Federal Aviation Administration
Aviation Rulemaking Advisory Committee

Air Carrier Operations Issue Area
All-Weather Operations Working Group

Task 1 – Certification and Operational Approval for All-Weather Operations

Task Assignment

H05R

TAS11

Federal Aviation Administration

Aviation Rulemaking Advisory Committee; All-Weather Operations Working Group

AGENCY: Federal Aviation Administration, DOT.

ACTION: Notice of establishment of All-Weather Operations Working Group.

SUMMARY: Notice is given of the establishment of an All-Weather Operations Working Group by the Aviation Rulemaking Advisory (ARAC). This notice informs the public of the activities of the ARAC.

FOR FURTHER INFORMATION CONTACT: Mr. Quentin J. Smith, Jr., Executive Director for Air Carrier Operations Issues, Flight Standards Service (AFS–200), 800 Independence Ave. SW., Washington, DC 20591; telephone (202) 267–8166, FAX: (202) 267–5230.

SUPPLEMENTARY INFORMATION: The Federal Aviation Administration (FAA) has established an Aviation Rulemaking Advisory Committee (ARAC) (56 FR 2190, January 22, 1991; and 58 FR 9230, February 19, 1993). One area that the ARAC deals with is air carrier operations. Other working groups in this area have dealt with issues such as autopilot takeoff minimum altitudes, fuel requirements, controlled rest on the flight deck, noise abatement, and flight crewmember fight/rest/duty requirements. The All-Weather Operations Working Group is being established to pursue the elimination of differences between the Joint Aviation Authorities' and the FAA's regulations and advisory materials in areas such as certification criteria and operational authority and criteria. The All-Weather Working Group will forward recommendations to the ARAC, which will then determine whether to forward them to the FAA.

Specifically, the Working Group's task is as follows:

To review and revise FAA advisory material associated with the certification and operational approval for all-weather operations, in particular lower weather minimums, in conjunction with the FAA/JAA harmonization work program.

A recommendation in the form of an Advisory Circular, or rulemaking, as appropriate, must be submitted in a format prescribed by the FAA. Other recommendations may be submitted in a format appropriate to the recommendation. All recommendations should be fully justified, and the justification should be submitted as part of the recommendation.

The Working Group should recommend time line(s) for completion of the task, including the rationale, for consideration at the meeting of the ARAC to consider air carrier operations issues held following publication of this notice.

The Working Group will give a status report on the task at each meeting of the ARAC held to consider air carrier operations issues.

The All-Weather Working Group will be comprised of experts from those organizations having an interest in the tasks assigned. A Working Group member need not necessarily be a representative of one of the member organizations of the ARAC. An individual who has expertise in the subject matter and wishes to become a member of the Working Group should write the person listed under the caption **FOR FURTHER INFORMATION CONTACT** expressing that desire, describing his or her interest in the task, and the expertise he or she would bring to the Working Group. The request will be reviewed with the ARAC Assistant Chair for Air Carrier Operations and the Chair of the All-Weather Working Group, and the individual will be advised whether or not the request can be accommodated.

The Secretary of Transportation has determined that the formation of use of the ARAC are necessary in the public interest in connection with the performance of duties of the FAA by law. Meetings of the ARAC to consider air carrier operations issues will be open to the public except as authorized by section 10(d) of the Federal Advisory Committee Act. Meetings of the All Weather Working Group will not be open to the public except to the extent that individuals with an interest and expertise are selected to participate. No public announcement of Working Group meetings will be made.

Issued in Washington, DC on October 7, 1994.

Quentin J. Smith, Jr.,

Assistant Executive Director for Air Carrier Operations Issues, Aviation Rulemaking Advisory Committee.

[FR Doc. 94–25773 Filed 10–17–94; 8:45 am]

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Recommendation Letter

AIR LINE PILOTS ASSOCIATION
535 HERNDON PARKWAY □ P.O. BOX 1169 □ HERNDON, VIRGINIA 20172 □ 703-689-2270
FAX 703-689-4370

December 15, 1997

Mr. Guy S. Gardner
Associate Administrator for Regulation and Certification
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

Subject: Advisory Circular 120-28D

Dear Mr. Gardner:

At our last meeting, the FAA's Aviation Rulemaking Advisory Committee Air Carrier Operations Issues Group considered a draft, harmonized revision of Advisory Circular 120-28D, Criteria for Approval of Category III Weather Minima for Takeoff, Landing, and Rollout. The issues group asked to FAA/JAA All Weather Operations Harmonization Working Group to make several, mainly editorial, changes and approved the document to be forwarded to the FAA.

We are pleased to forward this draft advisory circular for further FAA action to proceed with publication for comments and eventual approval as a final document.

