonstration periods, consistent with the new airborne systems to be used, FAA FSB requirements, and NAVAIDs, runways, and procedures to be used. Examples of this provision include addition of a new capability such as "engine inoperative" autoland to a system currently approved for "all engine" Category III, or introduction of an updated flight guidance system software version on an aircraft previously authorized for Category III for that operator. In such cases, the lowest authorized minima may be used, or may continue to be used, without additional demonstration.

10.10.3. Adding a New Category III Aircraft Type. Experienced Category III operators may operate new or upgraded aircraft types/systems, or derivative types, using reduced length demonstration periods (e.g., less than 6 months/100 landings) when authorized by AFS-400. Demonstration requirements are established considering any applicable FAA FSB criteria, applicability of previous operator service experience, experience with that aircraft type by other operators, experience of flightcrews of that operator for Category III and the type of system, and other such factors, on an individual basis. Appropriate minima reduction steps may also be established for an abbreviated demonstration period, consistent with prior operator experience, NAVAID's and runways used, and procedures to be used, etc. (e.g., newly acquired B757s being added to Category III OpSpecs, in addition to an operator's currently approved Category III A300 and MD-80 fleets).

10.11. Category III Program Status Following Operator Acquisitions/Mergers. Category III operators involved in acquisitions of other operators, or mergers, and their respective CHDO's, must ensure compatibility of programs. Procedures, airborne systems, runways served and any other relevant issues must be addressed before amending operations-specifications, or advising the surviving or controlling operator of the status of Category III OpSpecs of the acquired or merged operator. If CHDO doubt exists regarding applicability or status of Category III OpSpecs provisions for a resulting new, surviving, acquired, or merged carrier, AFS-400 should be consulted.

10.12. Initiating New Combined Category II and Category III Programs. Unless otherwise specified by AFS-400, Category II and Category III programs may be initiated simultaneously for new operators, or for existing operators currently approved for Category I. Appropriate provisions of both AC 120-29, as amended, and AC 120-28D are used. Operational Suitability Demonstration programs may be simultaneously conducted as long as procedures and systems applicable to both Category II and Category III minima are assessed (e.g., use of Category II DH vs. Category III AH). The lowest authorized minima established during the evaluation program should be as specified in section 10.9.

10.13. United States Carrier Category III Operations at Foreign Airports. An applicant having U.S. Category III approval may be authorized to use Category III minima at foreign airports on the FAA-approved list. Airports are approved and listed when the following conditions are met:

1. The airport is approved for Category III operations by the appropriate foreign airport authority.

2. The visual aids are equivalent to those used for U.S. Category III approaches.

3. Electronic ground aids are at least equivalent to those designated for U.S. Category III approaches.

4. The FAA office having responsibility for the area in which the foreign facility is located has reviewed and verified the conditions in items (1), (2), and (3) above.

The major factors to be considered when approving such airports will be the equivalence with U.S. standards of the approach light systems, high intensity runway lights, in-runway lights, quality and integrity of the approach and landing guidance systems, runway marking, procedures for reporting runway visibility, and airport surface traffic control. Although it is recognized that the systems at foreign airports may not be exactly in accordance with U.S. standards, it is important that any foreign facilities used for Category III provide the necessary information or functions consistent with the intent of the U.S. standards. Carriers desiring Category III approvals at foreign airports or runways not on the FAA-approved list should submit such requests through its FAA principal operations inspector to AFS-400, FAA Headquarters, Washington, D.C.

Typically for airports at which JAA rules apply, U.S. operators may expect to receive authorization to use the most restrictive of either the minima in their U.S. authorization for the aircraft type or flightcrew, or the lowest applicable JAA minima for the airport and runway used.

U.S. operators and pilots of aircraft operating internationally should be familiar with any unique provisions applicable to Category III operations at particular airports outside the U.S. As an example, international operators and pilots should be familiar with the need to convert minima specified in one form (e.g., meteorological visibility) to another different but equivalent form (e.g., RVR – see Section 8.6.2.2 and Appendix 7, Standard Operations-Specifications Part C Paragraph C051 for the applicable conversion table).

Figure 10.13-1 provides a checklist for carriers use to facilitate approval of Category II/III operations at facilities listed in the controlling states Aeronautical Information Publication (AIP). It should be used to ensure suitability of the intended facility and to verify conformance or equivalence with U.S. standards at non-U.S. airports. Completion of this checklist must reflect achieved or completed status, not planned actions for the future. For ICAO states that do not maintain an AIP, a copy of the Notice to Airmen (NOTAM), obstruction data, and/or a reliable and regular method of correspondence with the charting services used by U.S. certificate holders must be attached.

FACILITY CHECKLIST FOR CATEGORY II/III
(FOR NON-U.S. FACILITIES)

AIRPORT (ICAO ID): ________ COUNTRY: ____________ DATE: ____________

Runway: ________ Length: _________ Width: _________ G/S Angle (deg.): ___________

Lowest Minima ________________________ (ft./m) Runway TCH _____________ (ft./m)

Special Limitations (if any):

LIGHTING:
Approach _____ TDZ _____ Centerline ____ HIRL ____ Stopbars _____

Other (e.g., PAPI):

MARKINGS:
Runway _______ Taxiway _______ Other (e.g., Taxiway Position) __________

Critical Area Protection Policy (ceiling/visibility or conditions):
LOC _____________________________ G/S _________________________________

METEOROLOGICAL DATA: METAR's ________ TAF's ___________
TRANSMISSOMETERS:
(Locations/Lowest RVR reported/readout step increment)
Touchdown _______________ Mid _________________ Rollout _______________

OBSTRUCTION CLEARANCE ASSESSMENT COMPLETION DATE: _________________
Verified by: certificate holder ________, "state of the aerodrome" __________, other _______
Irregular terrain a factor (Y/N): _______ Similar type aircraft currently operate (Y/N) ________

NOTAM SOURCE/CONTACT: ____
FIELD CONDITIONS SOURCE/CONTACT ____

Attached procedure has been developed in accordance with:

FAA Handbook 8260.3B (TERPS) ____ ICAO PANS-OPS Doc. 8168-OPS/611, Vol.-11 ____

Other Criteria Accepted by FAA ____ (indicate criteria) ______________________________

Facility reviewed in accordance with ICAO Manual of All Weather Operations, as revised (DOC 9365/AN910) chapters 3, 5, and 6 DATE REVIEW COMPLETED: _________________

Name: _____________________________
Title: ______________________________
Signature: __________________________
Date: ______________________________

Attachments List:

Figure 10.13 - 1

10.14. Category III Operations on Off-Route Charters. Unless otherwise specified by AFS-400, experienced Category III operators may receive authorization to use Category III minima at United States off-route charter airports and runways as follows:

1) The runway must be on the FAA Category II/Category III status checklist, and not be restricted or require special evaluation (e.g., irregular terrain).

2) The aircraft used must be the same as or equivalent to an aircraft type already using the facility by another FAA certificated operator (e.g., a charter flight could be considered acceptable using an MD-83 with a "-971 Flight Guidance Control System (FGCS)" at a runway which had current Category III operations authorized for an MD-81 of another operator, but with an earlier but similar FGCS version).

3) Pilots must have sufficient information to safely conduct the low visibility operation regarding familiarity with the airport (e.g., SMGC procedures, taxi hold point or gate direction markings, gate location to be used).

4) The OpSpecs must authorize off-route charter Category III procedures, and

5) The CHDO must be advised of the specific airports, aircraft, crew qualifications and any special provisions to be used.

10.15. Approval of Category III Minima and Issuance of Operations Specifications. Applicants should submit documentation requesting approval of Category III weather minima to the FAA Certificate Holding District Office (CHDO) or Flight Standards District Office (FSDO) responsible for that operator's certificate. The application should demonstrate compliance with the appropriate provisions of applicable sections of this AC, particularly sections 7 through 12. Proposed operations specifications provisions should be included with the application.

The operators application documentation should be evaluated by the CHDO/FSDO and forwarded, with any recommendations, to the Technical Programs Division, AFS-400, FAA Headquarters, Washington, D.C., for review and concurrence. This review and concurrence is necessary prior to CHDO approval of Category III minima.

Following AFS-400 concurrence, OpSpecs authorizing Category IIIa or Category IIIb minima may be issued (see Appendix 7 for sample Operations Specifications examples).

During the period following the issuance of new or revised operations specifications for Category III (typically 6 months), the operator must successfully complete a suitable operations demonstration and data collection program in "line service" for each type aircraft, as the final part of the approval process.

The approval process is considered to be completed following a successful demonstration period. This is to ensure appropriate performance and reliability of the Category III system with that operators aircraft, procedures, maintenance, airports, and NAVAID's. This process must be completed before operations down to lowest requested minima are authorized. Section 10.5 addresses appropriate demonstration process criteria.

In situations involving newly manufactured airplanes or where otherwise authorized by FAA, the operations demonstration and data collection process may be initiated prior to the issuance of Category III operations specifications. Sections 10.9 through 10.12 provide criteria that may be used to establish acceptable operations demonstration time periods, and demonstration program scope for different operator situations, aircraft variants, and low visibility operating experience history.

10.16. Operations Specification Amendments. The operator is responsible for maintaining current OpSpecs reflecting current approvals authorized by FAA. Once FAA has authorized a change for airborne systems, new runways, or other authorizations, appropriate and timely amendments to affected OpSpecs should be issued. Issuance of amendments to guidance or procedures in other related material such as the Flight Operations Manual or Training Program may also be required. When updated standard operations specification provisions are adopted by FAA, provisions of those updated operations specifications should normally be applied to each operator's program in a timely manner.

10.17. Use of Special Obstacle Clearance Criteria (e.g., RNP criteria). This paragraph addresses use of special criteria such as "Required Navigation Performance" (RNP) criteria. Pending implementation of RNP criteria for public use Standard Instrument Approach Procedures (SIAP's), obstacle assessments using RNP criteria will be conducted on a case-by-case basis, and for Category III, only authorized as an element of special procedures for RNP qualified operators, using RNP qualified aircraft. Early application of RNP for special procedures is typically intended to apply to instrument procedure segments classified as a transition to a final approach segment, or to facilitate definition of suitable missed approach segments. Use of special obstacle clearance criteria or RNP criteria must be approved by AFS-400 for any Category III procedures.

If RNP procedures are used, the operator must have an acceptable method to assure that any waypoints which are considered critical to an instrument procedure (if any) are correctly defined, and are loaded into each applicable aircraft's database, initially, and at each change cycle.

10.18. Proof-of-Concept Demonstration for New Systems/Methods. Proof-of-Concept [PoC] as used in this AC is defined as:

A generic demonstration in a full operational environment of facilities, weather, crew complement, airborne systems and any other relevant parameters is necessary to show concept validity in terms of performance, system reliability, repeatability, and typical pilot response to failures as well as to demonstrate that an equivalent level of safety is provided.

Proof-of-Concept may be established by a combination of analysis, simulation and/or flight demonstrations in an operational environment. PoC is typically a combined effort of FAA airworthiness and operational organizations with the applicant, with input from any associated or interested organizations.

A typical PoC program consists of the following elements:

1. Applicant submits a request to either FAA Aircraft Certification or Flight Standards.

2. Meetings are arranged to include all disciplines involved: Aircraft certification; Flight Standards; National Resource Specialists (NRS's); the applicant, and supporting personnel as necessary (e.g., Air Traffic and representative flightcrews, as appropriate).

3. A test plan is established which includes input from applicable FAA organizations, the applicant, and as applicable, industry user groups.

4. The test plan should include as a minimum: system definition, operations procedures, qualification, training, weather and environment definition, normal, rare-normal, and non-normal conditions to be assessed, flightcrew, test subject, and test crew requirements, test procedures, test safety constraints as applicable, assessment criteria, and analysis, simulator and test aircraft requirements, and a clear understanding of what constitutes a successful test and proof of concept.

5. PoC is conducted using agreed subject pilots, as appropriate.

6. PoC data is collected in a suitable simulator environment and validated in a realistic airplane environment.

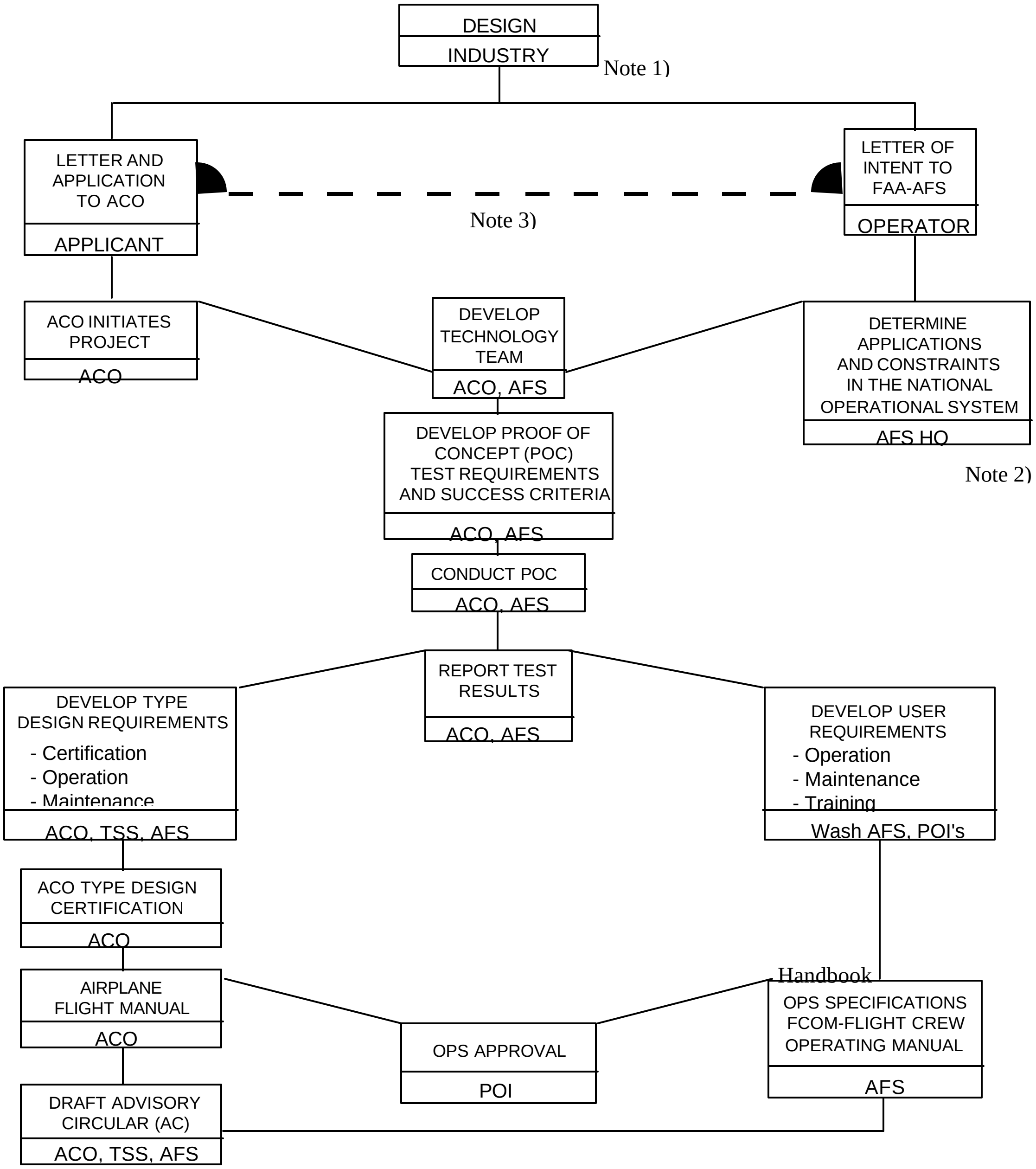
7. FAA is responsible for assessing the PoC data which is typically provided to FAA as agreed by FAA and the applicant. FAA reports relevant findings to the applicant and if applicable, interested industry representatives.

8. FAA operations and airworthiness organizations use the data to develop criteria for approval of type designs, certification processes and procedures, operating concepts, facilities, flightcrew/aircraft dispatcher and maintenance qualification, operations specification, operations procedures, manuals, AFM's, maintenance procedures, and any criteria necessary.

9. FAA AC criteria for airworthiness and operational approval typically is a product of PoC assessment.

This process is presented pictorially in the following figure.

TECHNOLOGY DEVELOPMENT PROCESS



Note: 1) Futher modifications to the applicant's original Type Design may require additional technology revisions and/or follow on Proof of Concept testing.
2) The AFS group has the responsibility to coordinate with all Industry technology groups (ALPA, APA, ATA, ADF Industry, manufactures, vendors, DOD, NASA, etc.)
3) Both the FAA ACO and FAA AFS should be contacted to provide certification and operational data to the respective offices.

Index: ACO - Aircraft Certification Office (Including Aircraft Evaluation Group)
AFS - Washington Flight Standards Policy Office
TSS - Transport Standards Staff

RRD7/19/94

11. FOREIGN AIR CARRIER CATEGORY III AT UNITED STATES AIRPORTS (PART 129 OPERATIONS SPECIFICATIONS).

11.1. Use of ICAO or FAA Criteria. International operators requesting or authorized for Category III at U.S. airports should meet criteria of 11.1.1 through 11.1.3 below.

11.1.1. Acceptable Criteria. Criteria Acceptable for use for assessment of international operator's applications for Category III at U.S. airports includes this AC, equivalent JAA criteria, or the ICAO Manual of All Weather Operations DOC 9365/AN910, as amended.

International operators previously approved by FAA in accordance with earlier criteria may continue to apply that earlier criteria. International operators seeking credit for operations addressed only by this revision of AC 120-28D (e.g., Category III HUD operations) must meet criteria of this AC, or equivalent criteria acceptable to FAA, for those applicable provisions.

11.1.2. Foreign Operator AFM Provisions. Unless otherwise authorized by FAA, aircraft used by international operators for Category III within the U.S. should have AFM provisions reflecting an appropriate level of Category III capability as demonstrated to or authorized by FAA, or demonstrated to or authorized by an authority recognized by FAA, as having acceptable equivalent Category III airworthiness criteria (e.g., European JAA, Canada MOT, UK CAA).

11.1.3. Foreign Operator Category III Demonstrations. International (Foreign) Air Carriers meeting FAA criteria, or criteria acceptable to FAA (e.g., European JAA, ICAO Criteria including Doc 9365/AN910), and having more than 6 months experience in use of Category III operations with the applicable aircraft type may be approved for Category III in accordance with provisions of their own regulatory authority, or in accordance with standard provisions of 14 CFR part 129 OpSpecs, which ever is the more restrictive. A separate demonstration period is not required for FAA if the “State of the Operator” does not require it. However, operators approved in accordance with this provision may nonetheless be subject to additional FAA demonstration for special situations, such as at airports with irregular underlying terrain (see 11.3), or for aircraft types not having flown to U.S. facilities having Category III procedures.

For international (foreign) operators having current U.S. Category III authorization, the Category III demonstration period may be reduced or waived for addition of a new type aircraft to the existing Category III authority. The demonstration period may be reduced or waived to the extent that a successful demonstration has been accepted by FAA for that aircraft type for any other U.S. or international operator.

International (Foreign) Air Carriers not meeting above provisions may be subject to the demonstration described at 10.5.2 and 10.9 (equivalent to those necessary for U.S. operators) as determined applicable by FAA.

11.2. Issuance of Part 129 Operations Specifications. International (Foreign) Air Carriers operating to U.S. airports which meet applicable provisions above are approved for Category III through issuance of part 129 OpSpecs (see Appendix 7).

Operators intending Category III operations at U.S. designated irregular terrain airports, or airports otherwise requiring special assessments must successfully complete those assessments prior to use of those facilities.

11.3. Use of Certain United States Facilities. Foreign operators typically use Category III procedures in the U.S. which are available as unrestricted public use procedures. However, FAA may also authorize certain restricted public use procedures and special Category III approach procedures for non-U.S. Operators. Typically, these procedures require special airborne equipment capability, special training, or non-standard facility and obstacle assessments. These special procedures are identified on the Category II/III status checklist and are not usually published as a part 97 Category III SIAP.

Foreign operators may be eligible to use certain of these procedures if they meet the same special criteria as would apply to a U.S. operator, and if they are approved by their own authority specifically for the use of the procedure. Some procedures may not be eligible for foreign use because of other applicable restrictions such as a restriction placed on private facility use. Special or restricted procedures require both FAA authorization and specific authorization from the state of the operator's controlling authority for each procedure. This is to ensure that both the operator and foreign authority are aware of the special provisions needed, and to ensure equivalent safety to use of standard ICAO criteria.

Each foreign operator seeking Category III procedure authorization at a facility not published as a standard and unrestricted Category III SIAP, or at any other facilities identified as special or restricted on the FAA Category II/III Status checklist, and that operator's controlling authority must:

1. Be aware of the restrictions applicable to the procedure (e.g., facility status),

2. Provide evidence to FAA of the controlling authority's approval of the operator for each special procedure requested, and

3. Must have the applicable limitations and conditions included in that operator's part 129 OpSpecs for each procedure to be used.

Foreign operators shall not normally be authorized special Category III operations to minima lower than those specified in part 97 Category III SIAPS consistent with ICAO criteria.

12. OPERATOR REPORTING, AND TAKING CORRECTIVE ACTIONS.

12.1. Operator Reporting. The reporting of satisfactory and unsatisfactory Category III aircraft performance is a useful tool in establishing and maintaining effective maintenance and operating policy and procedures. Information obtained from reporting data and its analysis is useful in recommending and issuing appropriate corrective action(s).

Accordingly, for a period of at least 1 year after an applicant has been advised that its aircraft and program meet Category III criteria, and reduced minima are authorized, the operator is to provide a monthly summary to the FAA of the following information:

1. The total number of approaches where the equipment constituting the airborne portion of the Category III system was utilized to make satisfactory (actual or simulated) approaches to the applicable Category III minima (by aircraft type).

2. The total number of unsatisfactory approaches by airport and aircraft registration number with explanations in the following categories - airborne equipment faults, ground facility difficulties, aborts of approaches because of ATC instructions, or other reasons.

3. Notify the certificate-holding office as soon as possible of any system failures or abnormalities which require flightcrew intervention after passing 100 ft. during operations in weather conditions below Category I minima.

4. Upon request, the certificate-holding district office will make this information available to AFS-400 for overall Category III program management, or to assist in assessment of program or facility effectiveness.

This 1 year recording and reporting requirement applies to the initial Category III airplane, however, when maintained over longer periods of time the report data substantiates a successful program and can identify trends, or recurring problems that may not be related to aircraft performance.

> **NOTE: The reporting burden contained in this AC does not require Office of Management and Budget approval under the provisions of the Paperwork Reduction Act of 1980, according to section 3502(4)(a).**

12.2. Operator Corrective Actions. In addition to the corrective actions contained in the operations and maintenance manuals, operators are expected to take appropriate corrective actions when they determine that conditions exist which could adversely affect safe Category III operations. Examples of situations for which an operator may need to take action restricting, limiting, or discontinuing Category III operations include:

Repeated aircraft system difficulties, repeated maintenance write-ups, chronic pilot reports of unacceptable landing performance, applicable service bulletin issuance, AD's, NAVAID status or performance problems, applicable NOTAM's, airport facility status change, air traffic procedure adjustment, lighting, marking, or standby power system status outages, airport construction, obstacle construction, temporary obstacles, natural disasters, adverse weather, snow banks, snow removal, icy runways or taxiways, deep snow in glide slope critical areas, inability to confirm appropriate critical area protection at non-United States airports, and other such conditions.

Examples of appropriate corrective action could be an adjustment of Category III programs, procedures, training, modification to aircraft, restriction of minima, limitations on winds, restriction of NAVAID facility use, adjustment of payload, service bulletin incorporation, or other such measures necessary to ensure safe operation.

List of Appendices

Appendix 1. - **DEFINITIONS AND ACRONYMS**

Appendix 2. - **AIRWORTHINESS APPROVAL OF AIRBORNE SYSTEMS USED DURING A TAKEOFF IN LOW VISIBILITY WEATHER CONDITIONS**

Appendix 3. - **AIRWORTHINESS APPROVAL FOR AIRBORNE SYSTEMS USED TO LAND AND ROLLOUT IN LOW VISIBILITY CONDITIONS**

Appendix 4. - **WIND MODEL FOR APPROACH AND LANDING SIMULATION**

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APPENDIX 1
DEFINITIONS AND ACRONYMS

This Appendix contains the definition of terms and acronyms used within this Advisory Circular (AC). The appendix also contains certain terms that are not used in this AC but are used in related AC's and are included for convenient reference. Certain definition of terms and acronyms are also provided to facilitate common use of this Appendix for other related AC's.

Definitions.

Actual Navigation Performance	A measure of the current estimated navigation performance, excluding Flight Technical Error (FTE). Actual Navigation Performance is measured in terms of accuracy, integrity, and availability of navigation signals and equipment. Note: Also see Estimated Position Uncertainty [EPU].
Aeronautical Chart Critical data	Data for Aeronautical charts determined in accordance with RTCA or ICAO Annex 4 criteria considered to have a very low probability of significant error and very high probability of validity [e.g., P_{error} per unit data element <1 X 10^{-8}]
Aeronautical Chart Essential data	Data for Aeronautical charts determined in accordance with RTCA or ICAO Annex 4 criteria considered to have a low probability of significant error and high probability of validity [e.g., P_{error} per unit data element <1 X 10^{-5}]
Aeronautical Chart Routine data	Data for Aeronautical charts determined in accordance with RTCA or ICAO Annex 4 criteria considered to have a routine possibility of significant error and routine validity [e.g., P_{error} per unit data element <1 X 10^{-3}]
Approach Intercept Waypoint (APIWP)	Variable waypoint used only when intercepting the Final Approach Segment (FAS).
Automatic Dependent Surveillance (ADS)	A surveillance technique in which aircraft automatically provide, via data link, data derived from on-board navigation and position fixing systems, including aircraft identification, four dimensional position and additional data as appropriate (ICAO - IS&RP Annex 6).
Alert Height	A height above the runway based on the characteristics of the aircraft and its fail-operational landing system, above which a Category III approach would be discontinued and a missed approach initiated if a failure occurred in one of the redundant parts of the fail operational landing system, or in the relevant ground equipment. (ICAO - IS&RP Annex 6).
Airborne Navigation system	The airborne equipment that senses and computes the aircraft position relative to the defined path, and provides information to the displays and to the flight guidance system. It may include a number of receivers and/or system computers such as a Flight Management Computer and typically provides inputs to the Flight Guidance System.

Automatic Go-Around	A Go-Around which is accomplished by an autopilot following pilot selection and initiation of the "Go-Around" autopilot mode, when an autopilot is engaged in an "approach mode."
Availability	An expectation that systems or elements required for an operations will be available to perform their intended functions so that the operation will be accomplished as planned to an acceptable level of probability.
Balked Landing	A discontinued landing attempt. Term is often used in conjunction with aircraft configuration or performance assessment, as in "Balked landing climb gradient," Also see "Rejected Landing."
Catastrophic Failure Condition	Failure Condition which would result in multiple fatalities, usually with the loss of the airplane.
Category I	A precision instrument approach and landing with a decision height not lower than 60m (200 ft) and with either a visibility not less than 800m (2400 ft), or a runway visual range not less than 550m (1800 ft). (ICAO - IS&RP Annex 6).
Category II	A precision instrument approach and landing with a decision height lower than 60m (200 ft) but not lower than 30m (100 ft) and a runway visual range not less than 350m (1200 ft). (ICAO - IS&RP Annex 6).
Category IIIa	A precision instrument approach and landing with a decision height lower than 30m (100 ft), or no decision height and a runway visual range not less than 200m (700 ft). (ICAO - IS&RP Annex 6).
Category IIIb	A precision instrument approach and landing with a decision height lower than 15m (50 ft), or no decision height and a runway visual range less than 200m (700 ft) but not less than 50m (150 ft). (ICAO - IS&RP Annex 6). FAA Note - the United States does not use Decision Heights for Category IIIb.
Category IIIc	A precision instrument approach and landing with no decision height and no runway visual range limitations. (ICAO - IS&RP Annex 6).
Class I Navigation	Navigation within the Service Volume of an ICAO Standard NAVAID.
Class II Navigation	A flight operation or portion of a flight operation (irrespective of the means of navigation) which takes place outside (beyond) the designated Operational Service Volume of an ICAO standard airway navigation facility or NAVAID (e.g., VOR, VOR/DME, NDB).
Combiner	The element of the head-up- display (HUD) in which the pilot simultaneously views the external visual scene along with synthetic information provided in symbolic form.
Command Information	Information that directs the pilot to follow a course of action in a specific situation (e.g., Flight Director).

Conformal Information	Information which correctly overlays the image of the real world, irrespective of the pilots viewing position.
Datum Crossing Height [DCH]	The height (in feet or meters) of the Flight Path Control Point above the Runway Datum Point.
Decision Altitude (DA)	A specified altitude in the precision approach at which a missed approach must be initiated if the required visual reference to continue the approach has not been established. (Adapted from ICAO - IS&RP Annex 6).
Decision Altitude (Height) DA(H)	For Category I, a specified minimum altitude in an approach by which a missed approach must be initiated if the required visual reference to continue the approach has not been established. The "Altitude" value is typically measured by a barometric altimeter or equivalent (e.g., Inner Marker) and is the determining factor for minima for Category I Instrument Approach Procedures. The "Height" value specified in parenthesis is typically a radio altitude equivalent height above the touchdown zone (HAT) used only for advisory reference and does not necessarily reflect actual height above underlying terrain. For Category II and certain Category III procedures (e.g., when using a Fail-Passive autoflight system) the Decision Height (or an equivalent IM position fix) is the controlling minima, and the altitude value specified is advisory. The altitude value is available for cross reference. Use of a barometrically referenced DA for Category II is not currently authorized for 14 CFR part 121, 129 or 135 operations at U.S. facilities (Adapted from ICAO - IS&RP Annex 6).
Decision Height (DH)	A specified height in the precision approach at which a missed approach must be initiated if the required visual reference to continue the approach has not been established (Adapted from ICAO - IS&RP Annex 6).
Design Eye Box	The three dimensional volume in space surrounding the Design Eye Position from which the HUD information can be viewed.
Design Eye Position	The position at each pilot's station from which a seated pilot achieves the optimum combination of outside visibility and instrument scan.
Defined Path	The path that is defined by the path definition function.
Desired Path	The path that the flightcrew and air traffic control can expect the aircraft to fly.
Enhanced Vision System	An electronic means to provide the flightcrew with a synthetic image of the external scene.
Estimate of Position Uncertainty [EPU], or Estimated Position Error [EPE]	A measure based on a scale which conveys the current position estimation performance - Also called Estimated Position Error (EPE)

Extended Final Approach Segment (EFAS)	That segment of an approach, co-linear with the Final Approach Segment, but which extends beyond the Glidepath Intercept Waypoint (GPIWP) or Approach Intercept Waypoint (APIWP).
External Visual Reference	Information the pilot derives from visual observation of real world cues outside the cockpit.
Extremely Improbable	A probability of occurrence on the order of 1×10^{-9} or less per hour of flight, or per event (e.g., takeoff, landing).
Extremely Remote	A probability of occurrence between the orders of 1×10^{-9} and 1×10^{-7} per hour of flight, or per event (e.g., takeoff, landing).
Fail Operational System	A system capable of completing the specified phases of an operation following the failure of any single system component after passing a point designated by the applicable safety analysis (e.g., Alert Height).
Fail Passive System	A system which, in the event of a failure, causes no significant deviation of aircraft flight path or attitude.
Field of View	As applied to a Head Up Display - the angular extent of the display that can be seen from within the design eye box.
Frequent	Occurring more often than 1 in 1000 events or 1000 flight hours.
Final Approach Course (FAC)	The final bearing/radial/track of an instrument approach leading to a runway, without regard to distance. For certain previously designed approach procedures that are not aligned with a runway, the FAC bearing/radial/track of an instrument approach may lead to the extended runway centerline, rather than to alignment with the runway.
Final Approach Fix (FAF)	The fix from which the final approach to an airport is executed. For standard procedures that do not involve multiple approaches segments intercepting the runway centerline near the runway, the FAF typically identifies the beginning of the straight-in final approach segment.
Final Approach Point (FAP)	The point applicable to instrument approaches other than ILS, MLS or GLS, with no depicted FAF (e.g., only applies to approaches such as an on-airport VOR or NDB), where the aircraft is established inbound on the final approach course from a procedure turn, and where descent to the next procedurally specified altitude, or to minimum altitude, may be commenced.
Final Approach Segment (FAS)	The segment of an approach extending from the Glidepath Intercept Waypoint (GPIWP) or Approach Intercept Waypoint (APIWP), whichever occurs later, to the Glidepath Intercept Reference Point (GIRP).
Flight Guidance System	The means available to the flightcrew to maneuver the aircraft in a specific manner either manually or automatically. It may include a number of components such as the autopilot, flight directors, relevant display and annunciation elements and it typically accepts inputs from the airborne navigation system.

Flight Path Alignment Point (FPAP)	The FPAP is a point, usually at or near the stop end of a runway, used in conjunction with the RDP and a vector normal to the WGS-84 ellipsoid at the RDP to define the geodesic plane of a final approach and landing flight path. The FPAP typically may be the RDP for the reciprocal runway.
Flight Path Control Point (FPCP)	The Flight Path Control Point (FPCP) is a calculated point located directly above the Runway Datum Point. The FPCP is used to relate the vertical descent of the final approach flight path to the landing runway.
Flight Technical Error (FTE)	The accuracy with which the aircraft is controlled as measured by the indicated aircraft position with respect to the indicated command or desired position. Note: FTE does not include human performance conceptual errors, typically which may be of large magnitude (e.g., entry of an incorrect way-point or waypoint position, selection of an incorrect procedure, selection of an incorrect NAVAID frequency, failure to select a proper flight guidance mode).
Glide Path Angle [GPA]	The glide path angle is an angle, defined at the FPCP, that establishes the descent gradient for the final approach flight path of an approach procedure. It is measured in the geodesic plane of the approach (defined by the RDP, FPAP, and WGS-84 ellipsoid's center). The vertical and horizontal references for the GPA are a vector normal to the WGS-84 ellipsoid at the RDP and a plane perpendicular to that vector at the FPCP, respectively.
Glide Path Intercept Waypoint (GPIWP)	The point at which the established glide slope intercept altitude (MSL) meets the Final Approach Segment (FAS), on a standard day, using a standard altimeter setting (1013.2 HPa or 29.92 in).
Glidepath Intercept Reference Point [GIRP]	The Glidepath Intercept Reference Point is the point at which the extension of the final approach path intercepts the runway.
GNSS Landing System (GLS)	A differential GNSS (e.g., GPS) based landing system providing both vertical and lateral position fixing capability. Note: Term may be applied to any GNSS based differentially corrected landing system providing lateral and vertical service for approach and landing equivalent to or better than that provided by a U.S. Type I ILS, or equivalent ILS specified by ICAO Annex 10.
Global Positioning System [GPS]	The NAVSTAR Global Positioning System operated by the United States Department of Defense. It is a satellite -based radio navigation system composed of space, control and user segments. The space segment is composed of satellites. The control segment is composed of monitor stations, ground antennas and a master control station. The user segment consists of antennas and receiver-processors that derive time and compute a position and velocity from the data transmitted from the satellites.
Global Navigation Satellite System [GNSS]	A world wide position, velocity and time determination system that uses one or more satellite constellations.
Guidance	Information used during manual control or monitoring of automatic control of the aircraft that is of sufficient quality to be used by itself for the intended purpose.

Go-around	A transition from an approach to a stabilized climb.
Hazardous Failure Condition	Failure Conditions which would reduce the capability of the airplane or the ability of the crew to cope with adverse operating conditions to the extent that there would be: (i) A large reduction in safety margins or functional capabilities; (ii) Physical distress or higher workload such that the flightcrew cannot be relied upon to perform their tasks accurately or completely; or (iii) Serious or fatal injury to a relatively small number of the occupants.
Head Up Display System	An aircraft system which provides head-up guidance to the pilot during flight. It includes the display element, sensors, computers and power supplies, indications and controls. It may receive inputs from an airborne navigation system or flight guidance system.
Hybrid System	A combination of two, or more, systems of dissimilar design used to perform a particular operation.
Improbable	A probability of occurrence greater than 1×10^{-9} but less than or equal to 1×10^{-5} per hour of flight, or per event (e.g., takeoff, landing).
Independent Systems	A system that is not adversely influenced by the operation, computation, or failure of some other identical, related, or separate system (e.g., two separate ILS receivers).
Infrequent	Occurring less often than 1 in 1000 events or 1000 flight hours.
Initial Missed Approach (IMAWP)	Waypoint used to define the Missed Approach Point (MAP).
Initial Missed Approach Segment	That segment of an approach from the Glide Path Intercept Waypoint (GPIWP) to the Initial Missed Approach Waypoint (IMAWP).
Instantaneous Field of View	The angular extent of a HUD display which can be seen from either eye from a fixed position of the head.
Integrity	A measure of the acceptability of a system, or system element, to contribute to the required safety of an operation.
Landing	For the purpose of this AC, landing will begin at 100 ft., the DH or the AH to the first contact of the wheels with the runway.
Landing rollout	For the purpose of this AC, rollout starts from the first contact of the wheels with the runway and finishes when the airplane has slowed to a safe taxi speed (in the order of 30 knots).
Major Failure Condition	Failure Condition which would reduce the capability of the airplane or the ability of the crew to cope with adverse operating conditions to the extent

	that there would be, for example, a significant reduction in safety margins or functional capabilities, a significant increase in crew workload or in conditions impairing crew efficiency, or discomfort to occupants, possibly including injuries.
Minimum Descent Altitude(Height) [MDA(H)]	See individual definitions below for MDA and MDH.
Minimum Descent Altitude (MDA)	A specified altitude in a non-precision approach or circling approach below which descent must not be made without the required visual reference. Minimum Descent Altitude (MDA) is referenced to mean sea level. (ICAO - IS&RP Annex 6).
Minimum Descent Height (MDH)	A specified height in a non-precision approach or circling approach below which descent must not be made without the required visual reference. Minimum Descent Height (MDH) is referenced to aerodrome elevation or to the threshold if that is more than 7 ft. (2m) below the aerodrome elevation. A MDH for a circling approach is referenced to the aerodrome elevation. (ICAO - IS&RP Annex 6). FAA Note - The United States does not use Minimum Descent Heights.
Minimum Use Height (MUH)	A height specified during airworthiness demonstration or review above which, under standard or specified conditions, a probable failures of a system is not likely to cause a significant path displacement unacceptably reducing flight path clearance from specified reference surfaces (e.g., airport elevation) or specified obstacle clearance surfaces.
Minor Failure Condition	Failure Condition which would not significantly reduce airplane safety and which involve crew actions that are well within their capabilities. Minor Failure Conditions may include, for example, a slight reduction in safety margins or functional capabilities, a slight increase in crew workload, such as routine flight plan changes, or some inconvenience to occupants.
Missed Approach	The flight path followed by an aircraft after discontinuation of an approach procedure and initiation of a go-around. Typically a “missed approach” follows a published missed approach segment of an instrument approach procedure, or follows radar vectors to a missed approach point, return to landing, or diversion to an alternate.
Monitored HUD	A HUD which has internal or external capability to reliably detect erroneous sensor inputs or guidance outputs, to assure that a pilot does not receive incorrect or misleading guidance, failure, or status information.
Non-Normal Means of Navigation	A means of navigation which does not satisfy one or more of the necessary levels of accuracy, integrity, and availability for a particular area, route, procedure or operation, and which may require use of a pilot's "emergency authority" to continue navigation.
NOTAM	Notice to Airmen - A notice distributed by means of telecommunication containing information concerning the establishment, condition or change in

	any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations. (ICAO - IS&RP Annex 6).
Performance	A measure of the accuracy with which an aircraft, a system, or an element of a system operates compared against specified parameters. Performance demonstration(s) typically include the component of Flight Technical Error (FTE).
Primary Means of Navigation	A means of navigation which satisfies the necessary levels of accuracy and integrity for a particular area, route, procedure or operation. The failure of a "Primary Means" of navigation may result in, or require reversion to a "non-normal" means of navigation, or an alternate level of RNP. NOTE: Qualification as a "primary means" of navigation typically requires that ANP/EPU be less than RNP for 99.99% of the time.
Redundant	The presence of more than one independent means for accomplishing a given function or flight operation. Each means need not necessarily be identical.
Rejected Landing	A discontinued landing attempt. A rejected landing typically is initiated at low altitude, but prior to touchdown. If from or following an instrument approach it typically is considered to be initiated below DA(H) or MDA(H). A rejected landing may be initiated in either VMC or IMC. A rejected landing typically leads to or results in a "go around," and if following an instrument approach, a "Missed Approach." If related to consideration of aircraft configuration(s) or performance it is sometime referred to as a "Balked Landing." The term "rejected landing is used to be consistent with regulatory references such as found in FAR121 Appendix E, and policy references as in FAA Order 8400.10.
Remote	A probability of occurrence greater than 1×10^{-7} but less than or equal to 1×10^{-5} per hour of flight, or per event (e.g., takeoff, landing).
Required Navigation Performance (RNP)	A statement of the navigation performance necessary for operation within a defined airspace (Adapted from ICAO - IS&RP Annex 6). NOTE: Required Navigation Performance is specified in terms of accuracy, integrity, and availability of navigation signals and equipment for a particular airspace, route, procedure or operation.
Required Navigation Performance Containment (RNP Containment)	RNP Containment represents a bound of the rare-normal performance and specified non-normal performance of a system, typically expressed as 2*RNP(X). When RNP represents Gaussian statistical performance at a level of two sigma (2 x standard deviation), then containment represents a nominal performance bound specified at the level of four sigma (4 x standard deviation). Note: RNP containment use may vary with intended operational applications.
Required Navigation Performance Level or Type (RNP Level or RNP Type)	A value typically expressed as a distance in nautical miles from the intended position within which an aircraft would be for at least 95 percent of the total flying time (Adapted from ICAO - IS&RP Annex 6).

NOTE: Applications of RNP to terminal area and other operations may also include a vertical and/or longitudinal component. ICAO may use the term RNP Type, while certain other States, aircraft manuals, procedures, and operators may use the term RNP Level.

Example - RNP 4 represents a navigation lateral accuracy of plus or minus 4 nm (7.4 km) on a 95% basis. RNP is typically defined in terms of its lateral accuracy, and has an associated lateral containment boundary.

Required Visual Reference	That section of the visual aids or of the approach area which should have been in view for sufficient time for the pilots to have made an assessment of the aircraft's position and rate of change of position, in relation to the desired flight path. In Category III operations with a decision height, the required visual reference is that specified for the particular procedure and operations (ICAO - IS&RP Annex 6 - Decision Height definition - Note 2).
Runway Datum Point (RDP)	The RDP is used in conjunction with the FPAP and a vector normal to the WGS-84 ellipsoid at the RDP to define the geodesic plane of a final approach flight path to the runway for touchdown and rollout. It is a point at the designated lateral center of the landing runway defined by latitude, longitude, and ellipsoidal height. The RDP is typically a surveyed reference point used to connect the approach flight path with the runway. The RDP may or may not necessarily be coincident with the designated runway threshold
Runway Segment (RWS)	That segment of an approach from the glidepath intercept reference point (GIRP) to Flight Path Alignment Point (FPAP).
Situation Information	Information that directly informs the pilot about the status of the aircraft system operation or specific flight parameters including flight path.
Standard Landing Aid (SLA)	In the context of this section of this AC, is a navigation service provided by a State which meets internationally accepted performance standards (e.g., ICAO Standards and Recommended Practices (SARP's) or equivalent State standards).
Supplementary Means of Navigation	A means of navigation which satisfies one or more of the necessary levels of accuracy, integrity, or availability for a particular area, route, procedure or operation. The failure of a "Supplementary Means" of navigation may result in, or require reversion to another alternate "normal" means of navigation for the intended route, procedure or operation. NOTE: Qualification as a "supplementary means" of navigation typically requires that ANP/EPU be less than RNP for 99% of the time.
Synthetic Reference	Information provided to the crew by instrumentation or electronic displays. May be either command or situation information.
Synthetic Vision System	A system used to create a synthetic image representing the environment external to the airplane.
Take off Guidance System	A system which provides directional command guidance to the pilot during a takeoff, or takeoff and aborted takeoff. It includes sensors, computers and power supplies, indications and controls.

Total Field of View	The maximum angular extent of the display that can be seen with either eye, allowing head motion within the design eye box.
Touch Down Zone (TDZ)	The first 3000 ft. of usable runway for landing, unless otherwise specified by the FAA, or other applicable ICAO or State authority (e.g., for STOL aircraft, or in accordance with an SFAR).
Visual Guidance	Visual information the pilot derives from the observation of real world cues, outside the cockpit and uses as the primary reference for aircraft control or flight path assessment.

Acronyms.

ACRONYM	EXPANSION
ABAS	Aircraft Based Augmentation System
AC	Advisory Circular
ACI	Adjacent Channel Interface
ADF	Automatic Direction Finder
ADI	Attitude Director Indicator
ADS	Automatic Dependent Surveillance
AFCS	Autopilot Flight Control System
AFDS	Autopilot Flight Director System
AFGS	Automatic Flight Guidance System
AFM	Airplane Flight Manual
AH	Alert Height
AHI	All-Weather Harmonization Items
AIP	Aeronautical Information Publication
ALS	Approach Light System
ANP	Actual Navigation Performance
APIWP	Approach Intercept Waypoint
APM	Aircrew Program Manager
APU	Auxiliary Power Unit
AQP	Advanced Qualification Program
ARA	Airborne Radar Approach
ASR	Airport Surveillance Radar
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
ATOGW	Allowable Takeoff Gross Weight
ATPC	Airline Transport Pilot Certificate
ATS	Air Traffic Service
AWO	All Weather Operations
BARO	[Abbreviation for "Barometric"]
BC	Back Course (e.g., ILS Back Course)
BITE	Built-In Test Equipment
CAA	Civil Aviation Authority
CDL	Configuration Deviation List
CFR	Code of Federal Regulations
CFR	Crash Fire Rescue

CHDO	Certificate Holding District Office
CMO	[FAA] Certificate Management Office
CMU	[FAA] Certificate Management Unit
CL	Centerline Lights
CNS	Communication, Navigation and Surveillance
CRM	Collision Risk Model
CRM	Cockpit Resource Management
CVR	Cockpit Voice Recorder
DA	Decision Altitude
DA(H)	Decision Altitude(Height)
DCH	Datum Crossing Height
DD	DME-DME updating
DDM	Difference of Depth Modulation
DEP	Design Eye Position
DGNSS	Differential Global Navigation Satellite System
DH	Decision Height
DME	Distance Measuring Equipment
DOD	[U.S.] Department of Defense
DOT	[U.S.] Department of Transportation
DP	Departure Procedure
EADI	Electronic Attitude Director Indicator
ECEF	Earth Centered Earth Fixed
EFAS	Extended Final Approach Segment
EGPWS	Enhanced Ground Proximity Warning System
EHSI	Electronic Horizontal Situation Indicator
EPE	Estimated Position Error
EPU	Estimated Position Uncertainty
EROPS	Extended Range Operations (any number of engines)
ET	Elapsed Time
ET	Error Term [FMS use]
ETOPS	Extended Range Operations with Two-Engine Airplanes
EVS	Enhanced Vision System
FAF	Final Approach Fix
FAP	Final Approach Point
FAR	Federal Aviation Regulation
FAS	Final Approach Segment

FBS	Fixed Base Simulator
FBW	Fly-by-wire
FCOM	Flight Crew Operating Manual
FDR	Flight Data Recorder
FGS	Flight Guidance System
FHA	Functional Hazard Assessment
FLIR	Forward Looking Infrared Sensor
FM	Frequency Modulation
FM	Fan Marker
FMC	Flight Management Computer
FMS	Flight Management System
FPAP	Flight Path Alignment Point
FPA	Flight Path Angle
FPCP	Flight Path Control Point
FSB	Flight Standardization Board
FSDO	[FAA] Flight Standards District Office
FSS	[FAA] Flight Service Station
FTE	Flight Technical Error
GA	Go-Around
GBAS	Ground Based Augmentation System
GCA	Ground Controlled Approach
GIRP	Glidepath Intercept Reference Point
GLS	GPS (or GNSS) Landing System
GNSS	Global Navigation Satellite System
GPA	Glide Path Angle
GPIWP	Glide Path Intercept Waypoint
GPWS	Ground Proximity Warning System
GPS	Global Positioning System
HAA	Height Above Airport
HAT	Height above Touchdown
HDG	Heading
HQRS	Handling Quality Rating System (see AC 25-7A, as amended)
HUD	Head Up Display
IAP	Instrument Approach Procedure
IAW	In Accordance With
ICAO	International Civil Aviation Organization

IFR	Instrument Flight Rules
IM	Inner Marker
IMAS	Initial Missed Approach Segment
IMAWP	Initial Missed Approach Waypoint
IMC	Instrument Meteorological Conditions
ILS	Instrument Landing System
INAS	International Airspace System
IOE	Initial Operating Experience
IRS	Inertial Reference System
IRU	Inertial Reference Unit
JAA	Joint Aviation Authority
JAR AWO	Joint Aviation Regulations – All Weather Operations
KRM	[Type of Landing system used in certain foreign States]
LAAS	Local Area Augmentation System
LAD	Local Area Differential
LAHSO	Land And Hold Short Operation
LDA	Localizer Descent Aid [approach type]
LLM	Lower Landing Minima
LMM	Compass Locator Middle Marker
LLTV	Low Light Level TV
LNAV	Lateral Navigation
LOC	[ILS] Localizer
LOE	Line operational evaluation
LOFT	Line oriented flight training
LOM	Compass Locator Outer Marker
LOS	Line oriented simulation
MAP	Mode Annunciator Panel
MAP	Missed Approach Point
MASPS	Minimum Aviation System Performance Standards
MB	Marker Beacon
MCP	Mode Control Panel
MDA	Minimum Descent Altitude
MDA(H)	Minimum Descent Altitude(Height)
MDH	Minimum Descent Height - NOTE: MDH is not used for U.S. Operations
MEH	Minimum Engage Height
MEL	Minimum Equipment List

METAR	ICAO Routine Aviation Weather Report
MLS	Microwave Landing System
MM	Middle Marker
MMEL	Master Minimum Equipment List
MMR	Multi-mode Receiver
MOT	Ministry of Transport
MRB	Maintenance Review Board
MSL	Mean Sea Level [altitude reference datum]
MUH	Minimum Use Height
MVA	Minimum Vectoring Altitude
NA	Not Authorized or Not Applicable
NAS	National Airspace System
NAVAID	Navigational Aid
ND	Navigation Display
NDB	Navigation Data Base
NDB	Non-directional Beacon
NOTAM	Notice to Airman
NRS	National Resource Specialist
OCA	Obstacle Clearance Altitude
OCH	Obstacle Clearance Height
OCL	Obstacle Clearance Limit
OIS	Obstacle Identification Surface
OM	Outer Marker
OSAP	Offshore Standard Approach Procedure
PAI	Principal Avionics Inspector
PAR	Precision Approach Radar
PC/PT	Proficiency Check/Proficiency Training
PF	Pilot Flying
PFC	Porous Friction Coarse [runway surface]
PIC	Pilot in Command
PIREP	Pilot Weather Report
PNF	Pilot Not Flying
POC	Proof of Concept
POI	Principal Operations Inspector
PMI	Principal Maintenance Inspector
PRD	Progressive Re-Dispatch

PRM	Precision Radar Monitor
PTS	Practical Test Standard
QFE	Altimeter Setting referenced to airport field elevation
QNE	Altimeter Setting referenced to standard pressure (1013.2HPa or 29.92")
QNH	Altimeter Setting referenced to airport ambient local pressure
QRH	Quick Reference Handbook
RA	Radio Altitude or Radar Altimeter
RAIL	Runway Alignment Indicator Light System
RCLM	Runway Center Line Markings
RDMI	Radio Direction Magnetic Indicator
RDP	Runway Datum Point
REIL	Runway End Identification Lights
RII	Required Inspection Item
RMI	Radio Magnetic Indicator
RMS	Root-mean-square
RNAV	Area Navigation
RNP	Required Navigation Performance
RNPx2	RNP Containment Limit (2 times RNP value)
RTCA	Radio Technical Commission for Aeronautics
RTS	Return to Service
RTO	Rejected Takeoff
RVR	Runway Visual Range
RVV	Runway Visibility Value
RWS	Runway Segment
RWY	Runway
SA	Selective Availability
SARPS	ICAO Standards and Recommended Practices
SBAS	Space Based Augmentation System
SDF	Simplified Directional Facility
SFL	Sequence Flasher Lights
SIAP	Standard Instrument Approach Procedure
SID	Standard Instrument Departure
SLA	Standard Landing Aid
SLF	Supervised Line Flying
SMGC	Surface Movement Guidance and Control
SMGCP	Surface Movement Guidance and Control Plan

SMGCS	Surface Movement Guidance and Control System
STAR	Standard Terminal Arrival Route
STC	Supplemental Type Certificate
STOL	Short Takeoff and Landing
SRE	[Type of Landing system used in certain foreign States]
SV	Space Vehicle
TACAN	Tactical Air Navigation system [NAVAID]
TAF	Terminal Aviation Forecast
TC	Type Certificate
TDZ	Touchdown Zone
TERPS	[U.S.] Standard for Terminal Instrument Procedures
TLS	Target Level of Safety
TOGA	Takeoff or Go-Around [FGS Mode]
TSE	Total system error
ua	micro amps
VASI	Visual Approach Slope Indicator
VDP	Visual Descent Point
VFR	Visual Flight Rules
VHF	Very High Frequency
VIS	Visibility
VOR	VHF Omni-directional Radio Range
VORTAC	Co-located VOR and TACAN
VMC	Visual Meteorological Conditions
VNAV	Vertical Navigation
V_1	Takeoff Decision Speed
V_{ef}	Engine Failure Speed
$V_{failure}$	Speed at which a failure occurs
V_{lof}	Liftoff Speed
V_{mcg}	Ground Minimum Control Speed
WAAS	Wide area augmentation system
WAD	Wide Area Differential
WAT	Weight, Altitude and Temperature
WGS	World Geological Survey
WGS-84	World Geological Survey - 1984
WP	Waypoint
xLS	[Generic term used to denote any one or more of the following NAVAID’s: ILS, MLS, or GLS]

APPENDIX 2
AIRWORTHINESS APPROVAL OF AIRBORNE SYSTEMS USED DURING A TAKEOFF IN LOW VISIBILITY WEATHER CONDITIONS

Mandatory terms used in this AC such as “shall” or “must” are used only in the sense of ensuring applicability of these particular methods of compliance when the acceptable means of compliance described herein is used. This AC does not change, add or delete regulatory requirements or authorize deviations from regulatory requirements.

1. PURPOSE. This appendix contains criteria for the approval of aircraft equipment and installations used during Takeoff in low visibility conditions (see section 4.2 Takeoff).

2. GENERAL. The type certification approval for the equipment, system installations and test methods should be based upon a consideration of factors such as the intended function of the installed system, its accuracy, reliability, and fail-safe features, as well as the operational concepts contained in the body of this AC. The guidelines and procedures contained herein are considered to be acceptable methods of determining airworthiness for a transport category airplane intended to conduct a takeoff in low visibility weather conditions.

The overall performance and safety of an operation should be assessed considering principle elements of the system, including aircraft, crew and facilities.

3. INTRODUCTION. This appendix provides airworthiness criteria for airplane systems that are required by section 4.2 Takeoff of this AC. These systems are required when visibility conditions, alone, may be inadequate for safe takeoff operation. This Appendix does not address all possible combinations of systems that might be proposed. This appendix provides criteria which represents an acceptable means of compliance with performance, integrity and availability requirements for takeoff in low visibility conditions. Alternative criteria may be proposed by an applicant.

Operations using non-ground based facilities, or evolving ground facilities (e.g., local or wide area augmented GNSS), and the use of some new aircraft equipment require Proof of Concept testing to establish appropriate Criteria for operational approval and system certification. The need for a Proof of Concept program is identified with this AC by a [PoC] designator.

The airworthiness criteria contained in this appendix for the takeoff system provides the requirements to track and maintain the runway centerline during a takeoff from brake release on the runway to liftoff and climb to 35 ft. AGL, and from brake release through deceleration to a stop for a rejected takeoff.

It is important to emphasize that the entire takeoff operation, through completion of the en route climb configuration, (see section 25.111), is considered to be an intensive phase of flight from an airworthiness perspective. The use of the takeoff system must not require exceptional skill, workload or pilot compensation. The takeoff system must provide an appropriate transition from lateral takeoff guidance (i.e., at about 35 ft. AGL) through transition to en route climb for a takeoff, and from brake release through deceleration to a stop for a rejected takeoff. Requirements for the airborne portion of the takeoff (i.e., above 35 ft. AGL) are provided in Appendix 9.

The takeoff system shall be shown to be satisfactory with and without the use of any outside visual references, except that outside visual references will not be considered when assessing lateral tracking performance. The airworthiness evaluation will also determine whether the combination of takeoff guidance and outside visual references would unacceptably degrade task performance, or require exceptional workload and pilot compensation, during normal operations and non-normal operations with system and airplane failure conditions.

For the purpose of the airworthiness demonstration, the operational concept for coping with the loss of takeoff guidance is based upon availability of some other method for the flightcrew to safely continue or reject the takeoff, if necessary.

Additional proof of concept demonstration may be appropriate for any operational concept that is not based on the presence of adequate outside visual references to safely continue or reject the takeoff, following loss of takeoff guidance. [PoC]

The minimum visibility required for safe operations will be specified by FAA Flight Standards in the operational authorization.

The intended takeoff path is along the axis of the runway centerline. This path must be established as a reference for takeoff in restricted visibility conditions. A means must be provided to track the reference path for the length of the runway in order to accommodate both a normal takeoff and a rejected takeoff.

The intended lateral path may be established in a number of ways. For systems addressed by this appendix, the required lateral path may be established by a navigation aid (e.g., ILS, MLS). Other methods may be acceptable if shown to be feasible by a PoC. Methods requiring PoC include, but are not limited to:

- the use of ground surveyed waypoints, either stored in an on-board data base or provided by data link to the airplane, with path definition by the airborne system,
- the use of inertial information following initial alignment,
- sensing of the runway surface, lighting and/or markings with a vision enhancement system (Indications of the airplane position with respect to the intended lateral path can be provided to the pilot in a number of ways.),
- deviation displays with reference to navigation source (e.g., ILS receiver, MLS receiver),
- on-board navigation system computations with corresponding displays of position and reference path, or
- by a vision enhancement system.

In addition to indications of the airplane position, the takeoff system should also compute and display command information (i.e., flight director), as lateral guidance, to the pilot, accounting for a number of parameters including airplane position, deviation from the reference path, and deviation rate. Takeoff system designs which provide only situational information, in lieu of command information, might be found acceptable, but would require a Proof of Concept demonstration. [PoC]

On-board navigation systems used for takeoff may have a number of possible navigation aid sensor elements by which to determine the position of an airplane including ILS, MLS, Global Navigation Satellite System (GNSS), Local Area Differential GNSS, Pseudolites, or inertial information, etc. Each of these elements has limitations with regard to accuracy, integrity and availability and should be used within their appropriate capability.

New Takeoff System designs may be developed which employ various combinations of aircraft systems, sensors and system architecture, and use ground and space based navigation sources. Such new systems may be approved if suitably demonstrated. [PoC]

4. TYPES OF TAKEOFF OPERATIONS. The operational concept and intended function of a takeoff system are important factors for its airworthiness approval. Section 4.2 Takeoff of the AC describes a variety of low visibility concepts and intended functions for takeoff systems which vary according to the degree of reliance on the system to accomplish the takeoff, climb, and as necessary, the aborted takeoff.

Takeoff under low visibility conditions may be conducted as follows:

1) Based on authorizations in standard OpSpecs to visibility values not requiring takeoff guidance, or

2) Based on authorizations requiring takeoff guidance.

The airworthiness criteria for takeoff systems are based on item 2) above. These systems should provide the required performance of the intended function, with acceptable levels of workload and pilot compensation to achieve the required level of safety.

5. TYPES OF TAKEOFF SERVICES. There are a number of navigation aids which may support aircraft systems in providing guidance to the flightcrew during takeoff in low visibility conditions. The required flight path is inherent in the design of some systems (e.g., ILS and MLS) but some systems require the flight path to be defined either in the airplane or provided to the airplane by datalink.

The accuracy, integrity and continuity of service of these external facilities, when used to support the takeoff system, will affect the overall safety of the operation (see Section 4.3.10). Criteria for ILS and MLS navigation aids for takeoff systems are the same as for landing systems.

5.1. ILS. The ILS is supported by established international standards for ground station operation (ICAO Annex 10, or State equivalent). Ground facility provisions are stated in Section 8.1 of this AC. These standards should be considered when demonstrating aircraft system operation.

5.2. MLS. The MLS is supported by established international standards for ground station operation (ICAO Annex 10, or State equivalent). Ground facility provisions are stated in Section 8.2 of this AC. These standards should be considered when demonstrating aircraft system operation.

5.3. GLS/GNSS [PoC]. This appendix section is not intended to provide a comprehensive acceptable means of compliance for airworthiness approval of GLS or GNSS based systems, but it does address key issues pertinent to any applicant who may seek early approval of a GLS (or GNSS based) system. Currently approved systems are ILS or MLS based. The application of new technologies and systems such as GLS requires an overall assessment of the integration of the airplane components with other navigation and related elements (e.g., new ground based elements, satellite elements) to ensure that the overall safety of the use of the system is acceptable. This GNSS section is also included to show the inherent differences between conventional ILS/MLS based systems and GLS (or GNSS) based systems that affect criteria development.

The performance, integrity and availability of any ground station elements, any data links to the airplane, any satellite elements and any data base considerations, when combined with the performance, integrity and availability of the airplane system, should be at least equivalent to the overall performance, integrity and availability provided by ILS to support low visibility operations.

5.3.1. GLS/GNSS Flight Path Definition. The required lateral path for the takeoff is key to the safety of the operation. The required path has to be established to ensure that the airplane stays within the confines of the runway.

In a GLS/GNSS based Takeoff System, the required lateral path is established by data, rather than the physical location of an RF signal in space. Earth referenced waypoints define the required path, which is coincident with the runway centerline. The airplane navigation and flight guidance system will require that the appropriate waypoints be provided either from an onboard database or via a datalink.

Certain "special waypoint" definitions, and other criteria are necessary to effectively implement takeoff operations using satellite systems and other integrated multi-sensor navigation systems. See Section 4.6 of this AC, *Flight Path Definition,* which shows the minimum set of "special waypoints" considered necessary to conduct takeoff operations in air carrier operations.

The required path may be stored in an airplane database for recall and use by the takeoff guidance and/or control system when required to conduct the operation.

The definition, resolution and maintenance of the waypoints which define the required path and flight segments is key to the integrity of this type of takeoff operation.

A mechanism should be established to ensure the continued integrity of the waypoints.

The integrity of any data base used to define flight critical path waypoints for a Takeoff System should be addressed as part of the certification process. The flightcrew should not be able to modify information in the data base which relates to the definition of the required flight path.