Thank you for your attention to this important air safety issue.

Sincerely,

William W. Edmunds Jr

William W. Edmunds, Jr.
Assistant Chairman
Aviation Rulemaking Advisory Committee

Attachment

U.S. Department
of Transportation
**Federal Aviation
Administration**

800 Independence Ave., S.W.
Washington, D.C. 20591

JUN - 9 1998

Mr. William W. Edmunds, Jr.
Air Line Pilots Association
P.O. Box 1169
Herndon, VA 20170

Dear Mr. Edmunds:

We have received your December 15 transmittal forwarding the draft Advisory Circular (AC) 120-28D, Criteria for Approval of Category III Weather Minima for Takeoff, Landing, and Rollout. This is a monumental document in terms of detail and coverage, and I commend the working group for its perseverance and dedication in accomplishing the development and harmonization of the draft AC.

I note that you have forwarded the draft document for further Federal Aviation Administration (FAA)action, including publication, and eventual approval as a final document. The FAA considers that the draft AC is here for review, as required by ARAC procedures. However, because the document is under review, the FAA has determined that it is in the best interest to publish a notice of availability in the Federal Register and seek public comment on the document now. That notice of availability was published on May 21.

I very much appreciate the time and personal dedication of the working group in this accomplishment. The FAA looks forward to working with them to finalize the advisory circular.

I offer my special thanks for your continued and excellent support of the Aviation Rulemaking Advisory Committee.

Sincerely,

Margaret Gilligan

for Guy S. Gardner
Associate Administrator
for Regulation and Certification

AIR LINE PILOTS ASSOCIATION
535 HERNDON PARKWAY □ P.O. BOX 1169 □ HERNDON, VIRGINIA 20170 □ 703-689-2270
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October 23, 1998

Mr. Thomas E. McSweeny
Associate Administrator for Regulation and Certification
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, DC 20591

Subject: Advisory Circular 120-29A, Criteria for Approval of Category I and Category II Weather Minima for Approach

Dear Mr. McSweeny:

The Aviation Rulemaking Advisory Committee Air Carrier Operations Issues Group has been discussing, among other things, revision of Advisory Circular (AC) 120-29A, Criteria for Approval of Category I and Category II Weather Minima for Approach. Attached is the latest version of their efforts in this regard.

The Issues Group discussed this draft revision at our last meeting. We consider it to be ready for publication for public comment in the Federal Register. The working group is available to assist in any further manner necessary to get the AC approved as a final document.

Thank you for the opportunity to assist in this important issue.

Sincerely,

William W. Edmunds Jr.

William W. Edmunds, Jr.
Assistant Chairman
Aviation Rulemaking Advisory Committee

WWE:ye
attachment

cc: Air Carrier Operations Issues Group

Recommendation

U.S. Department of Transportation

Federal Aviation Administration

Advisory Circular

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

AC 120-28D

U.S. Department
of Transportation

**Federal Aviation
Administration**

Advisory Circular

Subject: Criteria for Approval of Category III Weather Minima for Takeoff, Landing, and Rollout

Date: DRAFT 14 - 12/15/97
Initiated By: AFS-400

AC No: 120-28D
Change:

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.

Thomas Stuckey
Acting Director, Flight Standards Service

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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., 300 RVR (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.

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 Aircraft 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 aircraft 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 requirements 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, its 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.

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. 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.

AC 120-28C, dated March 9, 1984, and AC 20-57A dated January 12, 1971, is 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

Current editions of the following Acs:

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

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

AC 25.1309-1A, 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 CAT 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 low visibility takeoff is included in Appendix 1.

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). 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 requirements 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 additional credit provided for only in this AC must, however, use applicable criteria of this AC (e.g., for RNP based missed approach obstacle credit, meet pertinent provisions of Appendix 9). To get a particular credit cited by this AC, the operator need only meet the provision or provisions applicable (e.g., RVR 600 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, flight crews 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) flight crew 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 Operations specifications 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 safe without increasing pilot workload. 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 RVR 300 ft./75m.

Criteria for demonstration of systems eligible for takeoff minima below the level supported by use of visual reference alone are found in Appendix 2.

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 touch down zone). If a Hybrid system is employed, then the primary mode of operation must be automatic to touch down, 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, touch down, and rollout and permitting a safe go-around from any altitude to touch down 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 touch down zone and safely rollout if the controlling visibility is reported at or above applicable minima. Systems based on automatic control to touch down, or touch down 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 required 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 AC 120-29 as amended)

If Category III operations are predicated on the use of RNP, then the provisions of AC 120-29, as amended, for RNP apply to that phase of the operations down to 100 ft. HAT. Below 100 ft. HAT, the provisions of this AC apply to assure the necessary performance for landing and rollout. For a go-around and missed approach, RNP provisions may be applied from the initiation of the go-around to completion of this missed approach procedure in accordance with provisions of AC 120-29 or other RNP criteria acceptable to the FAA, as applicable.