5.3.2. GLS/GNSS Airplane Position Determination. The safety of a low visibility takeoff operation is, in part, predicated on knowing where the airplane is positioned relative to the required path. Navigation satellite systems exist which can provide position information to specified levels of accuracy, integrity and availability. The accuracy, integrity and availability can be enhanced by additional space and ground based elements. These systems provide certain levels of capability to support present low visibility operations and are planned to have additional future capability.

Satellite systems have the potential to provide positioning information necessary to guide the airplane during the takeoff operations. If operational credit is sought for these operations, the performance, integrity and availability must be established to support that operation. Ground based aids such as differential position receivers, pseudolites etc., and a data link to the airplane may be required to achieve the accuracy, integrity or availability for certain types of operation.

An equivalent level of safety to current ILS based low visibility takeoff operations should be established.

The role of the satellite based elements in the takeoff system should be addressed as part of the airplane system certification process until such time as an acceptable national, or international standards, for satellite based systems are established.

Basic GNSS (Un-augmented).

This is the basic navigation service provided by a satellite system. No additional elements are used to enhance accuracy or integrity of the operation.

Differential Augmentation.

If a ground based GNSS receiver is used to provide differential pseudo-range corrections, or other data to an airplane to support low visibility operations, the overall integrity of that operation will have to be established.

The role of the differential station in the takeoff system will have to be addressed as part of the airplane system certification process until such time as an acceptable national, or international standard, for the ground reference system is established.

Local Area Differential Augmentation.

Local Area Differential (LAD) augmentation consists of a set of ground based GNSS receivers that are used to derive pseudorange corrections and integrity data referenced to a point on or near the airport. This augmentation data is then provided to the airplane via a local, ground based data broadcast signal.

5.4. Other.

5.4.1. Datalink. A data link may be used to provide data to the airplane to provide the accuracy necessary to support certain operations (e.g., navigation way points, differential corrections for GNSS). The integrity, availability and continuity of service of the data link should be commensurate with the operation.

The role of the data link in the takeoff system must be addressed as part of the airplane system certification process until such time as an acceptable national, or international standard, for the ground system is established.

6. AIRWORTHINESS.

6.1. General Takeoff System. The following sections identify the performance and workload requirements for the takeoff roll, through liftoff and for the rejected takeoff. These requirements apply for takeoff systems that are intended for use in low visibility conditions below the floor for visual operations.

The airplane elements of the Takeoff System must be shown to meet the performance, integrity and reliability requirements identified for the type(s) of operation for which approval is sought. The relationship and interaction of the aircraft elements with non-aircraft elements must be established and understood.

The performance of the aircraft elements may be established with reference to an approved flight path (e.g., localizer) provided the overall performance is not compromised by budgeting between aircraft and non-aircraft elements.

When international standards exist for the performance and integrity aspects of any non-aircraft elements of the Takeoff System, the applicant can assume these standards will be applied by member States of ICAO.

When international standards do not exist for the performance and integrity aspects of any non-aircraft elements of the Takeoff System, the applicant must address these considerations as part of the airworthiness process. A means must be provided to inform the operator of the limitations and assumptions necessary to ensure a safe operation. It will be the responsibility of the operator and associated State regulatory authorities to ensure that appropriate criteria and standards are applied.

6.1.1. Takeoff Performance Prior to 35 Ft. AGL. The takeoff system is intended to provide a means for the pilot to track and maintain the runway centerline during a takeoff from brake release on the runway to liftoff to 35 ft. AGL, and during a rejected takeoff. Systems should ensure that a takeoff, or a rejected takeoff, can be safely completed on the designated runway, runway with clearway or runway with stopway, as applicable.

The system performance must be satisfactory, even in "non-visual conditions," for normal operations, aircraft failure cases (e.g., engine failure) and recovery from displacements from non-normal events. The system should be easy to follow and not increase workload significantly compared to the basic airplane. Consideration should not be given for performance improvements resulting from available visual cues.

The system should not require unusual skill, effort or excessive workload by the pilot to acquire and maintain the desired takeoff path. The display should be easy to interpret in all situations. Cockpit integration issues should be evaluated to ensure consistent operations and pilot response in all situations.

The continued takeoff or rejected takeoff operation should consider the effects of all reasonable events which would lead a flightcrew to make a continued takeoff or a rejected takeoff decision.

The airplane must not deviate significantly from the runway centerline during takeoff while the takeoff system is being used within the limitations established for it. The reference path of the system is usually defined by the ILS localizer, or other approved approach navigation aid, which normally coincides with the runway centerline. The performance of the system must account for differences, if any, between the runway centerline and the intended lateral path. Compliance may be demonstrated by flight test, or by a combination of flight test and simulation. Flight testing must cover those factors affecting the behavior of the airplane (e.g., wind conditions, ILS characteristics, weight, center of gravity). Specific takeoff system demonstration requirements are found in Section 7.1 of this appendix.

In the event that the airplane is displaced from the runway centerline at any point during the takeoff or rejected takeoff, the system must provide sufficient lateral guidance to enable the "pilot flying" to control the airplane smoothly back to the intended path in a controlled and predictable manner without significant overshoot or any sustained nuisance or divergent oscillations. Minor overshoot or oscillations around the centerline are permissible when not leading to unacceptable crew workload.

The performance envelope and conditions for evaluating takeoff systems for the following scenarios are described in Section 5.1.3 of this AC (Figure 5.1.3-1) for at least the following conditions:

a) Takeoff with all engines operating

b) Engine Failure at V_{ef} - continued takeoff*

c) Engine Failure just prior to V_1 - rejected takeoff *

d) Engine Failure at a critical speed prior to V_{mcg} - rejected takeoff *

* Wind and runway conditions consistent with basic aircraft takeoff performance demonstrations.

Figure 5.1.3-1 should not be interpreted to mean that the airplane can begin the takeoff roll up to 7m from the centerline. The pilot is expected to position and align the airplane on, or near, the runway centerline. While the pilot is positioning and aligning the airplane on the runway, the takeoff guidance system should provide an indication such that the flightcrew can confirm its proper operation.

For the rejected takeoff, the actual performance should reflect the effects of a dynamic engine failure, a short term increase in lateral deviation, and then converge toward the centerline during the deceleration to a full stop.

6.1.1.1. ILS. The aircraft system response to permanent loss of the localizer signal shall be established, and the loss of the localizer signal must be appropriately annunciated to the crew.

The aircraft system response during a switchover from an active localizer transmitter to a backup transmitter shall be established (Reference ICAO Annex 10).

6.1.1.2. MLS. The aircraft system response to the loss of the MLS signal shall be established, and appropriately annunciated to the crew.

The aircraft system response during a switchover from an active azimuth transmitter to a backup transmitter shall be established (reference ICAO Annex 10).

6.1.2. Workload Criteria. The workload associated with the use of the takeoff system shall be Satisfactory in accordance with the HQRS criteria of AC 25-7A, as amended, or equivalent. The takeoff system should provide required tracking performance with Satisfactory workload and pilot compensation, under foreseeable normal conditions. It may be assumed that the operational authorizations process will address any visual cues needed for the required task performance with satisfactory workload and pilot compensation.

The system should not require unusual skill, effort or excessive workload by the pilot to acquire and maintain the desired takeoff path. The display should be easy to interpret in all situations. Cockpit integration issues should be evaluated to ensure consistent operations and pilot response in all situations.

6.2. Takeoff System Integrity. The takeoff system shall provide command information, as lateral guidance, which, if followed by the pilot, will maintain the airplane on the runway during the takeoff roll through acceleration to liftoff or, if necessary, during a deceleration to a stop during a rejected takeoff.

The onboard components of the low visibility takeoff system and associated components, considered separately and in relation to other systems, should be designed to meet the requirements of Title 14 of the code of Federal Regulations (14 CFR) part 25, section 25.1309, in addition to any specific safety related criteria identified in this appendix. The elements not on the airplane should not reduce the overall safety of the operation to unacceptable levels. The following criteria is provided for the application of section 25.1309 to Takeoff Systems:

The system design should not possess characteristics, in normal operation or when failed, which would degrade takeoff safety, or lead to a hazardous condition. Any single failure of the airplane which could disturb the take-off path (e.g., engine failure, single electrical generator or bus failure, single IRU failure) must not cause loss of guidance information or give incorrect guidance information.

To the maximum extent possible, failures that would result in the airplane violating the lateral confines of the runway while on the ground should be detected by the takeoff system and promptly annunciated to the pilot. If pitch and/or speed guidance is also provided, failures that would result in rotation at an unsafe speed, pitch rate or pitch angle should be detected by the takeoff system and promptly annunciated to the pilot.

However, there may be failures, which result in misleading guidance, but cannot be annunciated. For these failures, outside visual references or other available information, that the pilot is expected to monitor, would be used by the pilot to detect the failures and mitigate their effects. These failures must be identified, and the ability of the pilot to detect them and mitigate their effects must be verified by analysis, flight test or both.

Whenever the takeoff system does not provide valid guidance appropriate for the takeoff operation, it must be clearly annunciated to the crew, and the guidance must be removed. The removal of guidance, alone, is not adequate annunciation. The annunciation must be located to ensure rapid recognition, and must not distract the pilot making the takeoff or significantly degrade the forward view.

The probability of the takeoff system generating misleading information that could lead to an unsafe condition shall be Improbable when the flightcrew is alerted to the condition by suitable fault annunciation or by information from other independent sources available within the pilot's primary field of view. For airworthiness, the effectiveness of the fault annunciation or information from other independent sources must be demonstrated.

The probability of the takeoff system generating misleading information that would be unsafe to follow, must be Extremely Improbable, if:

1. no means are available for the takeoff system to detect and annunciate the failure, and

2. no information is provided to the pilot to immediately detect the malfunction and take corrective action.

In the event of a probable failure (e.g., engine failure, electrical source failure) if the pilot follows the takeoff display and disregards external visual reference, the airplane performance must meet the requirements illustrated in figure 5.1.3-1.

In showing compliance with the performance and failure requirements, the probabilities of performance or failure effects may not be factored by the proportion of takeoffs which are made in low visibility.

Loss of any single source of electrical power or transient condition on any single source of electrical power should not cause loss of guidance to the pilot flying (PF), or loss of information that is required to monitor the takeoff to the pilot not flying (PNF).

Takeoff systems that use navigation aids other than ILS and MLS require an overall assessment of the integration of the airplane components with other elements (e.g., ground based aids, satellite systems) to ensure that the overall safety of the use of these takeoff systems is acceptable **[PoC]**.

6.3. Takeoff System Availability. When the Takeoff operation is predicated on the use of the Takeoff system, the probability of a system loss should be Remote (10-5/flight hour).

6.4. Flight Deck Information, Annunciation and Alerting. This section identifies information, annunciations, and alerting requirements for the takeoff system on the flight deck. The controls, indicators, and alerts must be designed to minimize crew errors which could cause a hazard. Mode and system malfunction indications must be presented in a manner compatible with the procedures and assigned tasks of the flightcrew. The indications must be grouped in a logical and consistent manner and be visible under all expected normal lighting conditions.

6.4.1. Flight Deck Information. System design or use should not degrade the flightcrews ability to otherwise adequately monitor takeoff performance or stopping performance.

The system shall be demonstrated to have no display or failure characteristics that lead to degradation of the crews ability to adequately monitor takeoff performance (e.g., acceleration, engine performance, takeoff speed callouts, attitude, and airspeed), conduct the entire takeoff, and make an appropriate transition to en route climb speed and configuration, for all normal, abnormal and emergency situations.

6.4.2. Annunciation. Prior to takeoff initiation and during takeoff, positive, continuous and unambiguous indications of the following information about the takeoff system must be provided and made readily evident to both pilots:

- system status

- modes of engagement and operation, as applicable
- guidance source

6.4.3. Alerting. The takeoff system must alert the flightcrew whenever the system suffers a failure or any condition which prevents the system from meeting the takeoff system performance requirements (see 6.1.1 of this appendix).

Alerts shall be timely, unambiguous, readily evident to each crewmember, and compatible with the alerting philosophy of the airplane. Annunciations must be located to ensure rapid recognition, and must not distract the pilot making the takeoff or significantly degrade the forward view.

6.4.3.1. Warnings. Warnings shall be provided for conditions that require immediate pilot awareness and action. Warnings are required for the following conditions:

a) Loss of takeoff guidance

b) Invalid takeoff guidance

c) Failures of the guidance system that require immediate pilot awareness and compensation

During takeoff, whenever the takeoff system does not provide valid guidance appropriate for the takeoff operation, it must be clearly annunciated to the crew, and the guidance must be removed. The removal of guidance, alone, is not adequate annunciation. The annunciation must be located to ensure rapid recognition, and must not distract the pilot making the takeoff or significantly degrade the forward view.

6.4.3.2. Cautions. Cautions shall be provided for conditions that require immediate pilot awareness and possible subsequent pilot action. These alerts need not generate a Master Caution light, which would be contrary to the takeoff alert inhibit philosophy. Cautions should be carefully generated so as not to cause flightcrew distraction during takeoff roll.

6.4.3.3. Advisories. Advisories shall be provided for conditions that require pilot awareness in a timely manner. Advisories should not be generated after takeoff has commenced.

6.4.3.4. System Status. Status of takeoff guidance system shall be provided (e.g., status of BITE/self-test).

7. Takeoff System Evaluation.

An applicant shall provide a certification plan which provides a description of the airplane systems, the basis for certification, the certification methods and compliance documentation. The certification plan should also describe how any non-airplane elements of the Takeoff System relate to the operation of airplane systems from a performance, integrity and availability perspective.

The certification plan shall identify the assumptions and considerations for the non-airplane elements of the system, and describe how the performance, integrity and availability ‘requirements’ of these elements are met.

For ILS and MLS based system elements, satisfaction of these requirements can be predicated upon compliance with either the ICAO SARP’s, equivalent state standard, or by reference to an acceptable standard for performance of any navigation service.

For the use of systems other than ILS or MLS for 'path in space' guidance, the assumptions and considerations for the non-airplane elements of the system may be different than applicable to ILS or MLS. If different than ILS or MLS, the applicant shall address these differences and how they relate to the airplane system certification plan.

As applicable, the plan for certification shall describe any new or novel system concepts or operational philosophy to allow the regulatory authority to determine whether criteria and requirements in excess of that contained in this appendix are necessary.

7.1. Performance Evaluation. For new systems and any significant changes to an existing system, the performance of the airplane and its systems must typically be demonstrated by flight test. Flight testing must include a sufficient number of normal and non-normal operations conducted in conditions which are reasonably representative of actual expected conditions and must cover the range of parameters affecting the behavior of the airplane (e.g., wind speed, ILS characteristics, airplane configurations, weight, center of gravity, and non-normal events).

The performance evaluation must verify that the Takeoff System meets the centerline tracking performance requirements and limits of section 6.1.1. of this appendix.

The system performance must be demonstrated in "non-visual conditions" for:

a) normal operations,

b) engine failure cases and,

c) recovery from displacements from non-normal events.

This performance shall be demonstrated to have a satisfactory level of workload and pilot compensation, such as defined by the FAA Handling Quality Rating System (HQRS) found in AC 25-7A, as amended, or equivalent.

The takeoff system shall be shown to be satisfactory with and without the use of any outside visual references, except that outside visual references will not be considered in assessing lateral tracking performance. The airworthiness evaluation will also determine whether the combination of takeoff guidance and outside visual references would unacceptably degrade task performance, require excessive pilot compensation or workload during normal and non-normal operations.

For the purpose of the airworthiness demonstration, the operational concept for coping with the loss of takeoff guidance is based upon availability of some other method for the flightcrew to safely continue or reject the takeoff. The airworthiness demonstration may include a loss of takeoff guidance.

The demonstration of system performance should comprise at least the following, (though more demonstrations may be needed, depending on the airplane characteristics and system design, and any difficulties encountered during testing):

- 20 normal, all-engine takeoffs.
- 10 completed takeoffs, with simulated engine failure at or after the appropriate V_{ef} for the minimum V_1 for the airplane. All critical cases must be considered.
- 10 rejected takeoffs, some with simulated engine failure just prior to V_1, and at least one run with simulated engine failure at a critical speed less than V_{mcg}.

For modified systems, credit may be permitted for earlier demonstration(s), but testing up to that necessary for a new system may be required if credit for similarity of design or performance is not appropriate.

Engine failures should be assessed with respect to workload and pilot compensation throughout the entire takeoff phase. In cases where the dynamics of retarding the throttle to idle do not adequately simulate the dynamics of an engine failure, the certifying authorities may require an actual engine shutdown for these demonstrations.

Demonstrated winds, during normal all engine takeoff, should be at least the headwinds for which credit is sought, and at least 150% of the cross winds and tailwinds for which credit is sought, but not less than 15 knots of headwind or crosswind.

The applicant shall demonstrate that operation of the takeoff system does not exhibit any guidance or control characteristics during the operation which would cause the flightcrew to react in an inappropriate manner.

The system shall be demonstrated to have no display or failure characteristics that lead to degradation of the crew's ability to adequately monitor takeoff performance (e.g., acceleration, engine performance, takeoff speed callouts), and conduct the entire takeoff, and make an appropriate transition to en route climb speed and configuration, for all normal, abnormal and emergency situations.

The system must be evaluated and demonstrated to meet the integrity and failure annunciation requirements of section 6.2, 6.4, and sub-sections of this appendix, as well as the pilot's ability to immediately detect and mitigate non-annunciated failures, as described in section 6.2.

For takeoff systems that use an ILS localizer signal, the airplane system response to loss of the localizer signal shall be demonstrated, and appropriately annunciated to the crew. The airplane system response during a switchover from an active localizer transmitter to a backup transmitter shall be demonstrated (Reference ICAO Annex 10).

For takeoff systems that use MLS, the airplane system response to the loss of the MLS signal shall be demonstrated, and appropriately annunciated to the crew. The airplane system response during a switchover from an active azimuth transmitter to a backup transmitter shall be demonstrated (Reference ICAO Annex 10).

For the evaluation of takeoff systems, the set of subject pilots provided by the applicant should have relevant variability of experience (e.g., experience with or without head-up- display (HUD), Captain or First Officer (F/O) crew position experience as applicable, experience in type). Subject pilots must not typically have special experience that invalidates the test (e.g., pilot's should not have special recent training to cope with HUD failures, beyond what a line pilot would be expected to have for routine operation). The set of pilots provided by the certifying authorities may have experience as specified by the authority appropriate to the test(s) to be conducted. The experience noted above for authority subject pilots or evaluation pilots may or may not be applicable or appropriate for the tests to be conducted.

Failure cases should typically be spontaneous and unpredictable on the subject's or evaluation pilot's part.

7.2. Safety Assessment. In addition to any specific safety related criteria identified in this appendix, a safety assessment of all airplane components of the takeoff system and associated components, considered separately, shall be conducted in accordance with AC 25.1309 to meet the requirements of section 25.1309.

In showing compliance with airplane system performance and failure requirements, the probabilities of performance or failure effects may not be factored by the proportion of takeoffs which are made in low visibility conditions.

The responses of the takeoff system to failures of navigation facilities must be considered, taking into account ICAO and other pertinent State criteria for navigation facilities, (for more information see Section 8 of this AC).

Documented conclusions of the safety analysis shall include:

a. A functional hazard assessment (FHA) conducted in accordance with section 25.1309 and a summary of results from the fault tree analysis, demonstrated compliance, and probability requirements for significant functional hazards.

b. Information regarding "alleviating flightcrew actions" that were considered in the safety analysis. This information should list appropriate alleviating actions, if any, and should be consistent with the validation conducted during testing. If alleviating actions are identified, the alleviating actions should be described in a form suitable to aid in developing, as applicable:

1) Pertinent provisions of the airplane flight manual procedures section(s), or

2) Flight Crew Operating Manual (FCOM) provisions, or equivalent, or

3) Pilot qualification criteria (e.g., training requirements, FSB provisions), or

4) Any other reference material necessary for an operator or flightcrew to safely use the system.

c. Information to support preparation of any maintenance procedures necessary for safety, such as:

1) Certification maintenance requirements (CMR),

2) Periodic checks, or

3) Other checks, as necessary (e.g., return to service).

d. Information applicable to limitations, as necessary.

e. Identification of applicable systems, modes or equipment necessary for use of the takeoff system, to aid in development of flight planning or dispatch criteria, or to aid in development of procedures or checklists for pilot selection of takeoff mode or assessment of system status, prior to initiation of takeoff.

f. Information necessary for development of Non-normal procedures.

8. AIRBORNE SYSTEM.

8.1. General. All general takeoff system requirements are found in section 6.1 of this appendix.

8.2. Peripheral Vision Guidance Systems [PoC]. Peripheral vision systems have not been shown to be suitable as primary means of takeoff guidance. Such systems may be used as a supplemental means of takeoff guidance only if a suitable minimum visual segment is available. A Proof of Concept evaluation program is necessary for Peripheral Vision Guidance systems intended for use as primary means of takeoff guidance or as supplemental means with visual segments less than the minimum required for un-aided operation.

8.3. Head Up Display Takeoff System. The following criteria is applicable to head up display takeoff systems:

a) The workload associated with use of the HUD must be considered in showing compliance with 14 CFR part 25, section 25.1523.

b) The HUD installation and display presentation must not significantly obscure the pilot's outside view.

c) The entire takeoff operation, through completion of the en route climb configuration, (see section 25.111), is considered to be an intensive phase of flight during which unnecessary pilot workload and compensation should be avoided. Appropriate transition from lateral takeoff guidance (i.e., at about 35 ft. AGL) through transition to en route climb for a takeoff, and from brake release through deceleration to a stop for an aborted takeoff should be ensured. For the entire takeoff and for all normal, and non-normal situations, except loss of the HUD itself, it must not be necessary for the "pilot flying (PF)" to make any immediate change of primary display reference for continued safe flight.

d) Control of Takeoff Flight Path. For the entire takeoff path and for all normal and non-normal conditions, except loss of the HUD itself, the HUD takeoff system must provide acceptable guidance and flight information to enable the PF to complete the takeoff, or abort the takeoff, if required. Use of the HUD takeoff system should not require excessive workload, exceptional skill, or excessive reference to other cockpit displays.

e) The HUD shall provide information suitable for the PF to perform the intended operation. The current mode of the HUD system itself, as well as the flight guidance/automatic flight control system, shall be clearly annunciated in the HUD, unless they can be acceptably displayed elsewhere.

f) Systems which display only lateral deviation as a cue for centerline tracking have not been shown to provide adequate information for the PF to determine the magnitude of the required directional correction. Consequently, with such displays workload and pilot compensation are considered excessive. A proposed system which displays situation information, in lieu of command information, requires a successful proof of concept evaluation. [PoC]

g) If the system is designed as a single HUD configuration, then the HUD shall be installed for the Captain's (pilot in command) crew station.

h) Associated cockpit information must be provided to the pilot not flying (PNF) to monitor the PF performance, and perform other assigned duties.

8.4. Satellite Based Systems [PoC]. Currently approved systems are ILS or MLS based. The application of new technologies and systems such as GLS/GNSS requires an overall assessment of the integration of the airplane components with other elements to ensure that the overall safety of the use of these systems is acceptable.

The performance, integrity and availability of any ground station elements, any data links to the airplane, any satellite elements and any data base considerations, when combined with the performance, integrity and availability of the airplane system, should be at least equal to the overall performance, integrity and availability provided by ILS to support equivalent low visibility operations.

The role of the satellite based elements in the takeoff system should be addressed as part of the airplane system certification process until such time as an acceptable national, or international standard, for the satellite based system is established.

8.4.1. Flight Path Definition. For Flight Path Definition considerations refer to Section 4.6 of the AC.

8.4.2. On Board Database. Unless there is a means to upload the path definition data via datalink, the required lateral ground path should be stored in an on board database for recall and incorporation into the guidance/control system when required to conduct the takeoff.

The definition, resolution and maintenance of the waypoints which define the required takeoff path should be consistent with the takeoff operation. A mechanism should be established to ensure the continued integrity of the takeoff path designators.

Corruption of the information contained in the on board data base used to define the reference flight path is considered Hazardous. Failures which result in hazardous unannunciated changes to the on board data base must be Extremely Remote.

The flightcrew should not be able to intentionally or inadvertently modify information in the on board data base which relates to the definition of the required flight path.

The integrity of any on board data base used to define takeoff path waypoints for a Takeoff System should be addressed as part of the certification process.

8.4.3. Datalink. Data may be sent to the airplane, via data link, so that the takeoff flight path can be defined with the required accuracy. The required takeoff path may be stored in a ground station database which is uplinked to an airplane, either on request or through continuous transmission. The airplane guidance and control system may incorporate such information to conduct the takeoff.

The integrity of the data link should be commensurate with the integrity required for the operation. The role of the data link in the takeoff system must be addressed as part of the airplane system certification process unless acceptable FAA, or international standards, for the ground system are established. The following items shall be addressed as part of the Takeoff System assessment:

a) Satellite systems used during takeoff must support the required performance, integrity and availability. This should include the assessment of satellite vehicle failures and the effect of satellite vehicle geometry on the required performance, integrity and availability.

b) The capability of the Takeoff System failure detection and annunciation mechanism to preclude an undetected failure, or combination of failures which are not Extremely Remote, from producing a hazardous condition. This assessment should include failure mode detection coverage and adequacy of monitors and associated alarm times.

c) The effect of airplane maneuvers on the reception of signals necessary to maintain the necessary performance, integrity and availability. Loss and re-acquisition of signals should be considered.

8.5. Enhanced Vision Systems [PoC]. Enhanced Vision Systems which penetrate visibility restrictions to provide the flightcrew with an enhanced view of the scene outside the airplane (e.g., radar) may be considered for airworthiness installation and demonstration. However, this Appendix does not comprehensively address a means of compliance for airworthiness installation approval of such

Enhanced Vision Systems. Performance must be demonstrated to be acceptable to the FAA through proof of concept testing, during which specific airworthiness and operational criteria may be developed.

Criteria for approval of the enhanced vision system must match its intended use. The fidelity, alignment and real time response of the enhanced view must be shown to be appropriate for the intended application. Enhanced Vision Systems also must not significantly degrade the pilot's normal view, when visual reference is available.

9. Airplane Flight Manual. Upon satisfactory completion of an airworthiness assessment and test program, the FAA-approved airplane flight manual or supplement, and any associated markings or placards, if appropriate, should be issued or amended to address the following:

1) Relevant conditions or constraints applicable to takeoff system use regarding the airport or runway conditions (e.g., elevation, ambient temperature, runway slope).

2) The criteria used for the demonstration of the system, acceptable normal and non-normal procedures (including procedures for response to loss of guidance), the demonstrated configurations, and any constraints or limitations necessary for safe operation.

3) The type of navigation aids used as a basis for demonstration. This should not be taken as a limitation on the use of other facilities. The AFM may contain a statement regarding the type of facilities or condition known to be unacceptable for use (e.g., For ILS or MLS) based systems, the AFM shall indicate that operation is predicated upon the use of an ILS (or MLS) facility with performance and integrity equivalent to, or better than, a United States Type II or Type III ILS, or equivalent ICAO Annex 10 Facility Performance Category III facility).

4) Applicable atmospheric conditions under which the system was demonstrated (e.g., demonstrated headwind, crosswind, tailwind),

5) For a Takeoff system meeting provisions of Appendix 2, the AFM (Section 3, Normal Procedures) should also contain the following statements:

> "The airborne system has been demonstrated to meet the airworthiness requirements of AC 120-28D Appendix 2 for Takeoff when the following equipment is installed and operative:
>
> <list pertinent equipment>"
>
> "This AFM provision does not constitute operational approval or credit for use of the takeoff system."

Examples of general AFM considerations and specific AFM provisions are provided in Appendix 6.

APPENDIX 3
AIRWORTHINESS APPROVAL FOR AIRBORNE SYSTEMS USED TO LAND AND ROLLOUT IN LOW VISIBILITY CONDITIONS

Mandatory terms used in this AC such as “shall” or “must” are used only in the sense of ensuring applicability of these particular methods of compliance when the acceptable means of compliance described herein is used. This AC does not change, add or delete regulatory requirements or authorize deviations from regulatory requirements.

1. PURPOSE. This appendix contains criteria for the approval of aircraft equipment and installations used for Landing and Rollout in low visibility conditions.

2. GENERAL. The type certification approval for the equipment, system installations and test methods should be based upon a consideration of factors such as the intended function of the installed system, its accuracy, reliability, and fail-safe features, as well as the operational concepts contained in the body of this AC. The guidelines and procedures contained herein are considered to be acceptable methods of determining airworthiness for a transport category airplane intended to conduct a landing and rollout in low visibility conditions.

In addition to the criteria found in this appendix, equipment and installation must also meet the criteria contained in AC 120-29, as amended, an equivalent foreign standard acceptable to the Administrator, or any other criteria acceptable to the Administrator.

The overall assurance of performance and safety of an operation can only be assessed when all elements of the system are considered.

3. INTRODUCTION. This appendix addresses the final approach, landing and the rollout phase of flight. Landing and Rollout Systems may combine various combinations of airplane sensors and system architecture with various combinations of ground and space based elements. This appendix provides criteria which represents an acceptable means of compliance with performance, integrity and availability requirements for low visibility approach, landing and rollout systems to accomplish a landing and rollout in low visibility conditions. Alternative criteria may be proposed by an applicant. With new emerging technologies, there is a potential for many ways of conducting low visibility landings. This appendix does not attempt to provide criteria for each potential combination of airborne and non-airborne elements.

Operations utilizing current ILS or MLS ground based facilities and airborne elements are in use, and the certification criteria for approval of these airborne systems are established. Other operations, using non-ground based facilities or evolving ground facilities (e.g., local or wide area augmented GNSS), and the use of some new aircraft equipment require Proof of Concept testing to establish appropriate criteria for operational approval and system certification. The need for a Proof of Concept program is identified in this AC with a [PoC] designator. This appendix provides some general guidelines, but not comprehensive criteria for airplane systems that require a Proof of Concept.

The low visibility landing system is intended to guide the airplane down the final approach segment to a touch down in the prescribed touch down zone, with an appropriate sink rate and attitude without exceeding prescribed load limits of the airplane. The rollout system is intended to guide the airplane to converge on and track the runway centerline, from the point of touch down to a safe taxi speed.

The low visibility landing system shall be shown to be satisfactory with and without the use of any outside visual references, except that outside visual references will not be considered when assessing lateral tracking performance. The airworthiness evaluation will also determine whether the combination of guidance and outside visual references would unacceptably degrade task performance, or require exceptional workload and pilot compensation, during normal operations and non-normal operations with system and airplane failure conditions.

For the purpose of the airworthiness demonstration, the operational concept for coping with the loss of guidance is based upon the availability of some other method to accomplish a go-around, landing, or rollout, if necessary. The airworthiness demonstration may include a loss of guidance.

The minimum visibility required for safe operations with such systems and backup means will be specified by FAA Flight Standards in the operational authorization.

The intended flight path may be established in a number of ways. For systems addressed by this appendix, the reference path may be established by a navigation aid (e.g., ILS, MLS). Other methods may be acceptable if shown feasible by a Proof of Concept [PoC]. Methods requiring PoC include, but are not limited to:

- the use of ground surveyed waypoints, either stored in an on-board data base or provided by data link to the airplane, with path definition by the airborne system,

- sensing of the runway environment (e.g., surface, lighting and/or markings) with a vision enhancement system.

On-board navigation systems may have various sensor elements by which to determine airplane position. The sensor elements may include ILS, MLS, Inertial information, GLS, other Global Navigation Satellite System (GNSS) elements, Local Area Differential GNSS, or GNSS related Pseudolites. Each of these sensor elements should be used within appropriate limitations with regard to accuracy, integrity and availability.

Indications of the airplane position with respect to the intended lateral path can be provided to the pilot in a number of ways.

- deviation displays with reference to navigation source (e.g., ILS receiver, MLS receiver), or

- on-board navigation system computations with corresponding displays of position and reference path

4. TYPES OF LANDING AND ROLLOUT OPERATIONS. The following types of Category III operations typically may be considered:

(1) Fail-operational landing with fail-operational rollout

(2) Fail-operational landing with fail-passive rollout

(3) Fail-passive landing with fail-passive rollout

(4) Fail-passive landing without rollout system capability

(5) The following engine inoperative capabilities may optionally* be demonstrated, for each or any of the cases listed above:

a) Landing with engine failure prior to initiation of the approach

b) Landing and rollout with engine failure after initiation of the approach, but prior to DA(H) or AH, as applicable.

***NOTE: The case of engine failure after passing AH (or DA(H)) through touchdown, or through touchdown and rollout as applicable, is typically addressed as a basic consideration for any system demonstration intended for Category III.**

The following definitions may be used for the operations described above.

Landing - for the purpose of this appendix, landing begins at 100 ft., the DH or the AH, to the first contact of the wheels with the runway.

Rollout - for the purpose of this Appendix, rollout starts from the first contact of a wheel(s) with the runway and finishes when the airplane has slowed to a safe taxi speed.

Safe Taxi Speed is the speed at which the pilot can safely taxi off the runway using typical exits, or bring the airplane expeditiously to a safe stop. The safe taxi speed may vary with visibility conditions, airplane characteristics, and means of lateral control.

5. TYPES OF LANDING AND ROLLOUT SERVICES.

5.1. ILS. The ILS is supported by established international standards for ground station operation. These standards should be used in demonstrating airplane system operation.

The airplane system response during a switchover from an active localizer transmitter to a backup transmitter shall be established. For procedures which do not use a localizer for missed approach, total failure (shutdown) of the ILS ground station may not significantly adversely effect go-around capability.

The Airplane Flight Manual shall indicate that operation is predicated upon the use of an ILS facility with performance and integrity equivalent to, or better than, an ICAO Annex 10 Facility Performance Category III ILS, a United States Type II or Type III ILS, or equivalent.

5.1.1. ILS Flight Path Definition. The required lateral flight path is inherent in the design of the ILS. Acceptable performance and integrity standards have been established for ILS (see section 8.1 of the AC).

5.1.2. ILS Airplane Position Determination. The airplane lateral position relative to the desired flight path is accomplished by an airplane ILS receiver which provides deviation from the extended runway centerline path when in the coverage area.

5.2. MLS. The MLS is supported by established ICAO Annex 10 international standards for ground station operation. These standards should be used in demonstrating airplane system operation.

The airplane system response during a switchover from an active azimuth transmitter to a backup transmitter shall be established. Total failure (shutdown) of the MLS ground station may not significantly adversely affect go-around capability.

The Airplane Flight Manual shall indicate that operation is predicated upon the use of an MLS facility with performance and integrity equivalent to, or better than, an ICAO Annex 10 Facility Performance Category III MLS, or equivalent.

5.2.1. MLS Flight Path Definition. The lateral required flight path is inherent in the design of the MLS. Acceptable performance and integrity standards have been established for MLS (see section 8.1 of the AC).

5.2.2. MLS Airplane Position Determination. The airplane lateral position relative to the desired flight path is accomplished by an airplane MLS receiver which provides deviation from the extended runway centerline path when in the coverage area.

5.3. GLS/GNSS [PoC]. This appendix section is not intended to provide a comprehensive acceptable means of compliance for airworthiness approval of GLS or GNSS based systems, but it does address key issues pertinent to any applicant who may seek early approval of a GLS (or GNSS based) system. Currently approved systems are ILS or MLS based. The application of new technologies and systems requires an overall assessment of the integration of the airplane components with other elements (e.g., new ground based aids, satellite elements) to ensure that the overall safety of the use of these systems for Category III. This GLS/GNSS section is also included to identify important differences between conventional ILS/MLS based systems and GLS/GNSS based systems that may affect GNSS or GLS criteria development.

The performance, integrity and availability of any ground station elements, any data links to the airplane, any satellite elements and any data base considerations, when combined with the performance, integrity and availability of the airplane system, should be at least equivalent to the overall performance, integrity and availability provided by ILS to support Category III operations.

5.3.1. GLS/GNSS Flight Path Definition. Appropriate identification of the required flight path for the landing and rollout is necessary to ensure safety of the operation. The required flight path should be established to provide adequate clearance between the airplane and fixed obstacles on the ground, between airplane on adjacent approaches, and to ensure that the airplane stays within the confines of the runway.

The effect of the navigation reference point on the airplane on flight path and wheel to threshold crossing height must be addressed.

In a GNSS based Landing and Rollout System, the required lateral path is established by data, rather than the physical location of an RF signal in space. Earth referenced waypoints define the required path, which is coincident with the runway centerline. The airplane navigation and flight guidance system will require that the appropriate waypoints be provided either from an onboard database or via a datalink.

Certain "special waypoint" definitions, "leg types," and other criteria are necessary to safely implement landing and rollout operations using satellite systems and other integrated multi-sensor navigation systems. Figure 4.6-1 of the AC shows the minimum set of "special waypoints" and "special leg types" considered necessary to conduct landing and rollout operations in air carrier operations.

The required flight path may be stored in an airplane database for recall and use by the command guidance and/or control system when required to conduct the landing and rollout.

The definition, resolution and maintenance of the waypoints which define the required flight path and flight segments is key to the integrity of this type of landing and rollout operation.

A mechanism should be established to ensure the continued integrity of the flight path designators.

The integrity of any data base used to define flight critical path waypoints for a Landing and Rollout System should be addressed as part of the certification process. The flightcrew shall not be able to modify information in the data base which relates to the definition of the required flight path for the critical portion of final approach through rollout.

5.3.2. GLS/GNSS Airplane Position Determination.

The safety of a low visibility landing and rollout operation is, in part, predicated on knowing where the airplane is positioned relative to the required flight path. Navigation satellite systems exist which can provide position information to specified levels of accuracy, integrity and availability. The accuracy, integrity and availability can be enhanced by additional space and ground based elements. These systems provide certain levels of capability to support present low visibility operations and are planned to have additional future capability.

Satellite systems have the potential to provide positioning information necessary to guide the airplane during landing and rollout. If operational credit is sought for these operations, the performance, integrity and availability must be established to support that operation. Ground based aids such as differential position receivers, pseudolites etc., and a data link to the airplane, may be required to achieve the accuracy, integrity or availability for certain types of operation.

An equivalent level of safety to current ILS based Category III operations should be established.

The role of the satellite based elements in the landing system should be addressed as part of the airplane system certification process until such time as an acceptable national, or international standards, for satellite based systems are established.

Basic GNSS (Unaugmented). This is the basic navigation service provided by a satellite system. No additional elements are used to enhance accuracy or integrity of the operation.

Differential Augmentation. The role of the differential station in the landing system should be addressed as part of the airplane system certification process, unless an acceptable national, or international standard, for the ground reference system is established.

Local Area Differential Augmentation. Local Area Differential (LAD) augmentation consists of a set of ground based GNSS receivers that are used to derive pseudo-range corrections and integrity data referenced to a point on or near the airport. This augmentation data is then provided to the airplane via a local, ground based data broadcast signal.

Wide Area Differential Augmentation. Wide Area Differential (WAD) augmentation is not applicable to Category III, except where used in conjunction with other sensors (e.g., to substitute for DME with ILS).

Typically only LAD systems provide a basis for establishing the necessary position fixing accuracy, integrity and availability for the final portion of a final approach segment or rollout. Unaugmented GNSS or WAD are typically only suited for support of initial or intermediate segments of an approach, final approach to restricted DA(H)s, or missed approach. GNSS or WAD may however be used in conjunction with Category III procedures for applications such as equivalent DME distance, or marker beacon position determination, when authorized by the operating rules.

5.3.3. Datalink. A data link may be used to provide data to the airplane to provide the accuracy necessary to support certain operations (e.g., navigation way points, differential corrections for GNSS).

The integrity of the data link should be commensurate with the integrity required for the operation.

The role of the data link in the landing system will have to be addressed as part of the airplane system certification process until such time as an acceptable U.S., or international standards for data link ground systems are established.

6. AIRWORTHINESS. This section identifies airworthiness requirements including those for performance, integrity, and availability which apply to all types of airplane systems, independent of the type of landing/navigation system used. The definitions of Performance, Integrity and Availability are found in Appendix 1.

The basic airworthiness criteria are intended to be independent of the specific implementation in the airplane or the type of Landing and Rollout system being used. Requirements for touch down performance, landing sink rates and attitudes, etc. (see section 6.3.1. below) are the same for landing systems with automatic flight control, and systems for manual flight control with command information (i.e., flight director) as guidance.

Criteria may be expanded further in later sections of this appendix as it applies to a particular airplane system or architecture.

The types of landing or landing and rollout systems which may be approved are listed in Appendix 3 section 4.

6.1. General. An applicant shall provide a certification plan which describes how any non-aircraft elements of the Landing and Rollout System relate to the aircraft system from a performance, integrity and availability perspective.

The plan for certification shall describe the system concepts and operational philosophy to allow the regulatory authority to determine whether criteria and requirements other than those contained in this appendix are necessary.

The applicant shall apply criteria contained in AC 120-29, as amended, an equivalent foreign standard acceptable to the Administrator, or any other criteria acceptable to the Administrator for the system during approach to at least 100 ft. HAT.

The safety level for automatic landing and rollout, or manual landing and rollout using command information as guidance, may not be less than that achieved by a conventional unguided manual landing using visual reference. In showing compliance with the performance and failure requirements, the probabilities of performance or failure effects may not be factored by the proportion of landings made with the landing and rollout system.

The landing and rollout system performance should be established considering the environmental and deterministic effects which may reasonably be experienced for the type of operation for which certification and operational approval will be sought.

Command information provided as guidance during the landing and rollout should be consistent with a pilot’s manual technique and not require excessive skill or crew workload to accomplish the operation.

For those segments of the flight path where credit is taken for non-automatic systems, acceptable performance of those systems for landing and rollout shall be shown by reference to instruments alone without requiring the use of external visual reference. This requirement is appropriate because the landing rollout may begin off centerline and at higher speed.

Where reliance is placed on the pilot to detect a failure of engagement of a mode when it is selected, and the pilot cannot reliably detect this failure by other means, an appropriate indication or warning must be given.

The transition from automatic control to manual control may not require exceptional piloting skill, alertness or strength.

In the absence of failure or extreme conditions, the behavior of the landing system, and the resulting airplane flight path, shall not be so unusual as to cause a pilot to inappropriately intervene and assume control.

The effect of the failures of the navigation facilities must be considered taking into account ICAO and other pertinent State criteria.

6.2. Approach Systems. The applicant shall establish acceptable approach performance to the criteria contained in AC 120-29, as amended, an equivalent foreign standard acceptable to the Administrator, or any other criteria acceptable to the Administrator.

6.3. Landing and Rollout System Performance. The stable approach (i.e., “normal maneuvering” without excessive attitudes, sink rates, path deviations or speed deviations) should be conducted to the point where a smooth transition is made to the landing.

If the landing system is designed to perform an alignment function prior to touch down, to correct for crosswind effects, it should operate in a manner consistent with a pilot's manual technique for crosswind landings for the aircraft type, typically using the wing low side slip procedure. Non-availability of the alignment mode, or failure of the alignment mode to perform its intended function must be easily detectable, or be suitably annunciated, so that the flightcrew can take appropriate action.

The landing system "landing flare to touch down" maneuver should reduce the airplane sink rate to a value and in a manner that is compatible with a normal flightcrew landing maneuver.

The automatic flight control system should provide de-rotation, consistent with a pilot’s manual technique. Systems which provide rollout guidance for manually controlled rollout are not required to provide de-rotation. Systems which provide de-rotation, automatically or with guidance for manual control, must avoid any objectionable oscillatory motion or nose wheel touch downs, pitch up or other adverse behavior as a result of ground spoiler deployment or reverse thrust operation.

Automatic control during the landing and rollout should not result in any airplane maneuvers which would cause the flightcrew to intervene unnecessarily.

Guidance provided during the landing and rollout should be consistent with a pilot’s manual technique, and not require excessive skill or crew workload to accomplish the operation.

6.3.1. Landing System Performance. All types of low visibility landings systems, including automatic flight control, guidance for manual control, and hybrid, shall be demonstrated to achieve the performance accuracy with the probabilities prescribed in this section. The performance values may vary where justified by the characteristics of the airplane.

The performance criteria and probabilities are as follows:

(a) Longitudinal touch down earlier than a point on the runway 200 ft. (60m) from the threshold to a probability of 1×10^{-6};

(b) Longitudinal touch down beyond 2700 ft.(823m) from threshold to a probability of 1 x 10-6;

(c) Lateral touch down with the outboard landing gear more than 70 ft. (21.3m) from runway centerline to a probability of 1 x 10-6.

(d) Structural limit load, to a probability of 1 x 10-6. An acceptable means of establishing that the structural limit load is not exceeded is to show separately and independently that:

(i) The limit load that results from a sink rate at touch down not greater than 10 f.p.s. or the limit rate of descent used for certification under 14 CFR part 25 subpart C (see section 25.473), whichever is the greater.

(ii) The lateral side load does not exceed the limit value determined for the lateral drift landing condition defined in part 25, section 25.479(d)(2).

(e) Bank angle resulting in hazard to the airplane to a probability of 1×10^{-7}. A hazard to the airplane is interpreted to mean a bank angle resulting in any part of the wing, high lift device, or engine nacelle touching the ground.

6.3.2. Speed Control Performance. Airspeed must be controllable to within +/- five knots of the approach speed*, except for momentary gusts, up to the point where the throttles are retarded to idle for landing. For operations flown with manual control of approach speed, the flightcrew must be able to control speed to within +/- five knots of the approach speed.

***NOTE: This criteria is not specific to low visibility systems, but must be met by low visibility systems.**

6.3.3. Rollout System Performance.

The rollout system, if included, should control the airplane, in the case of an automatic flight control system, or provide command information as guidance to the pilot, for manual control, from the point of landing to a safe taxi speed. The loss of rudder effectiveness, as the airplane speed is reduced, could be a factor in the level of approval which is granted to a system. The applicant should describe the system concept for rollout control so that the absence of low speed control, such as a nose wheel steering system, can be assessed.

Safe Taxi Speed is the speed at which the pilot can safely leave the runway or bring the airplane to a safe stop. The safe taxi speed may vary with visibility conditions, airplane characteristics, and means of lateral control. The performance criteria in this section assume a 150 ft. (45.7m) runway width. The rollout performance limit may be appropriately increased if operation is limited to wider runways.

The rollout system performance is referenced to the centerline of the runway. The intended path for the rollout system is usually defined by an ILS localizer, or other approved approach navigation system, which normally coincides with the runway centerline.

The rollout system should be demonstrated to:

(a) Not cause the outboard tire(s) to deviate from the runway centerline by more than 70 ft. (21.3m)*, starting from the point at which touch down occurs and continuing to a point at which a safe taxi speed is reached, to a probability of 1×10^{-6}.

(b) Capture the intended path or converge on the intended path (e.g., localizer centerline) in a smooth, timely and predictable manner. While a critically damped response is desired, minor overshoots are considered acceptable. Sustained or divergent oscillations or unnecessarily aggressive responses are unsatisfactory.

(c) Promptly correct any lateral movement away from the runway centerline in a positive manner.

(d) Following touchdown, if not already on a converging path, cause the airplane to initially turn and track a path to intercept the runway centerline at a point far enough in front of the airplane that it is obvious to the flightcrew that the rollout system is performing properly. Also, the rollout system should intercept the centerline sufficiently before the stop end of the runway, and before the point at which taxi speed is reached.

***NOTE: 70 ft.(21.3m) deviation from centerline is equivalent to outboard tire(s) at 5 ft. (1.5m) within the edge of a 150 ft. (45.7m) wide runway.**

6.3.4. Variables Affecting Performance. This section identifies the variables to be considered when establishing landing and rollout performance.

The performance assessment shall take into account at least the following variables with the variables being applied based upon their expected distribution:

(a) Configurations of the airplane (e.g., flap/slat settings);

(b) Center of gravity;

(c) Landing gross weight;

(d) Conditions of headwind, tailwind, crosswind, turbulence and wind shear (see Appendix 4 for acceptable wind models);

(e) Characteristics of applicable navigation systems and aid, variations in flight path definitions (ILS, MLS, GLS - ground, airplane and space elements etc.)

(f) Approach airspeed and variations in approach airspeed.

(g) Airport conditions (elevation, runway slope, runway condition).

(h) Individual pilot performance, for systems with manual control.

(i) Any other parameter which may affect system performance.

6.3.5. Irregular Approach Terrain. Approach terrain may affect the performance and pilot acceptance of the Approach and Landing system.

The information on the nominal characteristics of an airport is contained in ICAO Annex 14. This information can be used to characterize the airport environment for nominal performance assessment. However, the system shall be evaluated to determine the performance characteristics in the presence of significant approach terrain variations. At a minimum the following profiles should be examined:

a. Sloping runway - slopes of 0.8%.

b. Hilltop runway - 12.5% slope up to a point 60m prior to the threshold; or

c. Sea-wall - 6m (20 ft.) step up to threshold elevation at a point 60m prior to the threshold.

NOTE: In addition to the profiles described above, examination of the profiles of known airports with significant irregular approach terrain, at which operations are intended, is recommended (see section 5.18 of the AC).

6.3.6. Approach and Automatic Landing with an Inoperative Engine. For demonstration of engine inoperative capabilities, where the approach is initiated, and the landing made, with an inoperative engine, the landing system must be shown to perform a safe landing and, where applicable, safe rollout in this non-normal aircraft condition taking account the factors described in 5.17 and the following:

a. Failure of the critical engine, and for propeller, where applicable, accounting for feathering of the propeller following failure of the critical engine;

b. Appropriate landing flap configurations;

c. Loss of any systems associated with the inoperative engine, e.g., electrical and hydraulic power;

d. Crosswinds in each direction of at least 10 knots;

e. Weight of aircraft.

Whether or not engine out landing approval is sought, the go-around from any point on the approach to touch down must not require exceptional piloting skill, alertness or strength and must ensure that sufficient information is available to determine that the airplane can remain clear of obstacles (see section 6.3.7 below).

6.3.7. Inoperative Engine Information. Information for an operator to assure a successful go-around with an inoperative engine should be provided. The information may be in a form as requested by the operator, or as determined appropriate by the manufacturer. The information may or may not be provided to the operator as part of the AFM. Examples of acceptable information would include the following:

a. Information on height loss as a function of go-around initiation altitude, and

b. Performance information allowing the operator to determine that safe obstacle clearance can be maintained during a go around with an engine failure, or

c. A method to assess and extend applicability of engine inoperative takeoff performance obstacle clearance determinations for a balked landing or go-around event.

6.4. Landing and Rollout System Integrity. The applicant shall provide the certification authority with an overall operational safety assessment plan for the use of systems other than ILS or MLS for "path in space" guidance. This plan shall identify the assumptions and considerations for the non-aircraft elements of the system and how these assumptions and considerations relate to the airplane system certification plan.

The effect of the navigation reference point on the airplane on flight path and wheel to threshold crossing height shall be assessed.

6.4.1. Landing System Integrity. The onboard components of the landing system, considered separately and in relation to other associated onboard systems, should be designed to meet the requirements of section 25.1309, in addition to any specific safety related criteria identified in this appendix.

The following criteria is provided for the application of FAR § 25.1309 to Landing Systems:

Any single malfunction or any combination of malfunctions of the landing system that could prevent a safe landing or go around must be Extremely Improbable, unless it can be detected and annunciated, as a warning to allow pilot intervention to avoid catastrophic results, and shown to be Extremely Remote.

Failure to detect and annunciate malfunctions that could prevent a safe landing or go around must be Extremely Improbable.

The exposure time for assessing failure probabilities for Fail Passive landing systems is the average time required to descend from 100 feet HAT or higher to touchdown, and for Fail Operational landing systems the average time to descend from 200 feet HAT or higher to touchdown.

For a Fail Passive automatic landing system, a single malfunction or any combination of malfunctions must not cause a significant deviation of the flight path or attitude (e.g., hardover) following a system disengagement. The airplane must be safely trimmed, when the system disengages, to prevent these significant deviations.

A Fail Operational automatic landing system, following a single malfunction, must not lose the capability to perform lateral and vertical path tracking, alignment with runway heading (e.g., decrab), flare and touchdown within the safe landing requirements listed below.

Malfunction cases may be considered under nominal environmental conditions.

For the purpose of analysis, a safe landing may be assumed if the following requirements are achieved:

(a) Longitudinal touch down no earlier than a point on the runway 200 ft. (60m) from the threshold,

(b) Longitudinal touch down no further than 3000 ft. (1000m) from the threshold e.g., not beyond the end of the touch down zone lighting,

(c) Lateral touch down with the outboard landing gear within 70 ft. (21m) from runway centerline.

(These values assume a 150 ft. (45m) runway. The lateral touch down performance limit may be appropriately increased if operation is limited to wider runways),

(d) Structural limit load. An acceptable means of establishing that the structural limit load is not exceeded is to show separately and independently that:

(i) The limit load that results from a sink rate at touch down not greater than 10 f.p.s. or the limit rate of descent used for certification under part 25 Subpart C (see section 25.473), whichever is the greater.

(ii) The lateral side load does not exceed the limit value determined for the lateral drift landing condition defined in section 25.479(d)(2).

(e) Bank angle resulting in hazard to the airplane such that any part of the wing or engine nacelle touches the ground.

6.4.2. Rollout System Integrity. The rollout system, if provided shall provide automatic control, or guidance for manual control, to maintain the airplane on the runway to a safe taxi speed on the runway.

The onboard components of the rollout system, considered separately and in relation to other associated onboard systems, should be designed to meet the requirements of section 25.1309, in addition to any specific safety related criteria identified in this appendix.

The following criteria is provided for the application of FAR section 25.1309 to Rollout Systems:

a. A Fail Operational rollout system must meet the safe rollout performance requirements of Appendix 3 section 6.3.3 (i.e., no lateral deviation greater than 70 ft. (21.3m) from centerline) after any single malfunction, or after any combination of malfunctions not shown to be Extremely Remote. Malfunction cases may be considered under nominal environmental conditions.

b. For any rollout system, below 200 ft. HAT, unannunciated malfunctions that would prevent a safe rollout must be shown to be Extremely Improbable.

c. For a fail passive rollout system, the loss of a fail passive automatic rollout function after touchdown shall cause the automatic flight control system to disconnect. The loss of a Fail Passive rollout system after touchdown shall be Improbable. Whenever a fail passive guidance system for manual rollout does not provide valid guidance, an annunciation should be provided to both pilots, and the guidance removed. The removal of guidance, alone, is not adequate annunciation, unless independent information available within the pilot's primary field of view positively indicates the failure. The annunciation must be located to ensure rapid recognition, and must not distract the pilot flying or significantly degrade the forward view.

d. For any rollout system, for malfunctions that only affect low speed directional control (speeds below which rudder is ineffective for steering), rollout system performance should not cause the airplane wheels to exceed the lateral confines of the runway, from the point of touch down to the point at which a safe taxi speed is reached, more often than once in ten million landings. A safe taxi speed is considered to be a speed at which the pilot can resume manual control to safely exit the runway or expeditiously bring the airplane to a safe stop. A safe taxi speed may vary with airplane characteristics and available means of lateral control.

6.4.3. On Board Database Integrity [PoC]. The definition, resolution and maintenance of the waypoints which define the required flight path and flight segments is key to the integrity of this type of landing and rollout operation.

When the required flight path is defined by an on-board database, a mechanism should be established to ensure the continued integrity of the flight path designators.

The integrity of any on board data base used to define flight critical path waypoints for an Landing and Rollout System should be addressed as part of the certification process.

6.5. Landing and Rollout System Availability.

6.5.1. Landing System Availability. Below 500 ft. on approach, the probability of a successful landing should be at least 95% for approach demonstrations conducted in the airplane (i.e., no more than 5% of the approaches result in a go-around, due to the combination of failures in the landing system and the incidence of unsatisfactory performance). Compliance with this requirement typically should be established during flight test, with approximately 100 approaches.

For an airplane equipped with a Fail Passive landing system, the need to initiate a go-around below 100 ft. HAT on approach due to an airplane failure condition should be infrequent (i.e., typically fewer than 1 per 1000 approaches).

For a Fail Operational system, below 200 ft. HAT on approach, the probability of total loss of the landing system (even though appropriate annunciation of system loss is provided) must be Extremely Remote. For any annunciation that is provided, that annunciation must enable a pilot to intervene in a timely manner to avoid a catastrophic result. Total loss of the system without annunciation shall be Extremely Improbable.

6.5.2. Rollout System Availability. For a Fail Passive rollout system, from 200 ft. HAT through landing and rollout to a safe taxi speed, the probability of a successful rollout should be at least 95%, considering loss or failure of the rollout system.

For a Fail Operational rollout system, during the period in which the aircraft descends below 200 ft. HAT to a safe taxi speed, the probability of degradation from Fail Operational to Fail Passive should be infrequent (i.e., fewer than 1 degradation per 1000 approaches), and the probability of total loss of rollout capability should be Extremely Remote, considering loss or failure of the rollout system.

After touch down, complete loss of the Fail Operational automatic rollout function, or any other unsafe malfunction or condition, shall cause the automatic flight control system to disconnect. The loss of a Fail Operational rollout system after touch down shall be Extremely Remote.

6.6. Go-Around. The aircraft must be capable of safely executing a go-around from any point on the approach to touch down in all configurations to be certificated. The maneuver may not require exceptional piloting skill, alertness or strength.

a. A go-around from a low altitude may result in inadvertent runway contact, therefore the safety of the procedure should be established giving consideration to at least the following:

1) The automatic control and guidance produced by the go-around mode, if such a mode is provided, should be retained and be shown to have safe and acceptable characteristics throughout the maneuver,

2) Other systems (e.g., automatic throttle, brakes, spoilers and reverse thrust) should not operate in a way that would adversely affect the safety of the go-around maneuver.

b. Inadvertent selection of go-around mode after touch down should have no adverse effect on the ability of the aircraft to safely roll out and stop.

c. Height loss should be assessed to assure expeditious go-around from a range of altitudes during the approach and flare when under automatic control and when using the landing guidance system, as appropriate, and as follows:

1) Height loss may be assessed by flight testing (typically 10 go-arounds) supported by simulation.

2) The simulation should evaluate the effects of variation in parameters, such as weight, center of gravity, configuration and wind, and show correlation with the flight test results.

3) Normal procedures for a go-around for the applicable configuration should be followed. If engine-inoperative capability is sought, and use of the go-around mode is applicable to those operations, an assessment of the engine-inoperative go-around is necessary.

6.7. Automatic Braking System. If automatic braking is used for credit under section 5.16 of this AC, then the following apply:

a. The automatic braking system should allow anti-skid protection and have manual reversion capability. An automatic braking system should provide smooth and continuous deceleration from touch down until the airplane comes to a complete stop on the runway and provide:

1) Disconnect of the autobrake system must not create unacceptable additional crew workload or crew distraction from normal rollout braking.

2) Normal operation of the automatic braking system should not interfere with the rollout control system. Manual override of the automatic braking system must be possible without excessive brake pedal forces or interference with the rollout control system. The system should not be susceptible to inadvertent disconnect.

3) A positive indication of system disengagement and a conspicuous indication of system failure should be provided.

4) No malfunction of the automatic braking system should interfere with either pilots use of the manual braking system.

b. The demonstrated wet and dry runway braking distances, for each mode of the automatic braking system, should be determined in a manner consistent with part 121, section 121.195 (d) of 14 CFR and presented in the airplane flight manual as performance information.

6.8. Flight Deck Information, Annunciation and Alerting. This section identifies information, annunciations and alerting requirements for the flight deck.

The controls, indicators and warnings must be designed to minimize crew errors which could create a hazard. Mode and system malfunction indications must be presented in a manner compatible with the procedures and assigned tasks of the flightcrew. The indications must be grouped in a logical and consistent manner and be visible under all expected normal lighting conditions.

6.8.1. Flight Deck Information. This section identifies requirements for basic situation and command information.

For manual control of approach, landing and rollout flight path, the primary flight display(s), whether head down or head up, must provide sufficient information to enable a suitably trained pilot to maintain the approach path, to make the alignment with the runway, flare and land the airplane within the prescribed limits or to make a go-around without excessive reference to other cockpit displays.

Sufficient information should be provided in the flight deck to allow the pilots to monitor the progress and safety of the landing and rollout operation, using the information identified above and any additional information necessary to the design of the system.

Required in flight performance monitoring capability includes at least the following:

1) Unambiguous identification of the intended path for the approach, landing and rollout, (e.g., ILS/MLS/GLS approach identifier/frequency, and selected navigation source)

2) Indication of the position of the aircraft with respect to the intended path (e.g., situation information localizer and glide path, or equivalent).

6.8.2. Annunciation. A positive, continuous and unambiguous indication must be provided of the modes actually in operation, as well as those which are armed for engagement. In addition, where engagement of a mode is automatic (e.g., localizer and glide path acquisition), clear indication must be given when the mode has been armed by either action of a member of the flightcrew, or automatically by the system (e.g., a pre-land test - LAND 3).

6.8.3. Alerting. Alerting requirements are intended to address the need for warning, caution and advisory information for the flightcrew.

6.8.3.1. Warnings. FAR/JAR 25.1309 requires that information must be provided to alert the crew to unsafe system operating conditions to enable the crew to take appropriate corrective action. A warning indication must be provided if immediate corrective action is required. An analysis should be performed to consider crew alerting cues, corrective action required, and the capability of detecting faults.

Warnings must be given without delay, be distinct from all other cockpit warnings and provide unmistakable indication of the need for the flightcrew to take immediate corrective action. Aural warnings must be audible to both pilots under typically assumed worst case ambient noise conditions, but not so loud and intrusive as to interfere with the crew taking the required corrective action or readily accomplishing crew coordination. Visual warnings, such as lights or alphanumeric messages, must be distinct and conspicuously located in the primary field of view for both pilots.

After beginning final approach (e.g., typically prior to reaching 1000' HAT), the loss of a Fail Passive or Fail Operational system, shall be annunciated. Whenever a Fail Passive system, for manual control, does not provide valid guidance, it shall be indicated by a positive and unmistakable warning to both pilots, and the guidance removed. The removal of guidance, alone, is not adequate annunciation. The annunciation must be located to ensure rapid recognition, and must not distract the pilot flying or significantly degrade the forward view.

6.8.3.2. Cautions. A caution is required whenever immediate crew awareness is required and timely subsequent crew action may be required. A means shall be provided to advise the flightcrew of failed airplane system elements that affect the decision to continue or discontinue the approach.

a. After initiation of final approach (which typically occurs at or above 1000' HAT), a Fail Passive landing system, or landing and rollout system, shall alert the flightcrew to any malfunction or condition that would adversely affect the ability of the system to safely operate or continue the approach or landing.

b. After initiation of final approach (which typically occurs at or above 1000' HAT), a Fail Passive command guidance system (e.g., head-up- display (HUD) guidance), shall provide a clear, distinct and unmistakable indication to alert each pilot to any malfunction or condition that would adversely affect the ability of the system to safely operate or continue the approach or landing.

c. After initiation of final approach (which typically occurs at or above 1000' HAT), but above the airworthiness demonstrated Alert Height, a Fail Operational landing system or landing and rollout system (with either Fail Operational or Fail Passive rollout) shall alert the flightcrew to:

1) Any malfunction or condition that would adversely affect the ability of the system to safely operate or continue the approach or landing, and

2) Any malfunction that degrades the landing system from a Fail Operational to a Fail Passive landing system.

d. Below the airworthiness demonstrated Alert Height and throughout rollout, a Fail Operational landing systems shall inhibit alerts for malfunctions that degrade landing system capability from Fail Operational to Fail Passive status.

e. Deviation alerting - The FAA expects the flightcrew to monitor flight path deviations as indicated on the primary flight instruments, and does not require automatic alerting of excessive deviation. Nonetheless, FAA may approve systems which meet alternate appropriate criteria for deviation alerting (e.g., JAR/AWO). If a method is provided to detect excessive deviation of the airplane, laterally and vertically during approach to touch down and laterally after touch down, then it should not require excessive workload or undue attention. This provision does not require a specified deviation alerting method or annunciation, but may be addressed by parameters displayed on the ADI, EADI, HUD, or PFD. When a dedicated deviation alerting method is provided, its use must not cause excessive nuisance alerts.

f. For systems demonstrated to meet JAA criteria, compliance with the following criteria, from JAR-AWO 236, is an acceptable means of compliance, but is not a required means of compliance:

1) For systems meeting the JAR-AWO 236 criteria, excess-deviation alerts should operate when the deviation from the ILS, MLS, or GLS glide path or localizer centerline exceeds a value from which a safe landing can be made from offset positions equivalent to the excess-deviation alert, without exceptional piloting skill and with the visual references assumed to be available in these conditions.

2) For systems meeting the JAR-AWO 236 criteria, excess-deviation alerts should be set to operate with a delay of not more than one (1) second from the time that the deviation thresholds are exceeded.

3) For systems meeting the JAR-AWO 236 criteria, excess-deviation alerts should typically be active at least from 300 ft. (90m) HAT to 50 ft. HAT, but the glide path deviation alert may be discontinued below 100 ft. (30m) HAT.

6.8.3.3. Advisories. A means shall be provided to inform the flightcrew when the airplane has reached the operational Alert Height or Decision Height, as applicable.

6.8.3.4. System Status. A means should be provided for the operator and flightcrew to determine prior to departure and the flightcrew to determine after departure, the capability of the airplane elements to accomplish the intended low visibility operations. While en route, the failure of each airplane component adversely affecting the capability to conduct the intended landing operation should be indicated to the flightcrew as an advisory.

A means should be provided to advise the flightcrew of failed airplane system elements relating to landing system capability which otherwise could adversely affect a flightcrew's decision to use particular landing minima (e.g., adversely affect a decision to continue to a destination or divert to an alternate).

If multiple landing system capability is installed (e.g., MMR), then during approach, an indication of a failure in each non-selected airplane landing system element (e.g., an MLS or GLS receiver failure during conduct of an ILS approach) should be made available to the flightcrew as an indication of system status. Such failures or non-availability, however, should not produce a caution or warning if they are not relevant to the system in use.

System Status indications should be typically identified by names that are different than operational authorization categories (e.g., annunciations such as "LAND 3," or "DUAL" may be used). System or configuration status annunciations which may change over time as operational criteria change, or could be confusing or ambiguous if the flightcrew, operator, operation, runway or aircraft are otherwise constrained or found eligible for a particular minima or operation, should typically not be used (e.g., system or configuration annunciations such as "CAT I", "CAT II", or "CAT III" should typically not be used for new designs).

6.9. Multiple Landing Systems. International agreements have established a number of landing systems as being acceptable means to conduct instrument approach and landing. This section identifies requirements which relate to airplane systems which provide the capability to conduct approach and landing operations using these multiple landing systems (e.g., ILS, MLS, GLS).

6.9.1. General. Where practicable, the flight deck approach procedure should be the same irrespective of the navigation source being used.

A means (for example the current ILS facility identification) should be provided to confirm that the intended approach aid(s) has been correctly selected;

6.9.2. Indications. The following criteria apply to indications in the flight deck for the use of a multi-mode landing system:

The primary flight display shall indicate deviation data for the selected landing system.

The loss of deviation data shall be indicated on the display. It is acceptable to have a single failure indication for each axis common to all navigation sources.

6.9.3. Annunciations. The following criteria applies to annunciations in the flight deck when using a multi-mode landing system.

The navigation source (e.g., ILS, MLS, GLS, FMS) selected for the approach shall be positively indicated in the primary field of view at each pilot station;

The data designating the approach (e.g., ILS frequency, MLS channel, GLS 'channel') shall be unambiguously indicated in a position readily accessible and visible to each pilot;

A common set of ARM and ACTIVE mode indications (e.g., LOC and GS) is preferred for ILS, MLS and GLS operations;

A means must be provided for the crew to determine a failure of the non-selected navigation receiver function, in addition to the selected navigation receiver function. When considering equipment failures, the failure indications must not mislead through incorrect association with navigation source. For example, it would not be acceptable for the annunciation "ILS FAIL" to be displayed when the selected navigation source is MLS and the failure actually affects the MLS receiver;

6.9.4. Alerting. Flight operations may require planning to alternate destination runways or alternate airports for takeoff, en route diversion and landing. Various runways at these airports may have different landing systems. Thus, flight operations may be planned, released and conducted on the basis of using one or more landing systems.

Accordingly, the ability to determine the capability of each element of a multi-mode landing system should be available to the flightcrew to support flight planning.

A failure of a non-selected landing mode (i.e., ILS, MLS, GLS) shall be indicated to the flightcrew as an advisory if it has been determined that the mode is not available or will not be available for use during the next approach and landing.

A failure of the active element of a multi-mode landing system during an approach shall be accompanied by a warning, caution, or advisory, as appropriate.

An indication of a failure in each non-selected element a multi-mode landing system shall be available to the flightcrew as an advisory but should not produce a caution or warning. Such advisories may be inhibited during takeoff, below Alert Height, and at other times as determined necessary or appropriate for the alerting system and flight deck design philosophy of the aircraft type.

7. Landing and Rollout System Evaluation. An evaluation should be conducted to verify that the pertinent systems as installed in the airplane meet the airworthiness requirements of section 6 of this appendix. The evaluation should include verification of landing and rollout system performance requirements and a safety assessment for verification of the integrity and availability requirements. Engine failure cases and other selected failure conditions identified by the safety assessment should be demonstrated by simulator and /or flight tests.

An applicant shall provide a certification plan which describes:

a) The means proposed to show compliance with the requirements of section 6 of this appendix, with particular attention to methods which differ significantly from those described in this appendix.

b) How any non-airplane elements of the Landing and Rollout System relate to the airplane system from a performance, integrity and availability perspective.

c) The assumptions on how the performance, integrity and availability requirements of the non-airplane elements will be ensured.

d) The system concepts and operational philosophy to allow the regulatory authority to determine whether criteria and requirements in excess of that contained in this appendix are necessary.

Early agreement between the applicant and the FAA should be reached on the proposed certification plan. Upon completion of an FAA engineering design review and supporting simulation studies, a type inspection authorization (TIA) should be issued to determine if the complete installation of the equipment associated with Category III operations meets the criteria of this appendix.

7.1. Performance Evaluation. The performance of the airplane and its systems must be demonstrated by either flight test or by analysis and simulator tests supported by flight test. Flight testing must include a sufficient number of normal and non-normal approaches conducted in conditions which are reasonably representative of actual expected conditions and must cover the range of parameters affecting the behavior of the airplane (e.g., wind speed, NAVAID (e.g., ILS) characteristics, airplane configurations, weight, center of gravity, non-normal events).

The performance evaluation must verify that the Landing and Rollout System meets the performance requirements of sections 6.1, 6.2, and 6.3 and sub-sections of this appendix. The tests must cover the range of parameters affecting the behavior of the airplane (e.g., airplane configurations, weight, center of gravity, non-normal events) when the airplane encounters the winds described by either of the models in Appendix 4, or other model found acceptable by the Administrator, and the variations in flight path determination associated with the sensors used by the Landing and Rollout system. Flight testing must include a sufficient number of normal and non-normal approaches conducted in conditions which are reasonably representative of actual expected conditions.

The reference speed used as the basis for certification should be identified. The applicant should demonstrate acceptable performance within a speed range of -5 to +10 knots with respect to the reference speed, unless otherwise agreed by the FAA and the applicant. The reference speed used as the basis for certification should be the same as the speed used for normal landing operations, including wind and other environmental conditions.

The applicant shall demonstrate that the landing and rollout system does not exhibit any guidance system or control characteristics during the transition to rollout which would cause the flightcrew to react in an inappropriate manner (e.g., during nose wheel touch down, spoiler extension, initiation of reverse thrust).

Landing systems for manual control with guidance must meet the same requirements for touch down footprints, sink rates and attitude as automatic landing systems.

The landing and rollout system shall be shown to be satisfactory with and without the use of any outside visual references, except that outside visual references will not be considered in assessing path tracking and touch down performance. The airworthiness evaluation will also determine whether the combination of guidance and outside visual references would unacceptably degrade task performance, require excessive pilot compensation or workload during normal and non-normal operations.

For the purpose of the airworthiness demonstration, the operational concept for coping with the loss of guidance may assume the presence of adequate outside visual references for the flightcrew to safely continue the operation. The airworthiness demonstration should include the loss of guidance to show there are otherwise no adverse system effects.

For rollout systems for manual rollout with guidance, it shall be demonstrated that a safe rollout can be achieved with a Satisfactory level of workload and pilot compensation following a failure. Workload and task compensation may be assessed using the FAA Handling Quality Rating System (HQRS) found in AC 25-7A, as amended, or equivalent, with and without external visual reference. Rollout guidance must be demonstrated without external visual reference to show that a pilot can satisfactorily perform the lateral tracking task with the guidance alone. Rollout guidance must also be demonstrated with external visual reference to show that the combination of guidance and visual reference is compatible and does not unacceptably degrade task performance, require excessive pilot compensation or workload during normal and non-normal operations.

For the evaluation of low visibility systems for manual control with guidance for landing or rollout, the set of subject pilots provided by the applicant should have relevant variability of experience (e.g., experience with or without HUD, Captain or First Officer (F/O) crew position experience as applicable, and experience in type). Subject pilots must not typically have special experience that invalidates the test (e.g., pilot's should not have special recent training to cope with HUD failures, beyond that which a line pilot would be expected to have for routine operation). The set of pilots provided by the certifying authorities may have experience as specified by the authority appropriate to the test(s) to be conducted. The experience noted above for authority subject pilots or evaluation pilots may or may not be applicable or appropriate for the tests to be conducted.

Failure cases should typically be spontaneous and unpredictable on the subject's or evaluation pilot's part.

For the initial certification of a landing and rollout system for manual control with guidance (e.g., HUD guidance system) in a new type airplane or new type HUD installation, at least 1,000 simulated landings and at least 100 actual aircraft landings is typically necessary. For evaluation of these systems, individual pilot performance should also be considered as a variable affecting performance, see section 6.3.4. As described in the paragraph above, subject pilots of varying background and experience level should be used in the flight and simulation programs. Subject pilots should have appropriate qualifications and, when applicable, be trained in the use of the landing system in a manner equivalent to that expected for pilots who will use the system in operational service.

For data collection tests, after a significant number of consecutive approaches (e.g., 10 approaches), subject pilots should be afforded the opportunity for an appropriate rest break.

7.1.1. High Altitude Automatic Landing System Demonstration.

The following describes an acceptable means to demonstrate performance of automatic landing systems at high altitude with a combination of flight test results and validated simulation. The airport elevation at which satisfactory performance of an automatic landing system has been demonstrated by this method, may then be documented in the Airplane Flight Manual (AFM). The flight test demonstration is considered the primary source of data, which can then be supplemented with data from a validated simulation.

The minimum required altitude or elevation for the flight test which is used to demonstrate a desired AFM Elevation Value, by this method, is shown in Figure 7.1.1-1 and the accompanying table, below. For example, the applicant may document an AFM Elevation Value of 8,000 ft., by a successful flight demonstration at 8,000 ft., or by a flight demonstration at a minimum elevation of 5,000 ft. with a simulation to the desired 8,000 ft. Note, the lines in Figure 7.1.1-1 converge at 11,000 ft, which indicates that credit for simulation is not available at 11,000 ft or above.

The atmospheric temperature and pressure during the flight test, for either method, should not be more favorable than International Standard Atmosphere (ISA) conditions, to ensure that the density altitude is not less than the airport elevation. When the density altitude value of the flight test is less than the airport elevation, then the density altitude value should be used as the effective Flight Test Demonstrated Elevation, and this will decrease the maximum AFM Elevation Value.

Assuring acceptable autoland performance at high altitude by using a flight test validated simulation requires a sufficient quantity of flight test data. Flight test data should be obtained from approximately 10-15 landings at a Flight Test Demonstrated Elevation shown in Figure 7.1.1-1. For flight validation, the test airplane should be equipped with instrumentation to measure and record:

1) The airplane's trajectory, using an acceptably accurate method, such as by a differential global positioning system (DGPS) receiver, a laser optical tracker, a calibrated camera, or other equivalent method.

2) Touchdown vertical velocity and runway touchdown point, expressed in suitable units and coordinates.

3) Glideslope and Localizer signal deviations.

4) Airplane state parameters as necessary, including relevant powerplant and flight control, information.

5) Relevant Autopilot, autothrottle, and/or HUD guidance system parameters and performance.

6) Atmospheric conditions at the airport at the time of each approach, including temperature, barometric pressure (QNH), mean wind velocity and direction.

The simulation should be validated through comparison of simulation data with quantitative flight test measurements. Time histories of the airplane and systems performance in the approach, flare, touchdown, rollout and go-around flight phases, for flight tests at the Flight Test Demonstration Elevation should be compared with corresponding simulation results. The comparison between the flight test data and the simulation data should show that the two are consistent at corresponding altitudes.

Acceptable autoland performance at the selected AFM Elevation may then be based on validated simulation results, within the acceptable extrapolation range for flight test data shown in Figure 7.1.1-1. To assure acceptable autoland performance in a range of altitudes and atmospheric conditions up to and including the selected AFM Elevation, the simulation should include variation in atmospheric conditions at least as listed below. A sensitivity analysis should be conducted to assure that performance is not unsafe near any limits.

Unless otherwise found acceptable to the FAA, simulation cases should typically include the following:

a) Temperatures ranging from International Standard Atmosphere (ISA) value to ISA +40C.

b) Barometric pressure ranging from ISA value for that elevation to ISA -50 hPa.

c) Mean wind variations, including:

- headwinds to at least 25 knots
- crosswinds to at least 15 knots
- tailwinds to at least 10 knots

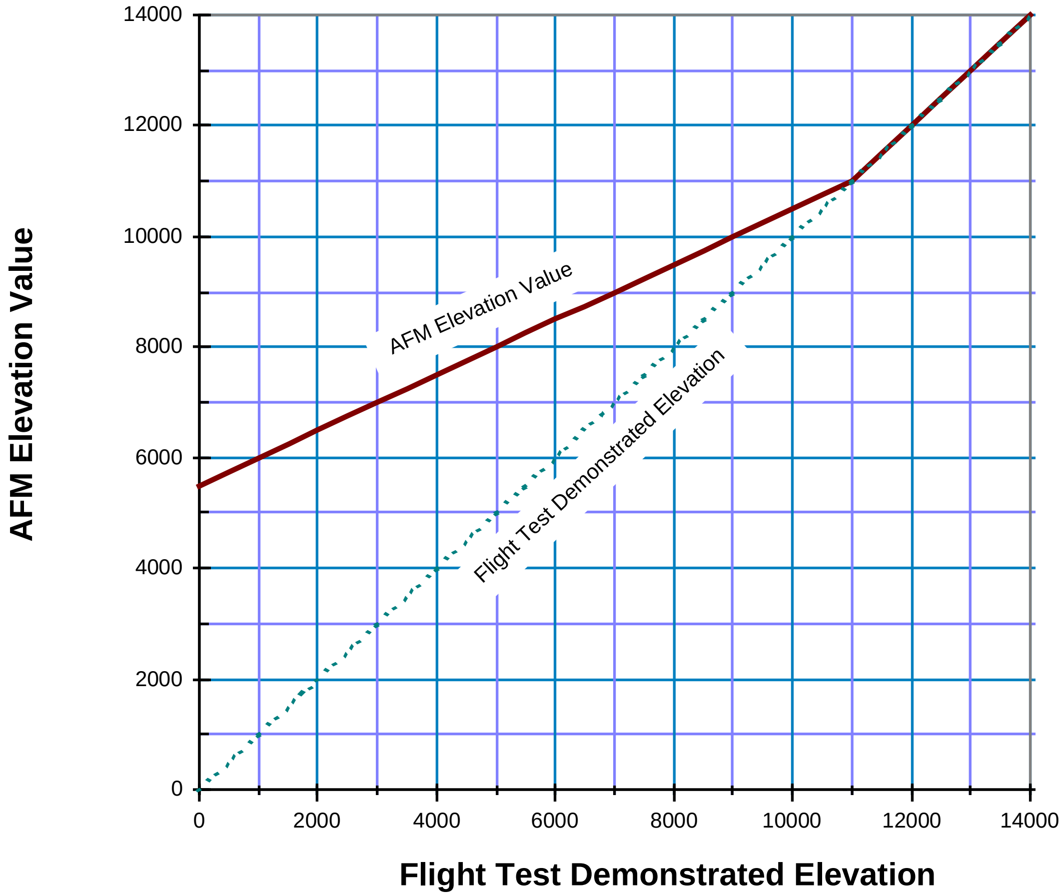


FIGURE 7.1.1-1: AFM ELEVATION VALUE FROM FLIGHT TEST AND VALIDATED SIMULATION

TABLE 7.1.1-1: EXAMPLE AFM ELEVATION VALUES

Flight Test Demonstration Airport Elevation (feet above mean sea level)	Airport Elevation Value Which May Be Listed in the AFM (feet above mean sea level)
1,000	6,000
2,000	6,500
3,000	7,000
5,000	8,000
7,000	9,000
9,000	10,000
11,000	11,000

7.1.2. Validation of Simulators for Pilot-in-the-Loop Systems. The certification process for a "Pilot-in-the-Loop" system intended for Category III typically requires use of a high fidelity, engineering quality simulation.

Advisory Circular (AC) 120-40B (7/29/91) Airplane Simulator Qualification, as amended, provides a means to qualify simulators for qualification of pilots. Meeting these requirements provides a known basis for acceptance of simulation capability, and is desirable, but may not necessarily be sufficient to meet the requirements of an engineering simulation to demonstrate landing system performance.

Training simulators may not have suitable fidelity in each relevant area, and may not be acceptable for use without modification. For purposes of system airworthiness demonstration, meeting the requirements of AC 120-40B is optional. Meeting the criteria of this AC provides an acceptable basis for establishing certification simulation capability.

When simulation is used for demonstration of manual "pilot-in-the-loop" systems with guidance, suitable simulation fidelity should be addressed for at least each critical characteristic affecting the validity of the simulation. An acceptable simulation should typically be capable of varying one parameter at a time, and be able to facilitate examination of the effects of specific wind, wind gradient, and turbulence conditions on approach and landing performance.

Factors of the simulation to be considered include the following:

- Guidance and control system interfaces
- motion base suitability
- "ground effect" aerodynamic characteristics
- wind/turbulence model suitability and adequacy of interface with the simulation
- suitability of landing gear and ground handling dynamics
- adequacy of stability derivative estimates used
- adequacy of any simplification assumptions used for the equations of motion;
- fidelity of flight controls and consequent simulated aircraft response to control inputs
- fidelity of the simulation of aircraft performance
- suitability of the simulation for alignment, flare, and rollout control tasks for any normal or non-normal configurations or disturbance conditions to be assessed
- adequacy of flight deck instruments and displays
- adequacy of simulator and display transient response to disturbances or failures (e.g., engine failure, autofeather, electrical bus switching)
- visual reference availability, fidelity, and delays
- suitability of visibility restriction models such as appropriate calibration of visual references for the tests to be performed for day, night, and dusk conditions as necessary
- ability to simulate flight deck visual cutoff angles
- ability to simulate fog, rain, snow or patchy or intermittent conditions or external visual runway, lighting, marking or nearby terrain scenes as necessary, or
- fidelity of any other significant factor or limitation relevant to the validity of the simulation.

For airworthiness certification credit, a review of the simulation, on a case by case basis, must address at least the following factors:

1) Simulation fidelity relevant to landing system assessment,

2) Stability derivatives, equation of motion assumptions, and relevant ground effect and air and ground dynamic models used,

3) Adequacy of the source of aerodynamic performance and handling quality data used,

4) Visual system fidelity and configuration,

5) Environmental models and methods of model input to the equations of motion, including suitable incorporation of altitude and atmospheric temperature effects,

6) Adequacy of adverse weather models (e.g., visual reference models, runway friction), and

7) Adequacy of irregular terrain models.

A suitably high degree of fidelity is required in each relevant component part of the simulation including: longitudinal, lateral and directional stability (static and dynamic), ground effect during takeoff or landing as applicable, rollout dynamic characteristics, propulsion system characteristics, (especially for turbo-propeller aircraft which have may have significant lift from thrust effects, and drag transient effects due to engine failure), flying qualities, display or visual system capability as it affects tracking tasks, force characteristics of flight controls (e.g., yoke/wheel, rudder, brakes), and performance of the airplane. The fidelity of the simulator may be demonstrated using matching time histories and ensemble touchdown footprint correlation obtained from flight test. The data provided to validate the simulation and the simulation data, itself, will be included as part of the type certification data package.

7.1.3. Simulations for Automatic System Performance Demonstration.

The certification process for systems intended for assessment of automatic systems for Category III operations (e.g., automatic landing systems, automatic landing and rollout systems) typically require the use of a high fidelity "fast-time" simulation.

For airworthiness certification credit, a review of the simulation, on a case by case basis, must address at least the following factors:

1) Simulation fidelity relevant to landing system assessment,

2) Stability derivatives, equation of motion assumptions, and relevant ground effect and air and ground dynamic models used,

3) Adequacy of the source of aerodynamic performance and handling quality data used,

4) Disturbance input method(s) and fidelity,

5) Environmental models and methods of model input to the equations of motion, including suitable incorporation of altitude and atmospheric temperature effects,

6) Adverse weather models (e.g., turbulence, wind gradients, wind models), and

7) Adequacy of irregular terrain models.

Fidelity of the aerodynamic model is needed for at least ground effect, propulsion effects, touch down dynamics, de-rotation, and landing gear models if required for ground rollout characteristics. The fidelity of the simulator may be demonstrated using matching time histories obtained from flight test. The data provided to validate the simulation and the simulation data, itself, will be included as part of the type certification data package.

7.1.4. Flight Test Performance Demonstration. A flight test performance demonstration should be conducted, in part, to confirm the results of simulation. A test airplane equipped with special instrumentation can be used to record the necessary flight test data, for subsequent correlation of flight test results with simulation results. Comparisons should address flight test data, "Monte Carlo simulation" results, and failure demonstration simulation results.

The principal performance parameters to be addressed include, as applicable: vertical and lateral flight path tracking with respect to the intended path (e.g., localizer error, glideslope error, lateral deviation from runway centerline during rollout); altitude and height above terrain during approach or the runway; air data vertical speed and radar altitude sink rate; airspeed and ground speed; and longitudinal and lateral runway touchdown point.

Instrumentation capable of appropriate sample rates and scaling should be used to record relevant parameters (as a function of time, when applicable) including: air data parameters (e.g., airspeed, angle of attack, temperature); aircraft position; attitude; heading; track; velocity and velocity errors (e.g., ground speed, speed error), relevant accelerations; pilot control inputs and resulting surface positions, command information (i.e., flight director), sink rate at touch down (for structural limit load); drift angle at touch down (for gear/tire load); applicable mode and mode transition information (e.g., flare, autothrottle retard, rollout engage); wind as measured at the airplane; a method to determine any unusual aircraft contact with the runway (e.g., wing, nacelle or tail skid ground contact); and reported surface winds and gusts near the runway, at the time of approach and landing.

Data taken during demonstration flight tests should be used to validate the simulation(s). Unless otherwise agreed by FAA, the objective of a flight test program should be to demonstrate performance of the system to 100% of the steady state wind limit values (e.g., typically at least a 25 kt headwind, 15 kt crosswind, and 10 kt tailwind) that are used in the simulation statistical performance analysis. The simulation can be considered validated if at least four landings are accomplished during flight test at no less than 80% of the intended limit steady state wind value, and a best effort has been made to achieve the full steady state wind component values. It must be shown that the landing system is sufficiently robust near the desired AFM wind demonstrated values.

7.1.5. Demonstration of Approach and Landing with an Inoperative Engine.

The applicant may optionally demonstrate the low visibility landing system with an inoperative engine, and, accordingly, the Airplane Flight Manual (AFM) may state what capability has been satisfactorily demonstrated. With the critical engine inoperative, the applicant may demonstrate the capability to “initiate” and complete the approach and landing. Alternatively, the applicant may demonstrate the capability to “continue” the approach and landing, following failure of the critical engine at any point above the Alert Height or Decision Height.

Provisions of section 5.17 of this AC apply to these demonstrations, as do provisions of this appendix related to landing and rollout performance. The applicant should identify the critical engine, if any, considering any steady state or transient effects on performance, handling, loss of systems, and landing mode status (e.g., alignment, flare, rollout). Individual engines may be critical for different reasons.

If the airplane configuration, procedures or operation are the same as that used in the performance demonstration of section 6.3.1 of this appendix for all-engine operation, compliance may be demonstrated by, typically, 10 to 15 landings. If there are differences in these airplane configurations, procedures or operations, the number of required landings will be determined by FAA, on a case by case basis.

If the airplane configuration, procedures or operation is changed significantly from the all-engine operating case, compliance must typically be demonstrated by statistical analysis of Monte-Carlo simulation results supported by flight test. Any effect on configuration or landing distance must be considered.

To aid planning for landing with an inoperative engine, or engine failure during approach or go-around, appropriate procedures, performance, and obstacle clearance information should be available to permit an operator to provide for a safe go-around at any point in the approach to touchdown. For the purposes of this requirement, demonstration or data regarding landing and go-around performance in the event of a second engine failure need not be considered.

If compliance for the case of initiation or continuation of an approach with engine failure is intended, a statement shall be included in the Non-normal Procedures, or equivalent section of the Flight Manual. The flight manual should note that approach and landing with an engine inoperative has been satisfactorily demonstrated. The AFM should list the relevant configuration and conditions under which that demonstration was made (see Appendix 3 section 9, and Appendix 6, regarding sample AFM provisions).

7.2. Safety Assessment. In addition to any specific safety related criteria identified in this appendix, a safety assessment of the Landing and Rollout system, considered separately and in conjunction with other systems, shall be conducted to meet the requirements of section 25.1309.

The safety level for an automatic landing and rollout system, or manual landing and rollout system with command information as guidance, should not be less than that typically achieved during a conventional manual landing accomplished by a pilot using a combination of external visual reference and flight instruments. Hence, in showing compliance with the performance and failure requirements, the probabilities of performance or failure effects may not be factored by the proportion of landings made using the landing and roll out system.

In showing compliance with airplane system performance and failure requirements, the probabilities of performance or failure effects may also not be factored by the proportion of approaches which are made in low visibility conditions.

The effect of the failure of navigation facilities must be considered taking into account ICAO and other pertinent State criteria.

Documented conclusions of the safety analysis shall include:

a. A summary of results from the fault tree analysis, demonstrated compliance, and probability requirements for significant functional hazards.

b. Information regarding "alleviating flightcrew actions" that were considered in the safety analysis. This information should list appropriate alleviating actions, if any, and should be consistent with the validation conducted during testing. If alleviating actions are identified, the alleviating actions should be described in a form suitable to aid in developing, as applicable:

1) Pertinent provisions of the airplane flight manual procedures section(s), or

2) Flight Crew Operating Manual (FCOM) provisions, or equivalent, or

3) Pilot qualification criteria (e.g., training requirements, FSB provisions), or

4) Any other reference material necessary for an operator or flightcrew to safely use the system.

c. Information to support preparation of any maintenance procedures necessary for safety, such as:

1) Certification maintenance requirements (CMR),

2) Periodic checks, or

3) Other checks, as necessary (e.g., return to service).

d. Information applicable to limitations, as necessary.

e. Identification of applicable systems, modes or equipment necessary for use of the landing system, to aid in development of flight planning or dispatch criteria, or to aid in development of procedures or checklists for pilot selection of modes or assessment of system status, prior to initiation of approach or during approach.

f. Information necessary for development of Non-normal procedures.

8. AIRBORNE SYSTEMS. The airborne system should be shown to meet the performance, integrity and availability requirements identified in this AC, as applicable to the type(s) of operation(s) intended. In addition, airborne systems intended for use for Category III approach and landing, or approach, landing and rollout shall comply with the pertinent sections of this appendix and the specific requirements which follow.

8.1. Automatic Flight Control Systems. When established on a final approach path below 1000 ft. HAT, it must not be possible to change the flight path of the airplane with the automatic pilot(s) engaged, except by initiating an automatic go-around.

It must be possible to disengage the automatic landing system at any time without the pilot being faced with significant out-of-trim forces that might lead to an unacceptable flight path disturbance.

It must be possible for each pilot to disengage the automatic landing system by applying a suitable force to the control column, wheel, or stick. This force should be high enough to preclude inadvertent disengagement, and low enough to be applied with one hand, but not as low as those described in section 25.143.

Following a failure or inadvertent disconnect of the automatic pilot, or loss of the automatic landing mode, when it is necessary for a pilot to immediately assume manual control, a visual alert and an aural warning must be given. This warning must be given without delay and be distinct from all other cockpit warnings. Even when the automatic pilot is disengaged by a pilot, a warning must sound for a period long enough to ensure that it is heard and recognized by that pilot and by other flightcrew members. The warning should continue until silenced by one of the pilots using an automatic pilot quick release control, or is silenced by another acceptable means. For purposes of this provision, an automatic pilot quick release control must be mounted on each control wheel or control stick.

8.2 Autothrottle Systems. The following criteria apply to an autothrottle system when used with a low visibility landing system, if an autothrottle is provided.

a. An automatic landing system must include automatic control of throttles to touch down unless it can be shown that:

1) Airplane speed can be controlled manually without excessive workload, in representative conditions for which the system is intended and as demonstrated; and

2) For manual control of throttles, the touch down performance limits must be achieved both for normal autopilot operations and applicable non-normal operations (e.g., engine failure, as applicable; during pilot takeover to manual control using HUD guidance, if part of a hybrid system).

b. An automatic throttle system must provide safe operation taking into account the factors listed in Appendix 3, section 7.1 Landing and Rollout Criteria. Additionally, the system should:

1) Adjust throttles to maintain airplane speed* within acceptable limits;

***NOTE: The approach speed may be selected manually or automatically. If automatically selected, each pilot must be able to determine that the aircraft is flying an appropriate speed.**

2) Provide throttle application at a rate consistent with the recommendations of the appropriate engine and airframe manufacturers,

3) Modulate thrust or throttle application at a rate consistent with, and with activity consistent with typical pilot expectation, considering speed error to be corrected, and any particular conditions or circumstances (e.g., flare retard, go-around thrust application, response to wind gradients), and

4) Respect maximum limits, minimum limits, and any limits necessary for specific conditions (e.g., anti-ice, approach idle).

c. An indication of pertinent automatic throttle system engagement must be provided.

d. An appropriate alert or warning of automatic throttle failure must be provided.

e. It must be possible for each pilot to override the automatic throttle (when provided) without using excessive force.

f. Automatic throttle disengagement switches must be mounted on or adjacent to the throttle levers where they can be operated without removing the hand from the throttles.

g. Following a failure, failure disconnect, or inadvertent disconnect of the automatic throttle, or uncommanded loss of a selected automatic throttle mode, a suitably clear and compelling advisory or indication should be provided.

8.3. Head Up Guidance.

a. For a Head Up Guidance landing system, intended for manual "pilot-in-the-loop" control during a low visibility approach and landing, and if applicable, a low visibility rollout, the HUD must provide sufficient command information as guidance to enable the pilot to maintain the approach path, to make the alignment with the runway, flare and land the airplane within the prescribed limits. The HUD must also provide sufficient information to enable the pilot to initiate a go-around without reference to other cockpit displays.

b. HUD manual guidance must not require exceptional piloting skill to achieve the required performance.

c. The workload associated with use of the HUD must be considered in showing compliance with the minimum flightcrew requirements found in section 25.1523.

d. Any HUD installation, or HUD display presentation, to comply with FAR 25.773, must not significantly obscure or degrade the pilot's outside view or field of view, or other flightcrew member's outside view or field of view, through the cockpit window(s). For compliance with this provision, consideration should be given to dynamic and/or extreme ambient lighting conditions which can affect the brightness of the display in a manner that adversely affect the suitability of outside view through the HUD and cockpit windows. The outside view must also be adequate around the HUD combiner through cockpit windows (e.g., no significant HUD combiner or electronics unit blockage of pilot view).

e. Head Up Guidance systems may be considered Fail Passive if, after a failure, the airplane's flight path does not experience a significant, immediate deviation due to the pilot following the failed guidance, before detecting the failure and discontinuing its use.

f. The active mode of the HUD system itself, as well as the flight guidance/automatic flight control system, must be clearly annunciated in the HUD, unless there are compensating features for displaying them elsewhere.

g. If a manual "pilot-in-the-loop" landing and rollout system is designed to be used as a single HUD configuration, the HUD should be installed at the captain's crew station.

h. For a dual HUD configuration, unless otherwise approved by FAA, procedures should be based on the concept that the Pilot Flying (PF) is the pilot using the HUD during an approach. The Pilot Not Flying (PNF) is expected to monitor other pertinent flight deck indications (e.g., head down PFD, ND, thrust or engine parameters, systems, annunciations other than those provided on the HUD, and alerts). While "head down" flight deck parameters may be assigned as a primary responsibility for a PNF, it is not necessary or expected that the PNF stow a PNF HUD. This provision does not preclude a PNF from referring to the HUD, or incorporating use of HUD information with outside visual reference, particularly when establishing or using outside visual reference. This provision also does not preclude other concepts for PF or PNF use of a dual HUD installation, if found acceptable by FAA.

i. If an automatic flight control system is used to control the flight path of the airplane prior to establishing manual "pilot-in-the-loop" HUD guidance on final approach (e.g., the autoflight system is used to intercept and establish tracking of the final approach path), the transition from automatic to manual flight shall be evaluated during either the HUD demonstration or automatic flight control system demonstration, or both demonstration(s).

j. Any transition from automatic flight control to manual control using HUD guidance must not require exceptional piloting skill, alertness, strength or excessive workload.

k. If the HUD fails at any time during a go-around (GA), the pilot must be able to satisfactorily revert to use of head down displays or instruments. The transition must be completed without unacceptable flight path transients, or loss of climb performance that could adversely affect obstacle clearance.

l. During demonstration of any HUD intended for use in Category III operations (e.g., to monitor autoland), and particularly for any HUD intended for manual "pilot-in-the-loop" flight guidance for Category III approach and landing, both landing cases and go-around (GA) cases should be demonstrated where:

1) External visual reference is available at or below 50 ft. HAT to touchdown, and

2) External visual reference is not available at any time below 50 ft. HAT to touchdown, and, if applicable, is also not available for rollout, and

3) External visual references and HUD and instrument references disagree (e.g., localizer centering errors).

m. If rollout guidance is provided on the HUD, the HUD information must enable the pilot to safely control the airplane along the runway after touch down within the prescribed limits. Both normal tracking and any applicable non-normal capture or tracking conditions (e.g., recovery from displacements) should be assessed.

n. After touch down, loss of a Fail Passive rollout system for manual control with guidance, shall be annunciated with an appropriate visual alert and removal of the command guidance.

o. Rollout systems which display only lateral deviation as a cue for centerline tracking have generally not been shown to provide adequate information to adequately control the aircraft or recover from displacements. Consequently, such displays are typically considered to have excessive workload and require excessive pilot task compensation. Also, systems which display only situation information in lieu of command information have not been shown to be effective. If proposed, either type of such system would require successful proof of concept evaluation. [PoC]

8.4. Hybrid HUD/Autoland Systems [PoC]. Hybrid systems must be demonstrated to be acceptable to the FAA in a proof of concept evaluation during which specific airworthiness and operation criteria will be developed, and they must otherwise meet the requirements of 5.8 and this appendix.

8.4.1. Hybrid HUD/Autoland System Fail Operational Equivalency Concept. Combining an automatic landing system which meets the Fail Passive criteria of this appendix with a HUD which also meets that same criteria does not necessarily ensure that an acceptable Fail Operational system will result. These systems may be combined to establish a Fail Operational system for low visibility operations provided certain considerations are addressed:

1) Each element of the system alone is shown to meet its respective requirements for a Fail Passive system.

2) The automatic landing system shall be the primary means of control, with the manual flight guidance system serving as a backup mode or reversionary mode.

3) Manual rollout flight guidance capability must be provided for hybrid systems which do not have automatic rollout capability. Such manual rollout capability must have been shown to have performance and reliability at least equivalent to that required of a Fail Passive automatic rollout system.

4) The transition between automatic mode of operation and manual mode of operator should not require extraordinary skill, training, or proficiency.

5) If the system requires a pilot to initiate manual control at or shortly after touch down, the transition from automatic control prior to touch down to manual control using the remaining element of the hybrid system (e.g., HUD) after touch down must be shown to be safe and reliable.

6) The capability of the pilot to use a hybrid system to safely accomplish the landing and rollout, following a failure of one of the hybrid system elements below alert height, must be demonstrated, even if operational procedures require the pilot to initiate a go-around.

7) Appropriate annunciations must be provided to the flightcrew to ensure a safe operation.

8) The combined elements of the system must be demonstrated to meet the required Fail Operational criteria necessary to support the operation (refer to Section 4 of the AC)

9) The overall system must also be shown to meet necessary accuracy, availability, and integrity criteria suitable for Fail Operational systems. Individual components must each be individually reliable (e.g., a highly reliable automatic flight control system and an unreliable HUD would not be acceptable).

Hybrid System Go Around Capability.

Demonstrations are necessary for each element of the hybrid system for low altitude go-around (GA), in the altitude range between 50 ft. HAT and touchdown.

Hybrid system demonstrations must be conducted in the following conditions:

a. Without external visual reference,

b. With visual reference, and

c. With the presence of external visual reference that disagrees with instrument reference (e.g., localizer centering errors).

8.4.3. Hybrid System Transition From Automatic to Manual Flight.

A safe manual takeover of airplane control to complete the landing within the established touchdown footprint must be demonstrated. Use of appropriate takeover response time delays for the transition should be considered during the demonstration.

These demonstrations must be conducted in the following conditions:

a. Without external visual reference,

b. With visual reference, and

c. With the presence of external visual reference that disagrees with instrument reference (e.g., localizer centering errors).

8.4.4. Hybrid System Pilot Not Flying (PNF). The pilot not flying (PNF) must have suitable information provided to accomplish appropriate assigned duties, to be an integral part of the crew, and to safely deal with immediate or subtle incapacitation of the Pilot Flying (PF) regardless of visual reference availability.

8.5. Satellite Based Landing Systems [PoC]. This appendix is intended to provide criteria, but not a comprehensive acceptable means of compliance for airworthiness approval of GNSS based low visibility landing systems (e.g., GLS). Airworthiness approval of a GLS requires an overall assessment of the integration of the airplane landing system components with other related non-airplane landing system elements (e.g., GLS differential transmitters, pseudolites, satellite constellation(s) characteristics, waypoint data sources and use, reference datum used) to ensure that the overall safety is acceptable.

The performance, integrity and availability of any ground station elements, any data links to the airplane, any satellite elements and any data base considerations, when combined with the performance, integrity and availability of the airplane system, should be at least equivalent to the overall performance, integrity and availability achieved when ILS is used to support Category III operations.

The following requirements apply to approach and landing systems using GNSS (e.g., GLS):

a. During the approach, the flightcrew must be advised if the GNSS service or landing system cannot support the required performance and integrity. This includes assessment of space vehicle (SV) degradation or failure, augmentation degradation or failure, including the effect of satellite vehicle geometry on the required performance, availability and integrity.

b. The GNSS system assessment should address failure mode detection coverage and adequacy of monitors and associated alarm times. GLS landing and rollout system performance, failure detection and annunciation should be consistent with any established ICAO Standards and Recommended Practices, FAA criteria, or other State criteria acceptable to FAA, unless otherwise approved by FAA.

c. The effect of airplane maneuvers on the reception of signals must be considered as necessary to maintain the required performance, availability and integrity. If applicable, loss and re-acquisition of signals should be considered. The effect of local terrain should also be considered.

8.5.1. Flight Path Definition. For Flight Path Definition considerations refer to Section 4.6 of this AC.

8.5.2. Aircraft Database. The required flight path may be uplinked to the airplane or may be stored in an aircraft database for recall and incorporation into the flight guidance and/or control system when required to conduct an approach, landing and rollout.

Corruption of the information contained in the data base used to define the reference flight path is considered Hazardous. Failures which result in unannunciated changes to the data base must be Extremely Remote.

For a procedural specified flight path intended to support automatic landing or manual flight guidance below 100 ft HAT, the flightcrew should not be able to modify information in the data base which relates to the critical definition of that required flight path, for any segment(s) of the procedure considered flight critical.

8.5.3. Differential Augmentation. Differential augmentation uses a set of GNSS receivers at known locations to derive differential corrections for each of the satellite pseudo-ranges. This network of GNSS receivers typically also provides signal in space integrity monitoring. If such a ground based augmentation system is used to provide differential pseudo-range corrections, or other data to an airplane to support Category III operations, the overall integrity of that operation must be established.

The role of the ground based augmentation system in the landing system must be considered during the aircraft system certification process until such time as an acceptable national, or international standard, for the ground reference system is established.

8.5.4. Datalink. A data link may be used to provide data to the airplane to provide the accuracy necessary to support certain operations.

The integrity of the data link should be commensurate with the integrity required for the operation.

The role of the data link in the landing system must be addressed as part of the aircraft system certification process until such time as an acceptable national, or international standard, for the ground system is established.

8.6 Enhanced Vision Systems or Synthetic Vision Systems [PoC]. Enhanced Vision System are typically considered to be those systems using airplane based sensors to penetrate visibility restrictions, and provide the flightcrew with a corresponding enhanced forward view of the scene outside the airplane (e.g., radar imagery presented in a perspective view, FLIR, LLTV). Synthetic Vision Systems (SVS) are typically those systems which create computer generated imagery or symbology representing how an outside forward vision scene would otherwise appear, or elements of that scene would appear, if a pilot could optically see through the visibility restriction or darkness.

This appendix section is not intended to address acceptable means of compliance for airworthiness approval of either Enhanced Vision Systems or Synthetic Vision Systems. Criteria for approval of an enhanced vision system or synthetic vision systems must match the system's proposed intended use, and must follow and be based on successful completion of proof of concept testing acceptable to FAA**.** Typically EVS or SVS systems would be expected to meet the same or equivalent performance accuracy, integrity, and availability criteria of other acceptable landing systems. Other limited uses, such as for assessing integrity alone (e.g., use as an independent landing monitor) may be assessed principally considering the proposed limited intended function. However, fidelity, alignment, penetration of weather, potential for misleading information, real time response, and any other relevant factor must be shown to be safe and appropriate for the intended application. If EVS or SVS information is to be presented on a head-up-display (HUD), such EVS or SVS information must additionally meet any pertinent HUD provisions (e.g., see Appendix 3, sections 8.3 and 8.4, as applicable). For a HUD presentation of EVS or SVS, a significant issue to be considered, even for no credit or limited credit, is the issue of potential blockage of cockpit window forward view (see provisions of Appendix 3, section 8.3 d.).

9. Airplane Flight Manual. Upon satisfactory completion of an airworthiness assessment and test program, the FAA-approved airplane flight manual or supplement, and any associated markings or placards, if appropriate, should be issued or amended to address the following:

1) Relevant conditions or constraints applicable to landing or landing and rollout system use regarding the airport or runway conditions (e.g., elevation, ambient temperature, runway slope).

2) The criteria used for the demonstration of the system, acceptable normal and non-normal procedures (including procedures for response to loss of guidance), the demonstrated configurations, and any constraints or limitations necessary for safe operation.

3) The type of navigation aids used as a basis for demonstration. This should not be taken as a limitation on the use of other facilities. The AFM may contain a statement regarding the type of facilities or condition known to be unacceptable for use (e.g., For ILS or MLS) based systems, the AFM should indicate that operation is predicated upon the use of an ILS (or MLS) facility with performance and integrity equivalent to, or better than, a United States Type II or Type III ILS, or equivalent ICAO Annex 10 Facility Performance Category III facility).

4) Applicable atmospheric conditions under which the system was demonstrated (e.g., demonstrated headwind, crosswind, tailwind) should be described as follows:

a) In the Limitations Section, the wind component values* used as a basis for statistical analysis, as supported by flight evaluation and validation, which may apply to use of the landing system, such as if credit for use is sought for low visibility operations,

***Note: These are the wind values for which the applicable criteria of Appendix 3, (see paragraph 5) below), have been met.**

b) In the Normal Operations Section, or equivalent section, maximum** wind component values experienced during the flight demonstration, described as "Demonstrated Wind Component(s)",

****Note: These values are provided for information only.**

c) For use of the landing system other than for low visibility credit (e.g., in wind or other conditions where system performance may not necessarily be supported by the statistical analysis), any necessary description of considerations, if other than the maximum demonstrated wind component values for the basic airplane*** apply.

*****NOTE: FAA does not apply a "landing system" wind limitation unless unacceptable system characteristics dictate use of a limitation. This is consistent with specification of the demonstrated wind component value for the basic airplane, which is included in the AFM for information, and is not limiting.**

5) For a landing or landing and rollout system meeting provisions of Appendix 3, the Normal Procedures, Normal Operations, or equivalent section, of the AFM should also contain the following statements:

"The airborne system has been demonstrated to meet the airworthiness requirements of AC 120-28D Appendix 3 for <specify the pertinent Landing or Landing and Rollout capability Section(s) criteria met> when the following equipment is installed and operative:

<list pertinent equipment>"

"This AFM provision does not constitute operational approval or credit for Category III use of this system."

6) Airplane Flight Manual provisions should be consistent with the following:

a) The AFM may list the alert height demonstrated,

b) The AFM should not specify a DA, DH or RVR constraint, and

c) The AFM should not include visual segment specifications.

Examples of general AFM considerations, specific AFM provisions, and location of those provisions for applicable landing or landing and rollout systems are provided in Appendix 6.

APPENDIX 4
WIND MODEL FOR APPROACH AND LANDING SIMULATION

In carrying out the performance analysis, one of the following models of wind, turbulence and wind shear may be used:

Wind Model A

Mean Wind
The mean wind is the steady state wind measured at landing. This mean wind is composed of a downwind component (headwind and tailwind) and a crosswind component. The cumulative probability distributions for these components are provided in Figure A4-1 (downwind) and Figure A4-2 (crosswind). Alternatively, the mean wind can be defined with magnitude and direction. The cumulative probability for the mean wind magnitude is provided in Figure A4-3, and the histogram of the mean wind direction is provided in Figure A4-4. The mean wind is measured at a reference altitude of 20 ft. AGL. The models of the wind shear and turbulence given in following sections assume this reference altitude of 20 ft. AGL is used.

Wind Shear
The wind shear component is that portion which affects the air mass moving along the ground (i.e., ground friction). The magnitude of the shear is defined by the following expression:

$$V_{wref} = 0.20407\ \overline{V}_{20}\ ln\left|\frac{h + 0.15}{0.15}\right|$$

where V_{wref} is the mean wind speed measured at h ft. and $\overline{V}_{20}$ is the mean wind speed at 20 ft. AGL.

Turbulence
The turbulence spectra are of the Von Karman form.

Vertical Component of Turbulence.
The vertical component of turbulence has a spectrum of the form defined by the following equation:

$$\Phi_w(\Omega) = \frac{L_w \sigma_w^2 \left| 1 + 2.67\left(1.339\, L_w \Omega\right)^2 \right|}{2\pi\left(1 + \left(1.339\, L_w \Omega\right)^2\right)^{11/6}}$$

where:

Φ_w = spectral density in $(\text{ft./sec})^2$

σ_w = root mean square (rms) turbulence magnitude in ft/sec = $0.1061\ \overline{V}_{20}$ (ft / sec)
where $\overline{V}_{20}$ is expressed in knots

L_w = scale length = h (for h < 1000 ft.)

Ω = spatial frequency in radians/ft. = ω / V_T

ω = temporal frequency in radians/sec, and

V_T = airplane speed in ft./sec.

Horizontal Component of Turbulence.

The horizontal component of turbulence consists of a longitudinal component (in the direction of the mean wind) and lateral component. The longitudinal and lateral components have spectra of the form defined by the following equations:

Longitudinal Component:

$$\Phi_u(\Omega) = \frac{L_u \sigma_u^2}{\pi\left(1 + \left(1.399\Omega L_u\right)^2\right)^{5/6}}$$

Lateral Component:

$$\Phi_v(\Omega) = \frac{L_v\ \sigma_v^2\left(1 + 2.67\left(1.339\, L_v \Omega\right)^2\right)}{2\pi\left(1 + \left(1.339\, L_v \Omega\right)^2\right)^{11/6}}$$

where the RMS Turbulence Scales are defined as below

$$\sigma_w = 0.1061\ \overline{V}_{20}\,(kts.)$$

a. When $h \geq 1{,}000\, ft.$ $\sigma_u = \sigma_v = \sigma_w$

b. When $h < 1{,}000\, ft.$

$$\sigma_u = \sigma_v = \sigma_w \left| \frac{1}{0.177 + 0.000823h} \right|^{0.4}$$

c. When $h \leq 0$

$$\sigma_u = \sigma_v = \sigma_w \left| \frac{1}{0.177} \right|^{0.4}$$

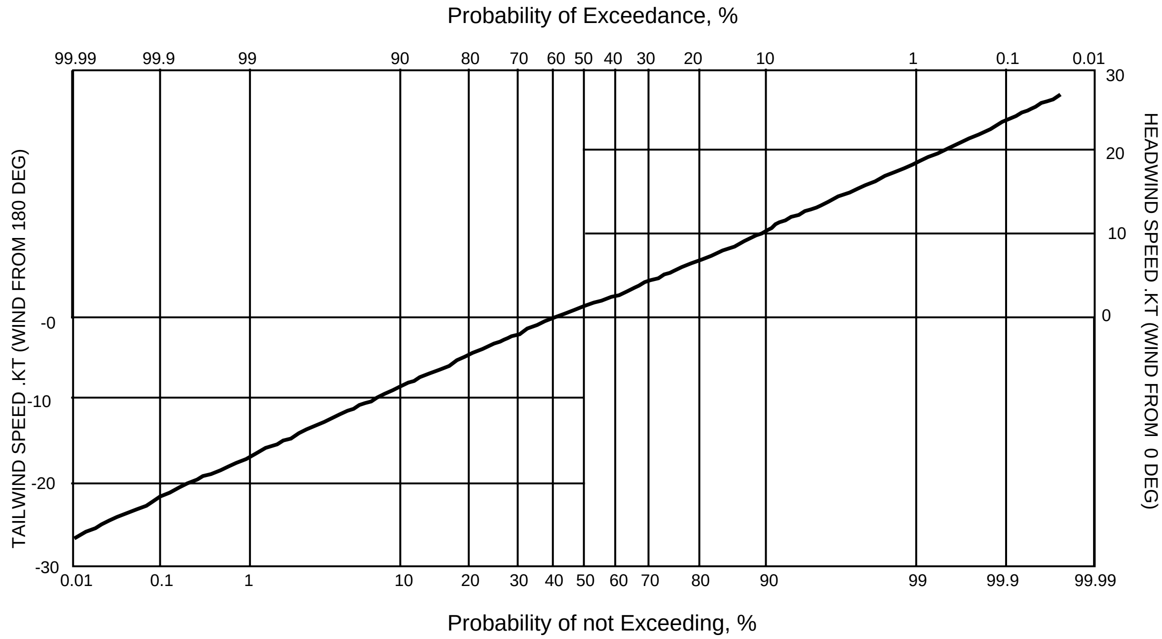
and where the Turbulence Scales are defined as below

a. When $h \geq 1{,}000\, ft.$ $L_u = L_v = L_w = 1{,}000$

b. When $h < 1{,}000\, ft.$ $L_w = h$

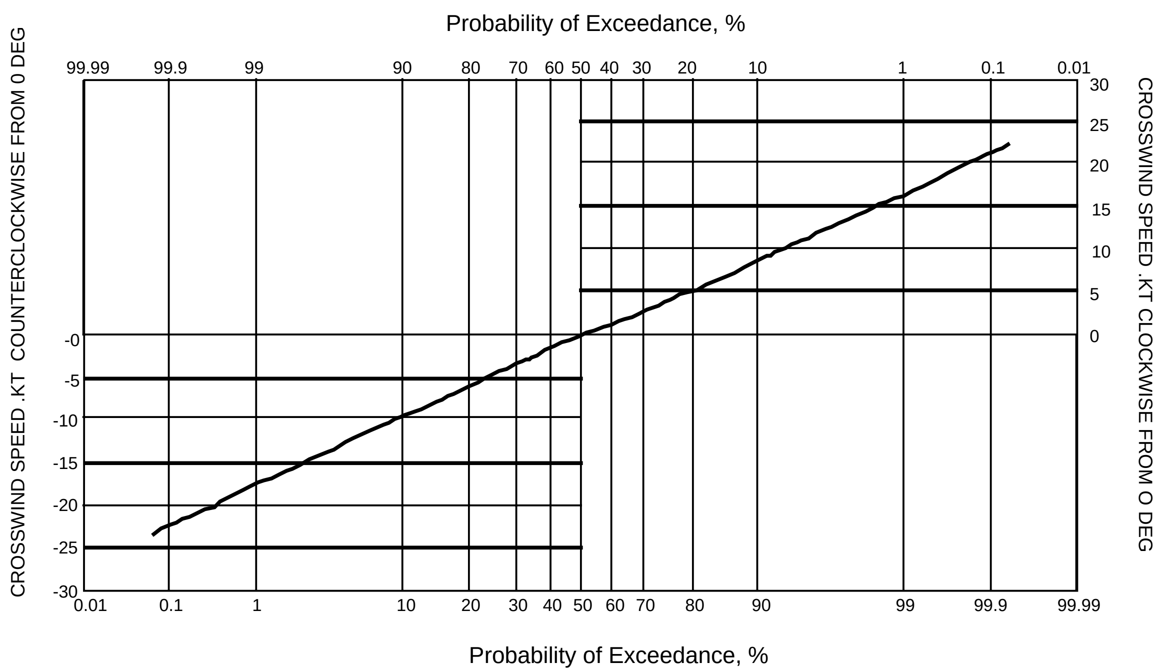
$$L_u = L_v = h \left| \frac{1}{(0.177 + 0.000823h)} \right|^{1.2}$$

c. When $h \leq 0\, ft$ $L_u = L_v = L_w = 0$



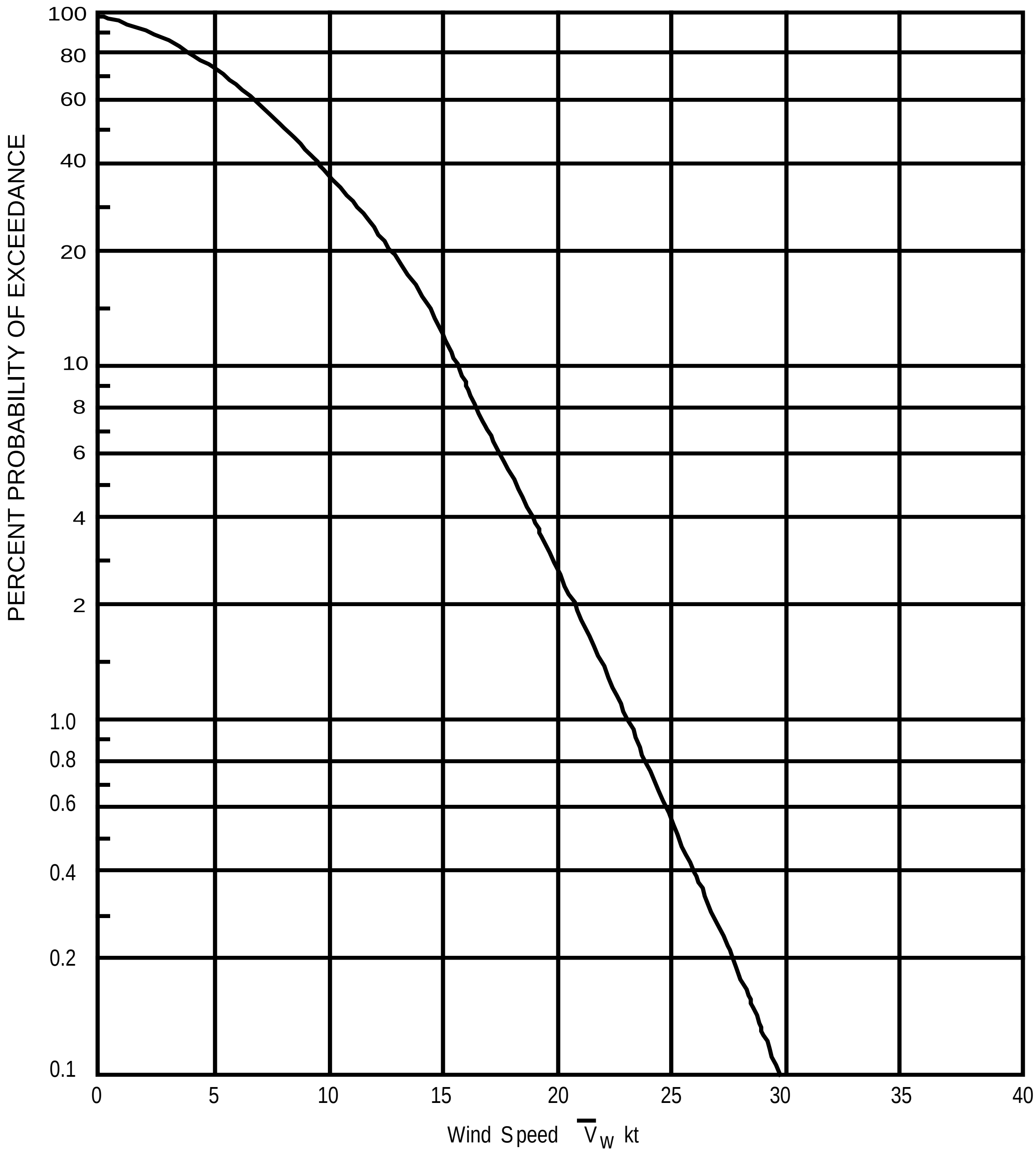
HEADWIND-TAILWIND DESCRIPTION

Figure A4-1



CROSSWIND DESCRIPTION

Figure A4-2



*ANNUAL PERCENT PROBABILITY OF MEAN WIND SPEED-
EQUALING OR EXCEEDING GIVEN VALUES*

Figure A4-3

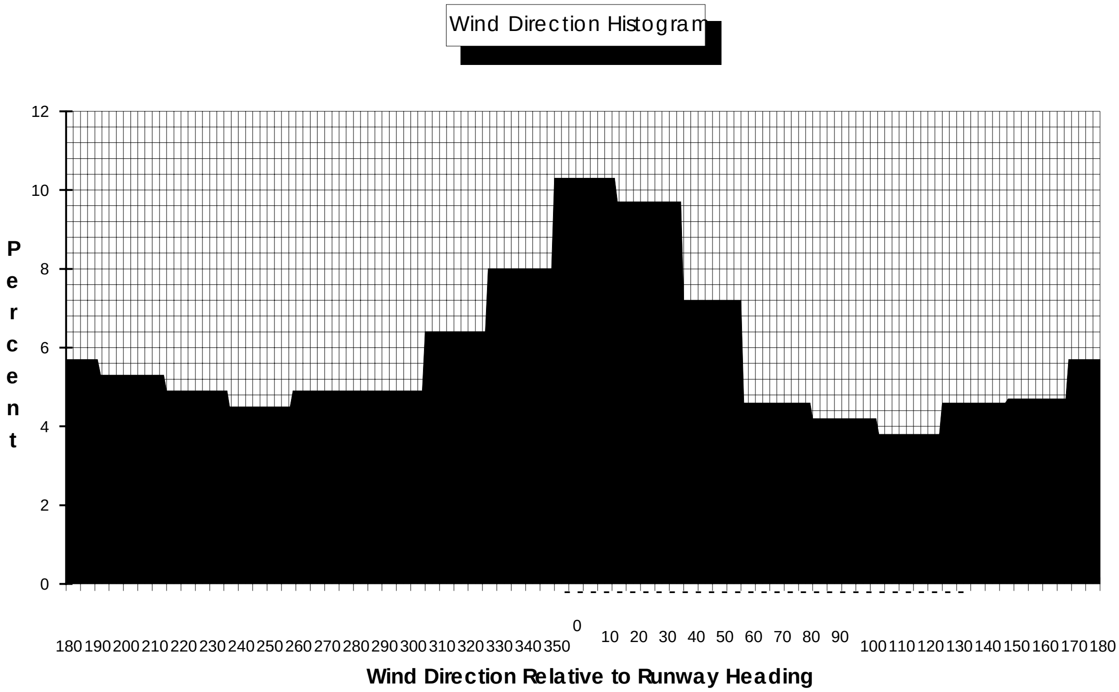
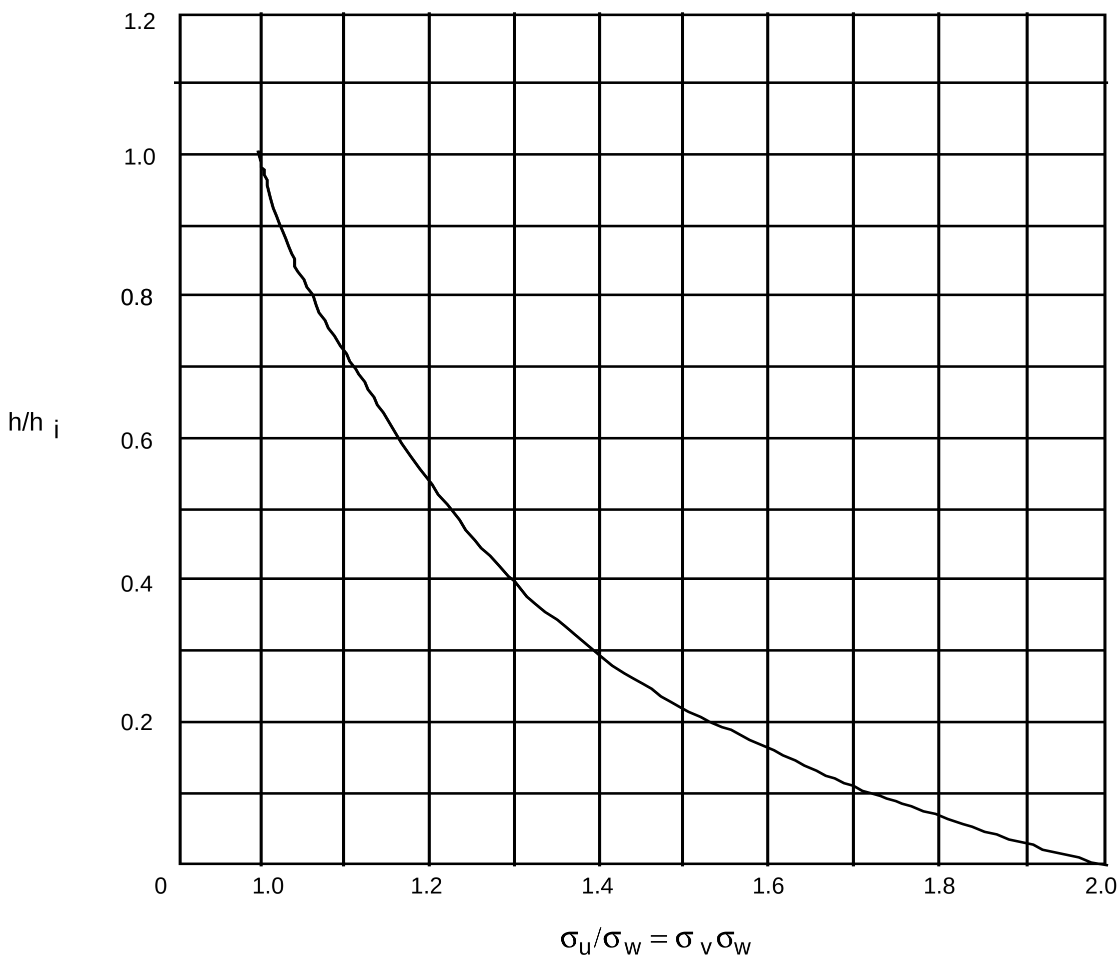

Wind Direction Histogram
12
10
8
6
4
2
0
Percent
180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
Wind Direction Relative to Runway Heading

Figure A4-4

$$\frac{\sigma_u}{\sigma_w} = \frac{\sigma_v}{\sigma_w} = \begin{cases} \dfrac{1}{[0.177 + 0.823\, h/h_i]^{.4}} & h < h_i \\ 1.0 & h \geq h_i \end{cases}$$



SELECTED DESCRIPTION FOR VARIANCES OF HORIZONTAL TURBULENCE COMPONENTS

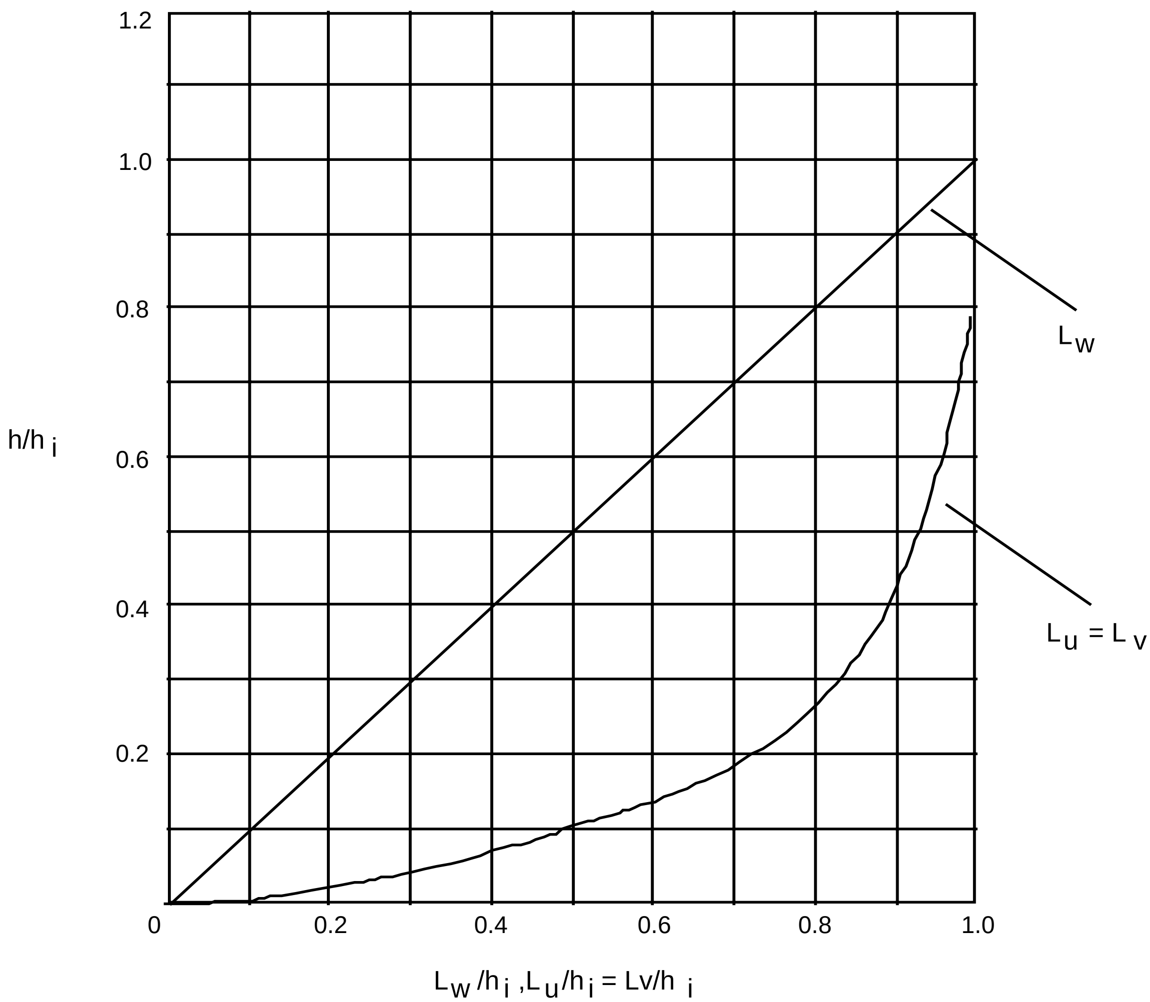
Figure A4-5

$$L_W = \begin{cases} h, & h < h_i \\ d, & h = h_i \end{cases}$$

$$L_u = \begin{cases} L_W \left(\dfrac{\sigma_u}{\sigma_w} \right)^3 = \dfrac{h}{[0.177 + 0.823\, h/h_i]^{1.2}} & h < h_i \\ d & h \geq h_i \end{cases}$$

$$L_V = L_u$$

h_i = Altitude above which turbulence is isotropic



SELECTED INTEGRAL SCALE DESCRIPTION

Figure A4-6

Wind Model B.

Mean Wind
It may be assumed that the cumulative probability of reported mean wind speed at landing, and the crosswind component of that wind are as shown in Figure A4-7. Normally, the mean wind which is reported to the pilot is measured at a height which may be between 6m (20 ft.) and 10m (33 ft.) above the runway. The models of wind shear and turbulence given in the following paragraphs assume this reference height is used.

Wind Shear

Normal Wind Shear. Wind shear should be included in each simulated approach and landing, unless its effect can be accounted for separately. The magnitude of the shear should be defined by the expression:

$$u = 0.43\ U \log_{10}(z) + 0.57\ U, \text{ for } z \geq 0.05 \text{ m} \qquad (1)$$

$$u \cong 0, \text{ for } z < 0.05\text{m}$$

where z is the height in meters
u is the mean wind speed at height z (meters)
U is the mean wind speed at 10m (33 ft.).

Abnormal Wind Shear. The effect of wind shears exceeding those described above should be investigated using known severe wind shear data.

Turbulence.

Horizontal Component of Turbulence. It may be assumed that the longitudinal component (in the direction of mean wind) and lateral component of turbulence may each be represented by a Gaussian process having a spectrum of the form:

$$\Phi(\Omega) = \frac{2\sigma^2}{\pi} \bullet \frac{L}{1 + \Omega^2 L^2} \qquad (2)$$

where $\Phi(\Omega)$ = a spectral density in (meters/sec)^2 per (radian/meter).

σ = root mean square (rms) turbulence intensity = 0.15 U

L = scale length = 183m (600 ft.)

Ω = frequency in radians/meter.

Vertical Component of Turbulence. It may be assumed that the vertical component of turbulence has a spectrum of the form defined by equation (2) above. The following values have been in use:

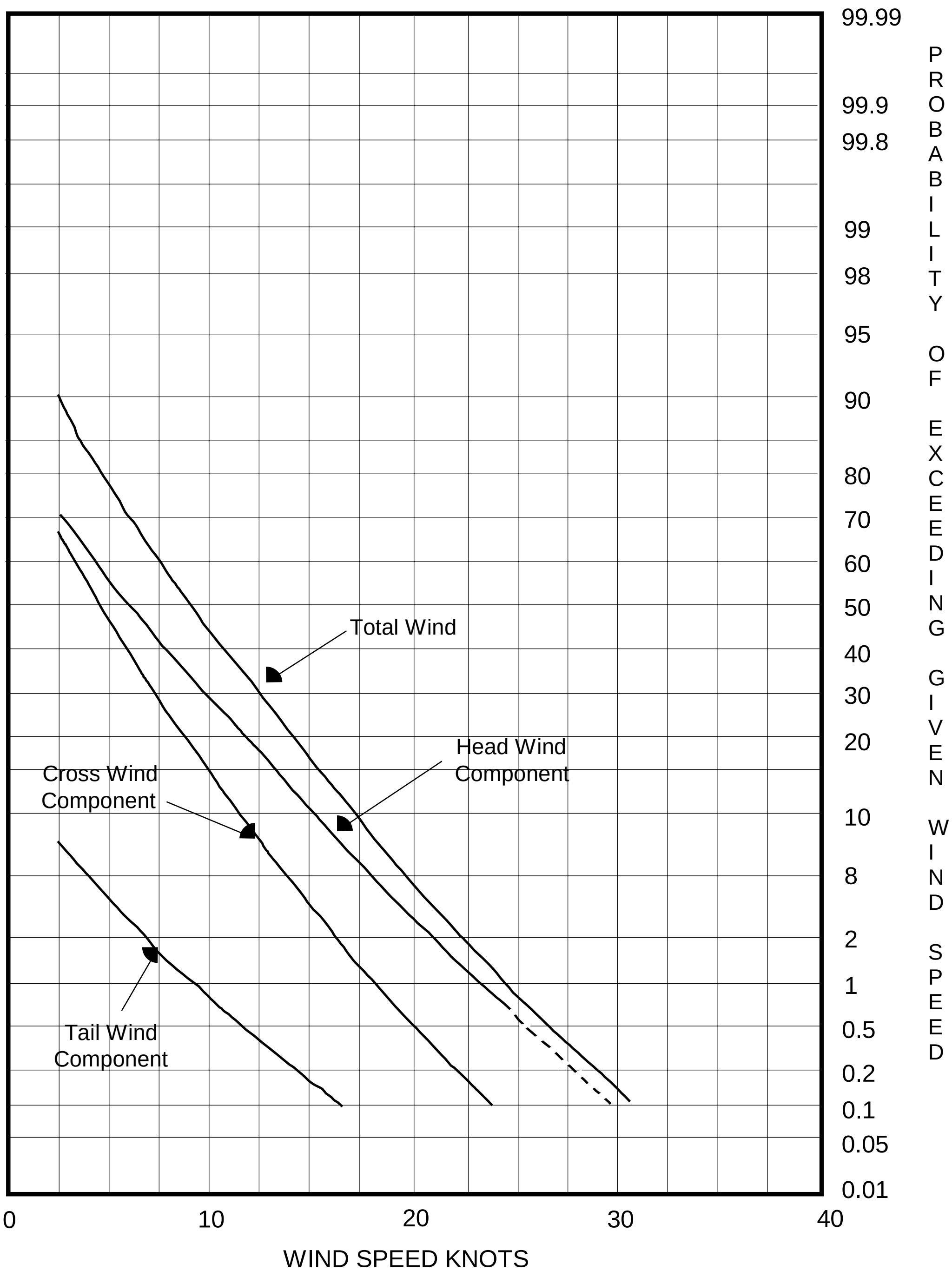
σ = 1.5 knots with L = 9.2m (30 ft.)

or alternatively

σ = 0.09 U with L = 4.6m (15 ft.) when z < 9.2m (30 ft.)

and

L = 0.5 z when 9.2 < z < 305m (30 < z < 1000 ft.)



Cumulative probability of reported Mean Wind, and Head Wind, Tail Wind Cross Wind Components, when landing.

NOTE: This data is based on world wide in-service operations of UK airlines (sample size about 2000)

Figure A4-7

APPENDIX 5. [RESERVED]
AIRWORTHINESS DEMONSTRATION OF DECELERATION AND BRAKING SYSTEMS OR DISPLAYS.

THIS APPENDIX INTENTIONALLY LEFT BLANK

[RESERVED]

APPENDIX 6
AFM PROVISIONS AND EXAMPLE AFM WORDING

6.1. Example Provision - AFM "Certificate Limitation" Section.

6.2. Example Provision - AFM “Normal Procedures” or “Normal Operation” Section [Typical Aircraft Type with Fail Operational and Fail Passive FGS Capability]

6.3. Example Provision - AFM “Normal Procedures” or “Normal Operation” Section [Typical Aircraft Type with Fail Passive FGS Capability]

6.1 Example Provision - AFM "Certificate Limitation" Section (With "Type Specific" Example Information and Notes)

(List Aircraft Type)
AIRPLANE FLIGHT MANUAL

Section 1 - CERTIFICATE LIMITATIONS

ELECTRONIC SYSTEMS

AUTOPILOT/FLIGHT DIRECTOR SYSTEM

Automatic Landing

Maximum wind component speeds when landing weather minima are predicated on autoland operations:

Headwind:	25 knots
Tailwind:	15 knots
Crosswind:	25 knots

The maximum and minimum glideslope angles are 3.25 degrees and 2.5 degrees respectively.

The autoland capability may be used with flaps 20 or 30, with both engines operative or with one engine inoperative. The Autopilot Flight Director System (AFDS) status annunciation must have LAND 2 or LAND 3 displayed and the SLATS DRIVE message must not be present.

Automatic Approach with Flaps 25

Autoland is not approved with flaps 25.

FAA APPROVED (**Date**) Section 3 Page ___

6.2 Example Provision - AFM "Normal Procedures" or "Normal Operation" Section [Typical Aircraft Type with Fail Operational and Fail Passive FGS Capability]

(List Aircraft Type)
AIRPLANE FLIGHT MANUAL

Section 3 - NORMAL PROCEDURES

AUTOPILOT - FLIGHT DIRECTOR SYSTEM (AFDS)

LOW WEATHER MINIMA - AUTOMATIC LANDING - FAIL-OPERATIONAL
The autopilot system has been shown to meet the applicable airworthiness, performance, and integrity criteria applicable to Category III as specified in FAA Advisory Circular (AC) 120-28D Appendix 3 for a fail-operational automatic landing system, with the following functions operative and LAND 3 annunciated:

Autoland status annunciation on both PFD's
Autothrottle
Independent ILS and radio altitude sources on the PFD for each pilot, i.e., the following alerting messages are not displayed:

SGL SOURCE DISPLAYS
SGL SOURCE RAD ALT
SINGLE SOURCE ILS

LOW WEATHER MINTMA - AUTOMATIC LANDING - FAIL-PASSIVE

The autopilot system has been shown to meet the applicable airworthiness, performance, and integrity criteria applicable to Category III as specified in FAA AC 120-28D Appendix 3 for a fail-passive automatic landing system, with the following functions operative and LAND 2 annunciated:

Autoland status annunciation on both PFD's
Independent ILS and radio altitude sources on the PFD for each pilot, i.e., the following alerting messages are not displayed:

SGL SOURCE DISPLAYS
SGL SOURCE RAD ALT
SINGLE SOURCE ILS

The demonstration for fail-passive autoland operations with LAND 2 annunciated included a requirement for a go-around if a subsequent autopilot system failure were to be detected on approach, if operational credit for use of autoland is required.

CAUTION: **If the autopilot disconnects during an engine-out go-around, loss of autopilot rudder control can result in large yaw and roll excursions.**

FAA APPROVED (**Date**) Section 3 Page ___

AUTOPILOT - F LIGHT DIRECTOR SYSTEM (AFDS) (Continued)

LOW WEATHER MINIMA - AUTOPILOT APPROACH

The autopilot system has been shown to meet the applicable airworthiness, performance, and integrity criteria applicable to Category II as specified in FAA (AC) 120-29__ Appendix __ for automatic approach with the following functions operative and LAND 3 or LAND 2 annunciated:

Independent ILS and radio altitude sources on the PFD for each pilot, i.e., the following alerting messages are not displayed:

SGL SOURCE DISPLAYS
SGL SOURCE RAD ALT
SINGLE SOURCE ILS

LOW WEATHER MINIMA - FLIGHT DIRECTOR

The flight director system has been shown to meet the applicable airworthiness, performance, and integrity criteria applicable to Category II as specified in FAA (AC) 120-29__ Appendix __ for manual approach with the following functions operative:

Normal flight controls
Air Data Inertial Reference Unit
Independent ILS and radio altitude sources on the PFD for each pilot, i.e., the following alerting messages are not displayed:

SGL SOURCE DISPLAYS
SGL SOURCE RAD ALT
SINGLE SOURCE ILS
SINGLE SOURCE F/D

FAA APPROVED (**Date**) Section 3 Page ___

6.3 Example Provision - AFM "Normal Procedures" or "Normal Operation" Section [Typical Aircraft Type with Fail Passive FGS Capability]

(List Aircraft Type)
AIRPLANE FLIGHT MANUAL

Section 3 - NORMAL OPERATIONS

AUTOPILOT - FLIGHT DIRECTOR SYSTEM (AFDS)

The Autopilot-Flight Director System is used as either a single channel autopilot or flight director for en route and single channel approaches. Dual autopilot channels provide fail-passive operation for automatic landing and go-around. Dual flight directors provide for takeoff, approach and go-around guidance.

The following flight path control functions for automatic (autopilot) and/or manual (flight director) control of the airplane are provided:

Lateral navigation

Vertical navigation

VOR

Localizer (Front course only) Approach

Autoland (Dual autopilot only)

Go-around (Dual autopilot and/or flight director only)

The following pilot assist functions for automatic (autopilot) and/or manual (flight director) control of the airplane are provided:

Control Wheel Steering (Autopilot only)

Heading select and hold

Vertical speed select and hold

IAS/Mach select and hold (Elevator control of speed in level change)

Altitude Select/Acquire or Capture and Hold

Takeoff (Dual Flight director only)

Go-around, one engine inoperative (Dual Flight director only)

The Captain's and First Officer's instruments (Display Source, VHF NAV and IRS) must not be on the same source when credit for use of the AFDS is necessary to make lower weather minima approaches.

An interlock is provided with the electrical transfer bus sensing circuit to preclude dual-channel autopilot operation on a single source of power. However, the Auxiliary Power Unit generator may be used as an independent power source.

FAA APPROVED (**Date**) Section 3 Page ___

Section 3 - NORMAL OPERATIONS

AUTOPILOT - FLIGHT DIRECTOR SYSTEM (AFDS) (Continued)

DEMONSTRATED CONDITIONS

The system has been demonstrated both with and without yaw damper and autothrottle and with normal landing flaps 30 and 40.

The approach speed selected for automatic approaches using autothrottles Was VREF + 5 knots (no wind correction).

The approach speed selected for autothrottle inoperative was VREF for calm air conditions and VREF + 1/2 (Headwind) + Full Gust for wind conditions.

The automatic landing system has been demonstrated in VMC conditions with the following wind conditions:

Headwind - 25 knots

Tailwind - 30 knots

Crosswind - 24 knots

Satisfactory Automatic Landing System performance has been demonstrated on U.S. Type II and Type III ILS ground facilities.

An autopilot minimum engage height (MEH) of 400 feet after takeoff has been demonstrated to provide satisfactory performance.

Single Engine Approach: The AFDS has demonstrated adequate performance for low visibility approach using a single engine, with flaps 15.

MINIMUM MULTICHANNEL ENGAGE ALTITUDE FOR AUTOLAND

On approach for autoland, dual channel operation should be engaged prior to 800 feet AGL. Check FLARE arm annunciation at approximately 500 feet AGL.

FAA APPROVED (**Date**) Section 3 Page ___

Section 3 - NORMAL OPERATIONS

AUTOPILOT - FLIGHT DIRECTOR SYSTEM (AFDS) (Continued)

AFDS SYSTEM CONFIGURATION

The AFDS equipment listings in this section do not necessarily denote all of the systems and equipment required for the types of operation specified. Applicable FAR's and AC's may prescribe an operational requirement for such additional systems such as autothrottle, or autobrakes. Operators should determine the total systems requirements for each type of operation prior to requesting OpSpecs authorization.

Demonstrated compliance with the airworthiness performance standards does not constitute approval to conduct operations in lower weather minimums.

DEMONSTRATED ALTITUDE LOSS

The demonstrated altitude loss due to a simulated hard-over autopilot malfunction is:

Level Flight:

Flaps up - 370 feet when recovery was initiated 3 seconds after the recognition point.

Approach:

(a) 23 feet with a 1 second time delay between recognition point and initiation of recovery.

(b) Negligible when recovery was initiated without delay after pilot recognition.

Go-Around:

The demonstrated altitude loss during an automatic go-around initiated below 100 feet AGL is listed below:

GA Altitude (ft AGL)	**Altitude Loss (ft)**
70 to 100	26
60	21
50	20
40	18
30	11
20	3
10	2.5

FAA APPROVED (**Date**) Section 3 Page ___

AUTOPILOT - FLIGHT DIRECTOR SYSTEM (AFDS) (Continued)

AUTOPILOT APPROACH/AUTOLAND (FAIL PASSIVE) (Applicable to Category III)

The Autopilot System has been shown to meet the applicable airworthiness and performance and reliability criteria of FAA AC120-28D for automatic approach and landing of the airplane to touchdown with the following additional equipment operative and FLARE arm annunciated.

Dual Channel Autopilot engaged

Low Range Radio Altimeter and display for each Pilot

Decision Height (DH) Display for each Pilot

Two Digital Air Data Computer Systems

Windshield Wipers for each Pilot

ILS Receiver and display for each Pilot

Flight Mode Annunciator for each Pilot

Two ADIRU's (associated with the engaged autopilots) in NAV mode

Dual Hydraulic Systems

Two sources of electrical power (The APU generator may be used as an independent power source)

Both Engines Operating

AUTOPILOT APPROACH (Applicable to Category II)

The Autopilot System has been shown to meet the airworthiness, performance, and reliability criteria of FAA AC 120-29 __, Appendix __ for Category II, for automatic approach with the following additional listed equipment operative:

Single or Dual channel Autopilot engaged

Low Range Radio Altimeter and display for each Pilot

Decision Height (DH) Display for each Pilot

Two Digital Air Data Computer Systems

Windshield Wipers for each Pilot

ILS Receiver and display for each Pilot

Flight Mode Annunciator for each Pilot

Two ADIRU's (associated with the engaged autopilot) in NAV mode

Two sources of electrical power (The APU generator may be used as an independent power source.)

Both Engines Operating

AUTOPILOT - FLIGHT DIRECTOR SYSTEM (AFDS) (Continued)

FLIGHT DIRECTOR (F/D)

The flight director command may be used as supplemental guidance to the primary speed and attitude indications for takeoff, climb and descent to acquire and maintain desired altitudes.

All of the autopilot command modes, except "CWS," are also available on the flight directors. An additional takeoff mode exists for the F/D only. One or both F/Ds may be on for all modes, except during T/O or GA which requires dual F/D ON.

FLIGHT DIRECTOR APPROACH (Applicable to Category II)

The flight director system has been shown to meet the applicable airworthiness, performance and reliability requirements of FAA AC 120-29__, Appendix __, for manual approach with the following equipment operative:

Both flight directors must be selected

Low Range Radio Altimeter and display for each Pilot

Decision Height (DH) Display for each Pilot

Two Digital Air Data Computer Systems

Windshield Wipers for each Pilot

ILS Receiver and display for each Pilot

Flight Mode Annunciator for each Pilot

Two ADIRU's in NAV mode.

Two sources of electrical power. (The APU generator may be used as an independent power source.)

Both Engines Operating

GO - AR0UND

When go-around is initiated the autothrottle system (if engaged) advances the thrust levers automatically. Flaps and landing gear must be controlled manually.

An Autothrottle, Flight Director and/or Dual Autopilot go-around may be initiated below a radio altitude of 2000 feet by pressing the go-around switches.

When a decision is made to abort an approach, actuate the go-around switches and assure rotation to go-around attitude. Verify thrust lever movement to achieve a nominal rate of climb* and retract flaps to flaps 15.**

After a positive rate of climb has been established, retract landing gear. Climb to a safe altitude, accelerate and retract remaining flaps according to takeoff flap retraction speed schedule. Monitor rate of climb, attitude, and airspeed.

Full go-around thrust may be obtained, after engine spool up, by reactivating the go-around switch(es).

In windshear, the recommended procedure is to delay flap and gear retraction until windshear is no longer a factor.

APPENDIX 7
STANDARD OPERATIONS SPECIFICATIONS

1. General. This appendix provides samples of standard operations specifications (OpSpecs) provisions typically issued for operations described in this AC. Standard OpSpecs are developed by FAA Flight Standards Service, Washington D.C., and are issued by certificate holding district offices (CHDO's) to each specific operator. Certificate Holding District Offices incorporate any necessary specific information applicable to that operator, to that operator's fleet of aircraft, or to that operator's specific operational environment or requirements (e.g., areas of operation).

OpSpecs specify limitations, conditions, and other provisions which operators must comply with to comply with the FAR. Standard OpSpecs are normally coordinated with industry prior to issuance to ensure a mutual and clear understanding of content and applicability, and to pre-determine the effect they may have on operations. After appropriate coordination new standard provisions, or amendments to existing provisions are incorporated into the FAA's computer based OpSpecs program used by field offices.

Use of standard OpSpecs provisions facilitates application of equivalent safety criteria for various operators, aircraft types and operating environments. Occasionally, it may be necessary to issue OpSpecs provisions that are non-standard because of unique situations not otherwise addressed by standard provisions. Non-standard OpSpec provisions may be more or less restrictive than standard provisions, depending on the circumstances necessary to show appropriate safety for the intended application. Nonstandard OpSpecs provisions typically should not be contrary to the provisions of standard paragraphs. In cases when a non-standard paragraph is more or less restrictive than a standard paragraph, appropriate justification must be provided.

The following Part A and Part C Standard OpSpecs paragraphs are provided:

2. A002 Definitions and Abbreviations

3. C051 Terminal Instrument Procedures

4. C055 Alternate Airport IFR Weather Minimums

5. C056 IFR Standard Takeoff Minimums, Part 121 Airplane Operations -- All Airports

6. C060 Category III Instrument Approach and Landing Operations

7. C078 IFR Lower Than Standard Takeoff Minimums

2. DEFINITIONS AND ABBREVIATIONS.

Sample operations specifications paragraph A002:

FAR 121 Operations Specifications - PART A

A002. Definitions and Abbreviations **HQ Control: 03/27/97**
HQ Revision: 010

Unless otherwise defined in these operations specifications, all words, phrases, definitions, and abbreviations have identical meanings to those used in the Federal Aviation Act of 1958, as amended. Additionally, the definitions listed below are applicable to operations conducted in accordance with these operations specifications.

(1) Instrument Approach Categories are defined as follows:

Category I	An instrument approach and landing with a decision altitude(height) or minimum descent altitude(height) not lower than 60m (200 ft) and with either a visibility not less than 800m (2400 ft), or a runway visual range not less than 550m (1800 ft).
Category II	A precision instrument approach and landing with a decision height lower than 60m (200 ft) but not lower than 30m (100 ft) and a runway visual range not less than 350m (1200 ft).
Category IIIa	A precision instrument approach and landing with a decision height lower than 30m (100 ft), or no decision height and a runway visual range not less than 200m (700 ft).
Category IIIb	A precision instrument approach and landing with a decision height lower than 15m (50 ft), or no decision height and a runway visual range less than 200m (700 ft) but not less than 50m (150 ft).
Category IIIc	A precision instrument approach and landing with no decision height and no runway visual range limitations.

(2) Other related definitions are as follows:

Certificate Holder. In these operations specifications the term "certificate holder" shall mean the holder of the certificate described in Part A paragraph A001 and any of its officers, employees, or agents used in the conduct of operations under these operations specifications.

Class I Navigation. Class I navigation is any en route flight operation or portion of an operation that is conducted entirely within the designated Operational Service Volumes (or ICAO equivalent) of ICAO standard airway navigation facilities (VOR, VOR/DME, NDB). Class I navigation also includes en route flight operations over routes designated with an "MEA GAP" (or ICAO equivalent). En route flight operations conducted within these areas are defined as "Class I navigation" operations irrespective of the navigation means used. Class I navigation includes operations within these areas using pilotage or any other means of navigation which does not rely on the use of VOR, VOR/DME, or NDB.

Class II Navigation. Class II navigation is any en route flight operation which is not defined as Class I navigation. Class II navigation is any en route flight operation or portion of an en route operation irrespective of the means of navigation) which takes place outside (beyond) the designated Operational Service Volume (or ICAO equivalents) of ICAO standard airway navigation facilities (VOR, VOR/DME, NDB). However, Class II navigation does not include en route flight operations over routes designated with an "MEA GAP" (or ICAO equivalent).

Operational Service Volume. The Operational Service Volume is that volume of airspace surrounding a NAVAID which is available for operational use and within which a signal of usable strength exists and where that signal is not operationally limited by co-channel interference. Operational Service Volume includes all of the following:

(1) The officially designated Standard Service Volume excluding any portion of the Standard Service Volume which has been restricted.

(2) The Expanded Service Volume.

(3) Within the United States, any published instrument flight procedure (victor or jet airway, SID, STARS, SIAPS, or instrument departure).

(4) Outside the United States, any designated signal coverage or published instrument flight procedure equivalent to U.S. standards.

Reliable Fix. A "reliable fix" means station passage of a VOR, VORTAC, or NDB. A reliable fix also includes a VOR/DME fix, an NDB/DME fix, a VOR intersection, an NDB intersection, and a VOR/NDB intersection provided course guidance is available from one of the facilities and the fix lies within the designated operational service volumes of both facilities which define the fix.

Runway. In these operations specifications the term "runway" in the case of land airports, water airports and heliports, and helipads shall mean that portion of the surface intended for the takeoff and landing of land airplanes, seaplanes, or rotorcraft, as appropriate.

Navigation Facilities. Navigation facilities are those ICAO Standard Navigation Aids (VOR, VOR/DME, and/or NDB) which are used to establish the en route airway structure within the sovereign airspace of ICAO member states. These facilities are also used to establish the degree of navigation accuracy required for air traffic separation service and Class I navigation within that airspace.

Planned Re-dispatch or Re-release En Route. The term "planned re-dispatch or re-release en route" means any flag operation (or any supplemental operation that includes a departure or arrival point outside the 48 contiguous United States and the District of Columbia) that is planned before takeoff to be re-dispatched or re-released inflight in accordance with section 121.631(c) to a destination airport other than the destination airport specified in the original dispatch or release.

3. TERMINAL INSTRUMENT PROCEDURES.

Sample operations specifications paragraph C051:

C051, Terminal Instrument Procedures.

a. The certificate holder is authorized to conduct terminal instrument operations using the procedures and minimums specified in these operations specifications, provided one of the following conditions is met:

(1) The terminal instrument procedure used is prescribed by these operations specifications.

(2) The terminal instrument procedure used is prescribed by Title 14 Code of Federal Regulations (CFR) Part 97, Standard Instrument Approach Procedures.

(3) At U.S. military airports, the terminal instrument procedure used is prescribed by the U.S. military agency operating the airport.

b. If Applicable, Special Limitations, and Provisions for Instrument Approaches at Foreign Airports.

(1) At authorized foreign airports, the terminal instrument procedure used is prescribed or approved by the government of an ICAO contracting State. The terminal instrument procedure must meet criteria equivalent to that specified in either the United States Standard for Terminal Instrument Procedures (TERPS) or ICAO Document 8168-OPS, Procedures for Air Navigation Services-Aircraft Operations (PANS-OPS), volume II, or Joint Aviation Authorities (JAR-OPS1).

(2) Terminal instrument procedures may be developed and used by the certificate holder for any foreign airport, provided the certificate holder makes a determination that each procedure developed is equivalent to U.S. TERPS, ICAO PANS-OPS, or JAR-OPS1 criteria and submits to the FAA a copy of the terminal instrument procedure with supporting documentation.

(3) At foreign airports, the certificate holder shall not conduct terminal instrument procedures determined by the FAA to be "not authorized for United States air carrier use." In these cases, the certificate holder may develop and use a terminal instrument procedure provided the certificate holder makes a determination that each procedure developed is equivalent to U.S. TERPS, ICAO PANS-OPS, or JAR-OPS1 criteria and submits to the FAA a copy of the terminal instrument procedure with supporting documentation.

(4) When operating at foreign airports where the metric system is used and the minimums are specified only in meters, the certificate holder shall use the metric operational equivalents in the following table for both takeoff and landing operations. This table converts commonly used RVR values appropriate to existing operational approvals. Values not shown may be interpolated.

RVR	
FEET	**METERS**
300 ft	75 m
400 ft	125 m
500 ft	150 m
600 ft	175 m
700 ft	200 m
1000 ft	300 m
1200 ft	350 m
1600 ft	500 m
1800 ft	550 m
2000 ft	600 m
2100 ft	650 m
2400 ft	750 m
3000 ft	1000 m
4000 ft	1200 m
4500 ft	1400 m
5000 ft	1500 m
6000 ft	1800 m

METEOROLOGICAL VISIBILITY		
STATUTE MILES	**METERS**	**NAUTICAL MILES**
1/4 sm	400 m	1/4 nm
3/8 sm	600m	3/8 nm
1/2 sm	800 m	1/2 nm
5/8 sm	1000 m	5/8 nm
3/4 sm	1200 m	7/10 nm
7/8 sm	1400 m	7/8 nm
1 sm	1600 m	9/10 nm
1 1/8 sm	1800 m	1 1/8 nm
1 1/4 sm	2000 m	1 1/10 nm
1 1/2 sm	2400 m	1 3/10 nm
1 3/4 sm	2800 m	1 1/2 nm
2 sm	3200 m	1 3/4 nm
2 1/4 sm	3600 m	2 nm
2 1/2 sm	4000 m	2 2/10 nm
2 3/4 sm	4400 m	2 4/10 nm
3 sm	4800 m	2 6/10 nm

(5) When operating at foreign airports where the landing minimums are specified only in RVR and meteorological visibility is provided, the certificate holder shall convert meteorological visibility to RVR by multiplying the reported visibility by the appropriate factor, shown in the following table.

[equivalent RVR to be used for minima = (reported meteorological visibility) x (factor from table below)]

AVAILABLE LIGHTING	DAY	NIGHT
High Intensity approach and runway lighting	1.5	2.0
Any type of lighting installation other than above	1.0	1.5
No lighting	1.0	N/A

NOTE: The conversion of reported Meteorological Visibility to RVR shall not be used for takeoff minima, Category II or III minima, or when a reported RVR is available.

4. ALTERNATE AIRPORT IFR WEATHER MINIMUMS

Sample operations specifications paragraph C055:

U.S. Department of Transportation Federal Aviation Administration	Operations Specification	Form Approved OMB No. 2120-00028

C055. Alternate Airport IFR Weather Minimums. The certificate holder is authorized to derive alternate airport weather minimums from the following table. In no case shall the certificate holder use an alternate airport weather minimum other than any applicable minimum derived from this table. In determining alternate airport weather minimums, the certificate holder shall not use any published instrument approach procedure which specifies that alternate airport weather minimums are not authorized. Credit for alternate minima based Category II or Category III capability is predicated on authorization for engine inoperative Category III operations for the certificate holder, aircraft type and flightcrew for the respective Category II or Category III minima applicable to the alternate airport.

Alternate Airport IFR Weather Minimums

Approach Facility Configuration	Ceiling	Visibility
	(no change from existing provisions)	
	(no change from existing provisions)	
(additional provision added to paragraph C55)		
For airports with a published Category II or Category III approach, and at least two operational navigational facilities, each providing a straight-in precision approach procedure to different, suitable runways.	For Category II procedures, a ceiling of at least 300' HAT, or, For Category III procedures, a ceiling of at least 200' HAT.	For Category II procedures, a visibility of at least RVR4000 or, For Category III procedures, a visibility of at least RVR1800.

5. IFR TAKEOFF MINIMUMS, PART 121 AIRPLANE OPERATIONS - ALL AIRPORTS

Sample operations specifications paragraph C056:

C056.	**IFR Takeoff Minimums, Part 121 Airplane Operations - All Airports**	**Control:**	**10/05/90**
		Revision:	**011**

Standard takeoff minimums are defined as 1 statute mile visibility or RVR 5000 for airplanes having 2 engines or less and 1/2 statute mile visibility or RVR 2400 for airplanes having more than 2 engines. RVR reports, when available for a particular runway, shall be used for all takeoff operations on that runway. All takeoff operations, based on RVR, must use RVR reports from the locations along the runway specified in this paragraph.

a. When a takeoff minimum is not published, the certificate holder may use the applicable standard takeoff minimum and any lower than standard takeoff minimums authorized by these operations specifications. When standard takeoff minimums or greater are used, the Touchdown Zone RVR report, if available, is controlling.

b. When a published takeoff minimum is greater than the applicable standard takeoff minimum and an alternate procedure (such as a minimum climb gradient compatible with aircraft capabilities) is not prescribed, the certificate holder shall not use a takeoff minimum lower than the published minimum. The Touchdown Zone RVR report, if available, is controlling.

6. CATEGORY III INSTRUMENT APPROACH AND LANDING OPERATIONS

Sample Operations Specifications Paragraph C060:

C060, Category III Instrument Approach and Landing Operations.

The certificate holder is authorized to conduct Category III instrument approach and landing operations to the airports and runways listed in subparagraph g. using the procedures and minimums specified in this paragraph and shall conduct no other Category III operations.

a. Category III Approach and Landing Minimums. The certificate holder is authorized to use the following Category III landing minimums for the aircraft listed below at authorized airports and runways, provided the special limitations in subparagraph g are met. These minimums are the lowest authorized at any airport.

1. Category III Fail-Passive Operations		
Airplane M/M/S	**DH**	**Lowest Authorized RVR**

****

2. Category III Fail-Operational Operations		
Airplane M/M/S	**DH/AH**	**Lowest Authorized RVR**

****

b. Required Category III Airborne Equipment. The flight instruments, radio navigation equipment, and other airborne systems required by the applicable Section of the Code of Federal Regulations (CFR) must be installed and operational for Category III operations at or above RVR 600. The additional airborne equipment listed or referenced in the following table is also required and must be operational for Category III operations below RVR600.

Airplane M/M/S	Additional Equip. & Special Provisions

c. Required RVR Reporting Equipment. The certificate holder shall not conduct any Category III operation unless the following RVR reporting systems are installed and operational for the runway of intended landing.

(1) For Category III landing minimums as low as RVR600 (175 meters), the Touchdown Zone, Mid, and Rollout RVR reporting systems are required and must be used. Touchdown Zone and Mid RVR reports are controlling for all operations. The Rollout report provides advisory information to pilots.

(2) For Category III landing minimums below RVR600 (175 meters) using fail-passive rollout control systems, the Touchdown Zone, Mid, and Rollout RVR reporting systems are required and must be used. All three RVR reports are controlling for all operations.

(3) For Category III landing minimums below RVR600 (175 meters) using fail-operational rollout control systems, the Touchdown Zone, Mid, and Rollout RVR reporting systems are normally required and are controlling for all operations. If one of these RVR reporting systems is temporarily inoperative, these operations may be initiated and continue using the two remaining RVR reporting systems. Both RVR reports are controlling.

d. Pilot Qualifications. A pilot-in-command shall not conduct Category III operations in any airplane until that pilot has successfully completed the certificate holder's approved Category III training program, and has been certified as being qualified for Category III operations by one of the certificate holder's check airmen properly qualified for Category III operations or an FAA inspector. Pilots in command who have not met the requirements of Section 121.652 shall use high minimum pilot landing minima not less than RVR1800.

e. Operating Limitations. The certificate holder shall not begin the final approach segment of an instrument approach procedure, unless the latest reported controlling RVR for the landing runway is at or above the minimums authorized for the operation being conducted. If the aircraft is established on the final approach segment and the controlling RVR is reported to decrease below the authorized minimums, the approach may be continued to the AH/DH applicable to the operation being conducted. Unless all of the following conditions are met, the certificate holder shall not begin the final approach segment of a Category III instrument approach:

(1) The airborne equipment required by subparagraph b. is operating satisfactorily.

(2) All required elements of the Category III ground system, except sequence flashing lights, are in normal operation. A precision or surveillance radar fix, a NDB, VOR, DME fix, its published Waypoint, or a published minimum GSIA fix, may be used in lieu of an outer marker.

(3) All Category III operations using minimums below RVR600 shall be conducted to runways which provide direct access to taxi routings equipped with serviceable taxiway centerline lighting which meets U.S. or ICAO criteria for Category III operations.

(4) The crosswind component on the landing runway is 15 knots or less.

(5) The runway field length requirements, the special operational equipment requirements, and the special limitations listed or referenced in the following table are met. If required runway field length factors are listed in this table, the required field length is established by multiplying these factors by the runway field length required by the provisions of Section 121.195(b) or 14 CFR Part 135, Section 135.385(b), as appropriate.

Airplane Make/Model/Series	**Category III Required Field Length**			**Special Operational Equipment or Special Limitations**
	RVR not less than RVR700	**RVR600**	**RVR less than RVR600**	

f. Missed Approach Requirements.

(1) For Category III approaches with a fail-passive landing system a missed approach shall be initiated when any of the following conditions exist:

(a) At the DH, if the pilot has not identified the required visual references with the touch down zone or touch down zone lights to verify that the aircraft will touch down in the touch down zone.

(b) At or before the DH, if the controlling RVR is reported below the lowest RVR authorized for fail passive operations.

(c) If, after passing the DH, visual reference is lost or a reduction in visual reference occurs which prevents the pilot from continuing to verify that the aircraft will touch down in the touch down zone.

(d) When a failure in the fail-passive flight control system occurs prior to touch down.

(e) If the pilot determines that touch down cannot be safely accomplished within the touch down zone.

(f) When any of the required elements of the ground system becomes inoperative before arriving at DH.

(g) The crosswind component at touchdown is expected to be greater than 15 knots.

(2) For Category III approaches with a fail-operational landing and rollout control system, a missed approach shall be initiated at or before AH when any of the following conditions exist:

(a) A failure occurs in one of the redundant systems in the aircraft before reaching the AH.

(b) Any of the required elements of the ground system becomes inoperative. However, Category III approaches and landings may be continued even though the sequence flashers and the approach lights became inoperative.

(c) The crosswind component at touchdown is expected to be greater than 15 knots.

(3) The preceding subparagraphs f.(1) and (2) do not preclude continuation of a higher minimum Category approach if the system failures do not affect the systems required for the higher approach minimums.

g. Authorized Category III Airports and Runways. The certificate holder is authorized to conduct Category III operations at the airports and runways listed in the following table.

Airport Ident	Runways	Special Limitations

**7. IFR LOWER THAN STANDARD TAKEOFF MINIMUMS,
14 CFR PART 121 AIRPLANE OPERATIONS - ALL AIRPORTS.**

Sample Operations Specifications Paragraph C078:

IFR Lower Than Standard Takeoff Minimums, 14 CFR Part 121 Airplane Operations - All Airports.
Standard takeoff minimums are defined in paragraph C056 of these operations specifications. The certificate holder is authorized to use lower than standard takeoff minimums under the following provisions and limitations. Runway visual range (RVR) reports, when available for a particular runway, shall be used for all takeoff operations on that runway. All takeoff operations, based on RVR, must use RVR reports from the locations along the runway specified in this paragraph.

a. When takeoff minimums are equal to or less than the applicable standard takeoff minimum, the certificate holder is authorized to use the lower than standard takeoff minimums described below:

(1) Visibility or runway visual value (RVV) 1/4 statute mile or touchdown zone RVR 1600, provided at least one of the following visual aids is available. The touchdown zone RVR report, if available, is controlling. The mid RVR report may be substituted for the touchdown zone RVR report if the touchdown zone RVR report is not available.

(a) Operative high intensity runway lights (HIRL).
(b) Operative runway centerline lights (CL).
(c) Runway centerline marking (RCLM).
(d) In circumstances when none of the above visual aids are available, visibility or RVV 1/4 statute mile may still be used, provided other runway markings or runway lighting provide pilots with adequate visual reference to continuously identify the takeoff surface and maintain directional control throughout the takeoff run.

(2) Touchdown zone RVR 1000 (beginning of takeoff run) and rollout RVR 1000, provided all of the following visual aids and RVR equipment are available.

(a) Operative runway centerline lights (CL).
(b) Two operative RVR reporting systems serving the runway to be used, both of which are required and controlling. A mid-RVR report may be substituted for either a touchdown zone RVR report if a touchdown zone report is not available or a rollout RVR report if a rollout RVR report is not available.

(3) Touchdown zone RVR 500 (beginning of takeoff run), mid RVR 500, and rollout RVR 500, provided all of the following visual aids and RVR equipment are available.

(a) Operative runway centerline lights (CL).
(b) Runway centerline markings (RCLM).
(c) Operative touchdown zone and rollout RVR reporting systems serving the runway to be used, both of which are controlling, or three RVR reporting systems serving the runway to be used, all of which are controlling. However, if one of the three RVR reporting systems has failed, a takeoff is authorized, provided the remaining two RVR values are at or above the appropriate takeoff minimum as listed in this subparagraph.

b. At foreign airports which have runway lighting systems equivalent to U.S. standards, takeoff is authorized with a reported touchdown zone RVR of 150 meters, mid RVR of 150 meters, and rollout

RVR of 150 meters. At those airports where it has been determined that the runway lighting system is not equivalent to U.S. standards, the minimums in subparagraphs a(1) or (2), as appropriate, apply.

c. In circumstances when the touchdown zone RVR reporting system has failed, is inaccurate, or is not available, the certificate holder is authorized to substitute pilot assessment of equivalent RVR for any touchdown zone RVR report required by this operations specification paragraph provided that:

(1) The pilot has completed the approved training addressing pilot procedures to be used for visibility assessment in lieu of RVR, and
(2) Runway markings or runway lighting is available to provide adequate visual reference for the assessment.

d. Additional provisions for **takeoff guidance systems**--all airports, if applicable. Not withstanding the lower than standard takeoff minimums specified in subparagraph a of this operations specification, the certificate holder is authorized to use the takeoff minimums specified for the aircraft and airports listed in this subparagraph provided the special provisions and conditions described below are met. The certificate holder shall conduct no other takeoffs using these takeoff minimums.

(1) Special provisions and limitations.
(a) Operative runway centerline lights (CL)
(b) Operative high intensity runway lights (HIRL)
(c) Serviceable runway centerline markings (RCLM)
(d) Front course guidance from the localizer must be available and used (if applicable to guidance systems used)
(e) The reported crosswind component shall not exceed 10 knots.
(f) Operative touchdown zone, and rollout RVR reporting systems serving the runway to be used, both of which are controlling, or three RVR reporting systems serving the runway to be used, all of which are controlling. However, if one of the three RVR reporting systems has failed, a takeoff is authorized, provided the remaining two RVR values are at or above the appropriate takeoff minimum as listed in this subparagraph.
(g) The pilot-in-command and the second-in-command have completed the certificate holders approved training program for these operations.
(h) All operations using these minimums shall be conducted to runways which provide direct access to taxi routings which are equipped with: operative taxiway centerline lighting which meets U.S. or ICAO criteria for Category III operations; or other taxiway guidance systems approved for these operations.

(2) Authorized airplanes using takeoff guidance systems--all airports. The certificate holder is authorized to use the following takeoff minimums for the airplanes listed below. (if subparagraph d is not authorized, use N/A in the Airplane M/M/S column):

Airplane M/M/S	Lowest Authorized RVR	Required Takeoff Guidance System

APPENDIX 8
IRREGULAR TERRAIN ASSESSMENT

The following information describes the operational evaluation process, procedures, and criteria applicable to approval of flight guidance systems (e.g., autoland or "pilot-in-the-loop" manual flight guidance systems) to support Category III procedures and minima at airports identified in the FAA Order 8400.8 and "Category II/III Status List" as having irregular underlying approach terrain.

Background. FAA type design approval of flight guidance systems provides for generic performance evaluation of autoland capability or "pilot-in-the-loop" manual flight guidance capability through simulation with reference terrain conditions, and flight testing at a few particular locations. This is to verify suitability of the design analysis. When an aircraft is type certificated (or STC'd) for use of a flight guidance systems, it is not the intent, nor is it practical that each model of aircraft, flight guidance system, radar altimeter type, NAVAID receiver type, etc., be tested at each conceivable location that it could potentially be used in operation, domestic and foreign. Additionally, NAVAID performance itself (e.g., ILS system) may vary somewhat from location to location or time to time due to different ATS critical area protection procedures to assure NAVAID performance (e.g., to minimize reflective interference). While type design certification by FAA, and frequent flight inspection by FAA or foreign authorities, addresses generic system performance, specific operational review and approval of particular aircraft type/site autoland performance is necessary when minima are predicated on use of autoland or other manual flight guidance system (e.g., head-up- display (HUD)) use. This is especially important at airports with irregular pre-threshold terrain (e.g., cliffs, valleys, sea walls) in the area of final approach, within approximately 1500 ft. of the landing threshold.

At typical airports/runways that are not considered to be "special terrain" (e.g., those not restricted by FAA Order 8400.8 and the CAT II/III Status List) the review and approval process usually consists of verifying the operator's report of performance for a small number of "line landings" using the flight guidance system in weather conditions better than those requiring use of Cat II or lower minima. This is true whether the review and approval is for a new operator or aircraft type at a particular runway, or is for a "follow-on" operator or aircraft type starting service at a runway previously found suitable for a particular type aircraft and system. If the review and approval is for a "special terrain" runway, particularly for a first of an aircraft type or system to base Category II or Category III minima on using a particular flight guidance system at that runway, then a specific evaluation including an operational demonstration is generally necessary.

This paper describes the general evaluation process, procedures, and criteria to be applied for such cases. Since circumstances often are unique in assessing aircraft/ flight guidance system/site performance, this summary represents an acceptable method. It is not the only method that may be proposed by FAA or an applicant. Credit may be applied for relevant testing by the manufacturer, for similar airborne systems, or for performance at similar locations (e.g., subsequent special terrain airport approvals). Certain aircraft/ flight guidance system combinations may require more extensive testing when an aircraft may exhibit unique characteristics at a particular runway (e.g., transient Radio Altimeter failure indication due to disagreement or unlock, inappropriate auto throttle response, inconsistent flare performance).

Accordingly, before establishing test requirements with a manufacturer or operator for special terrain airports or particular runways, the proposed evaluation plan should be coordinated with AFS-400. This should be done prior to agreement by the Principal Operations Inspector or Principal Avionics Inspector with the operator on the testing to be done and data to be collected.

Flight Guidance System Evaluation Process At Special Terrain Airports or Runways That Are Proposed For Category III Procedures Or Minima

A. Case I - First of a Type/Model at Any Special Terrain Airport/Runway.
Case I , First of a Type/Model, applies to the first Special Terrain airport/runway to be approved for a particular type (e.g., first L1011 autoland approval for irregular terrain at any airport – such as first L1011 use of KSEA Runway 16R, if not otherwise previously approved at KSEA, or any other "Special terrain airport" such as KCVG, KDEN, or KPIT).

1). Evaluation objective. Assess and verify normal flight guidance system performance from an operational perspective, and identify miscellaneous factors needed for a safe Cat III operation (e.g., alert height or decision height identification).

2). Procedure. Perform at least 4 to 6 successful evaluation landings in typical atmospheric conditions regarding wind and turbulence, using the applicable operational aircraft configuration, with a representative aircraft from the fleet, (e.g., a typical aircraft maintained using routine maintenance practices, not specially configured, not specially tested, or otherwise not specially selected from the operator's fleet). If the flight guidance system may be susceptible to an uncertain performance characteristic (e.g., long flare in a tailwind condition, pitch/throttle coupling oscillation during flare) the evaluation should take place when the system may be put to an appropriate test of the applicable crosswind, tailwind, headwind, wind gradient, or other critical condition applicable, consistent with the operator's proposed conditions or limits and the AFM's demonstrated conditions or limits.

Confirm the initial assessment of 4 to 6 data recorded evaluation landings, with subsequent successful initial operational landings (typically the first 25 or more) as reported by the operator (e.g., data recording or other special observation, other than by the regularly assigned flightcrew, is not required).

3). Evaluator(s). A person qualified to assess flight guidance system function and performance should conduct these evaluations as the FAA observer (e.g., typically an Category III qualified and experienced APM of a Category III authorized operator, a qualified AFS-400 representative, a qualified AEG representative, or an appropriate FAA National Resource Specialist (NRS)). FAA may designate other suitably qualified representatives to assess flight guidance system function and performance as necessary (e.g., suitably qualified check airman, fleet manager, FAA DER).

4). FGS Performance/Data Recording. Generally, some form of quantitative data should be recorded and reviewed as verification of performance. Methods used in the past include, but are not limited to either method a, or method b, or method c below or any combination:

a) Method A - Data Recording and Observation. Record pertinent flight guidance system performance data using a DFDR or a Quick reference recorder, or equivalent, which has ability to record the parameters shown below. The recording should be at a sufficiently high sample rate (e.g., at a rate $\geq$ 1 sample per second), for the part of the flight path of interest (typically from 300'HAT through de-rotation after touchdown).

- barometric altitude
- radio altitude
- radio altitude rate (h dot)

- glide slope error
- vertical speed
- elevator command
- pitch attitude
- throttle position
- airspeed
- Mode transition or engagement

Manual observations may be made for touchdown point (lateral, longitudinal), wind profile from 1000 ft. to surface (e.g., from an INS or IRS that is capable of displaying winds at typical approach speeds).

b) Method B - Review of Manufacturer's Data. A review of the manufacturer's data from flight guidance system development flight testing at the same special terrain runway, or equivalent, may be used to confirm items shown in 5) below.

c) Method C - Photo recording. Photo recording of pertinent instruments or instruments and outside view, with a video camera or equivalent, allowing post flight replay and review of indications noted in Method A above.

5) Data review and Analysis. The final approach, flare, and touchdown profile should be reviewed to ensure suitability of at least each of the following.

a) Suitability of the resulting flight path

b) Acceptability of any flight path displacement from the nominal path (e.g., Glide slope deviation, deviation from nominal flare profile),

c) Proper mode switching

d) Suitable touchdown point,

e) Suitable sink rate at touch down,

f) Proper flare initiation altitude

g) Suitable flare "quality" (e.g., no evidence of early or late flare, no overflare or underflare, no undue "pitchdown down" tendency at flare initiation or during flare, no flare oscillation, no abrupt flare, no inappropriate pitch response during flare, no unacceptable floating tendency, or other unacceptable characteristic that a pilot could interpret as failure or inappropriate response of the flight guidance system and disconnect, disregard, or contradict the FGS),

h) No unusual flight control displacements (e.g., elevator control input spikes, or oscillations),

i) Appropriate throttle retard (e.g., no early or late throttle retard, no failure to retard, no undue reversal of the retard, no undue pitch/throttle coupling),

j) Appropriate speed decay in flare (e.g., no unusually low speed risking high pitch attitude and tail strike, no excessive float, appropriate speed decay even if well above V_{ref} at flare initiation due to planned wind or gust compensation),

k) Proper mode initiation or mode transition relating to altitude or radio altitude inputs, such as crosswind alignment initiation, if applicable (e.g., Appropriate radio altitude (RA) trigger of crosswind alignment, to be sure that an appropriate mode transition occurs, even though underlying approach terrain may be irregular).

6) Miscellaneous Issues.

a. Determine acceptability of any variable radio altitude (RA) indications. Regarding Alert Height (AH) or Decision Height (DH) identification, determine the acceptability of any variable radio altitude (RA) indications or displays (e.g., considering variability due to underlying terrain variability in the last stage of the approach near Alert Height or Decision height). Assure that display indications are sufficiently stable and continuous to readily identify or define AH or DH. If an Inner Marker is to be used to establish Alert Height or Decision Height, determine if the inner marker function is adequate.

b. Address any anomalies occurring during the assessment (e.g., autopilot trip, firm landing, flare oscillation). Additional testing may be needed to clearly identify and resolve any particular problem identified.

c. Determine if special training, or other operational constraints are needed to accommodate peculiar approach or flare characteristics (e.g., require visual reference at flare initiation, apply a 50 ft. DH).

d. Authorization for use should occur only after repeated successful landings have been demonstrated and any anomalies experienced have been resolved.

B. Case II - Subsequent Special Terrain Airport/Runway Authorization for a Particular Type. Case II addresses the “First of a Model” at a particular runway, but at a subsequent “Special Terrain Airport” runway (e.g., After an aircraft type has already been successfully demonstrated at some special terrain airport runway – such as the first ever B767 type FGS use at KPIT Rwy 28L, after prior approval at KSEA).

1) Evaluation objective. Same as Case I

2) Procedure. Same as Case I.

3) Evaluator(s). Same as Case I.

4) FGS Performance/Data Recording **-** Data recording is not generally required. However, if the results of landings are marginal or unacceptable, the data recording and assessment procedures applicable to Case I may be needed to assess any remedial action required.

5) Data review and Analysis. Same as Case I.

6) Miscellaneous Issues. Same as Case I.

C. Case III - Subsequent Operator Use of a Particular Special Terrain Airport/Runway and Type Combination.

A Certificate Holding District Office (CHDO) (e.g., POI, PAI, APM) may review a request for an operator to use a particular Special Terrain Airport/runway and aircraft type, and with AFS concurrence, approve subsequent airline operation of a particular type at that special terrain airport/runway. Any authorization should be based on 25 or more successful "line" landings reported by the operator requesting authorization in weather conditions not requiring credit for FGS system use. The experience reported by operator should include no unsuccessful landing attempts or failures. If problems or failures are reported, then Case II or Case I procedures may be needed to resolve potential unique aircraft configuration effects, procedural effects, maintenance effects, or other effects.

D. Case IV – "Not-For-Credit" Use of Special Terrain Airport/Runway and Type Combinations.

"Not-For-Credit" use of "Special Terrain Airport/Runway and Type Combinations" applies to operators desiring to use an FGS (e.g., Autoland or Flight Guidance HUD) at a Special Terrain Airport/Runway, but not for any landing minima credit.

In this instance, a representative of the CHDO may evaluate the use during first line operations or specify that an operator representative (e.g., technical pilot, qualified management pilot, or check airman who is experienced with flight guidance system operation and performance) assess and verify adequate flight guidance system performance. This assessment should be completed prior to initiating routine operational use of the flight guidance system to touchdown at each "Special Terrain" runway. It is desirable, but not necessary, that a qualified APM, or equivalent, witness each "special terrain airport" evaluation.

The CHDO should request and review flight guidance system reports from line crews for at least the first 5 line landings to confirm appropriate performance. If problems occur, processes for cases I through IV may be needed to resolve problems depending on the severity and cause of problem (e.g., maintenance problem, unusual winds, lack of ATS critical area protection, problem with a modification to the FGS, use of a different associated component, such as substitution of a different and incompatible radar altimeter model).

A "Not-For-Credit" evaluation may be done in line operation as long as no previous reported problems have been noted with the same or similar aircraft type, and no NOTAM's or other restrictions preclude such operations. If problems have been reported for the same or similar type, treatment as Case I through III, as applicable above, may be appropriate.

> **NOTE: Unless otherwise restricted by an operator or CHDO, flight guidance system operations "Not-for-Minima-Credit" may generally be conducted on any ILS runway that does not have a restricting note on the approach plate (e.g., localizer unusable for rollout, glideslope unusable below xxx ft. AGL) and that has an adequate glide slope threshold clearance height (TCH) suitable for the aircraft type). If problems are noted in the operator's evaluation, the operator should specify that flight guidance system use should not be accomplished at that site to touchdown. This may be done through a flightcrew bulletin or equivalent. Conversely, an operator may publish a list of runways approved for flight guidance system use to touchdown, or through rollout.**

APPENDIX 9
TAKEOFF SYSTEM PERFORMANCE AFTER LIFTOFF

Takeoff system operation should be continuous and smooth through transition from the runway portion of the takeoff to the airborne portion and reconfiguration for en route climb. The criteria found in this paragraph is not unique to low visibility takeoff systems, but such systems must meet these requirements in addition to those found in Section 6.1.1 of Appendix 2. The pilot must be able to continue the use of the same primary display(s) for the airborne portion as for the runway portion. Changes in guidance modes and display formats must be automatic.

a) If the probability of the takeoff system presenting misleading guidance to the pilot is not Extremely Improbable, it must be shown that loss of the airplane will not occur if the takeoff system presents misleading guidance, whether caused by performance anomaly or malfunction. Compliance with this requirement can be demonstrated by showing that the display of misleading guidance information is Improbable when the flightcrew is alerted to the condition by:

- suitable annunciation means, or
- by information from other independent sources (e.g., primary flight references) available within the pilot's primary eye-scan area.

NOTE: For takeoff systems using a Head Up Display (HUD) to present takeoff guidance, the head down instrument panel is typically not within the pilot's primary eye-scan area. Thus, annunciations displayed in locations near the HUD field of view, such as the glare shield, may be found suitable, if they are clear, conspicuous and unambiguous to the pilot while focused on using the HUD.

b) The display of misleading guidance for takeoff shall be Extremely Improbable if no alternate means are available to detect the malfunction or to assess alternate sources of the guidance information, or if the transition to an alternate means of guidance is impractical.

c) The vertical axis guidance of the takeoff system during normal operation shall result in the appropriate pitch attitude, and climb speed for the airplane considering the following factors.

Normal rate rotation of the airplane to the commanded pitch attitude, at V_R-10 knots for all engines and V_R-5 knots for engine out, will not result in a tail-strike.

The system should provide commands that lead the airplane to smoothly acquire a pitch attitude that results in capture and tracking of the All-Engine Takeoff Climb Speed, $V_2 + X$. X is the All-Engine Speed Additive from the AFM (normally 10 knots or higher). If pitch limited conditions are encountered, a higher climb airspeed may be used to achieve the required takeoff path without exceeding the pitch limit.

d) For engine-out operation, the system should provide commands that lead the airplane to smoothly acquire a pitch attitude that results in capture and tracking of the following reference speeds:

V_2, for engine failure at or below V_2. This speed should be attained by the time the airplane has reached 35 ft. altitude.

Airspeed at engine failure, for failures between V_2 and $V_2 + X$.

$V_2 + X$, for failures at or above $V_2 + X$. Alternatively, the airspeed at engine failure may be used, provided it has been shown that the minimum takeoff climb gradient can still be achieved at that speed.

e) The loss of an electrical source (e.g., as a result of engine failure) shall not result in the guidance to either pilot being removed.

f) The flightcrew should be clearly advised that takeoff guidance is unusable when the system does not provide guidance appropriate to the takeoff phase of flight. In the case of the split-cue flight director, the guidance command associated with the inappropriate information shall be removed from view. In the case of the single-cue flight director, the guidance cue shall be removed.