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 touch down, or approach, flare, touch down 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 touch down or rollout performance must be considered when evaluating Fail Operational systems. Fail Operational systems may be used to touch down 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 touch down in conjunction with a rollout system that is not fail-operational is acceptable as long as a minimum RVR is specified for rollout.

This AC contains criteria for approval of minima as low as RVR 150 using a fail-operational system for landing and rollout. Approval of minima less than RVR 150 would require a proof of concept demonstration.

Note: A landing system includes each of the elements in the aircraft which are necessary to perform the landing and rollout function (e.g., flight control, hydraulics, electrics, sensors).

The required redundancy may be provided by multiple automatic landing systems, by multiple automatic landing and rollout systems or by hybrid systems.

The reliability and performance of the required redundant operational systems should be such that continued safe operation to landing for Category IIIa, or landing and rollout for Category IIIb, can be achieved following any failure condition occurring below the Alert Height that is not shown to be extremely improbable.

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 requirements of Appendix 3 for fail operational systems are considered to meet these reliability and performance criteria.

The following are typical arrangements by which the requirements for Fail Operational Systems may be met:

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 touch down and rollout, if applicable, plus an independent and adequately failure protected flight guidance system, suitable for landing and rollout with guidance provided for the flying pilot and monitoring displays for the non-flying pilot.

Note: A proof of concept demonstration would be necessary for this arrangement.

4. Two independent and adequately monitored flight guidance systems with independent displays for the pilot flying and the pilot not flying, each capable of supporting a landing and rollout.

Note: A proof of concept demonstration would be necessary for this arrangement.

Aircraft authorized for fail-operational Category III in accordance with this AC should meet requirements of Appendix 3, or equivalent. Aircraft previously demonstrated to meet acceptable fail-operational criteria of earlier ACs or alternate criteria (e.g., JARs) may receive additional credits specified in provisions of this AC through appropriate showing of compliance with applicable provisions of this AC and subsequent amendment of applicable operations specifications.

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 touch down 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.

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 are from an altitude at least 200 ft. above the touch down zone elevation or higher.

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 required 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 touch down 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 touch down in the touch down 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 touch down zone. In the event of a failure of the airborne system at any point in the approach to touch down, a missed approach will be required.

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 requirements necessary 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 touch down zone or to complete a safe manual or automatic go-around from any altitude to touch down 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 requirements specified in Appendix 3. Aircraft previously demonstrated to meet Fail Passive requirements using earlier 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 autoflight 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 US 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 touch down 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 touch down 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 touch down 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 touch down 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 touch down, 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 touch down.

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 touch down. If the automatic go-around mode can be engaged at or after touch down, it should be shown to be safe. The ability to initiate an automatic go-around at or after touch down is not required.

4.3.7 Category IIIa.

Category IIIa operations may be conducted with either Fail Operational or Fail Passive systems. The lowest approvable landing minima for Category IIIa is RVR-700 or a foreign equivalent of 200 meters. (Note: For certain Category IIIb operations using fail passive systems, see paragraph 4.3.8.)

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 touch down.

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

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 touch down zone, and safely initiate rollout.

Unless otherwise specified by FAA, aircraft having operation specifications authorizing RVR 700 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 are 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 1000 RVR 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 1000 RVR based on a fail passive system must meet the airworthiness requirements of Appendix 3 or equivalent for any new authorization of minima less than 1000 RVR.

New aircraft types or derivative aircraft with new flight control system designs should be demonstrated in accordance with the requirements of 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 systems may be used, but are limited Cat IIIb minima not less than RVR 600 (175 m). Airborne systems used for Cat IIIb 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, touch down, 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 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 fail operational operations, the availability of visual reference is not a specific requirement for continuation of an approach to touch down. 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 touch down zone, and rollout.

Visual reference requirements for fail passive operations to minima not less than RVR 600 (175 m) are the same as specified for Cat IIIa.

Category IIIb operations may be conducted to an RVR not less than 600 ft. without a rollout control system.

Category IIIb operations may be conducted to a minima not lower than RVR 300 (75 meters) when using a rollout control system shown to meet Fail Passive criteria of Appendix 3. Category IIIb operations may be conducted to minima not less than 150 RVR (50 meters) with rollout control systems shown to meet the Fail Operational criteria of Appendix 3.

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 Requirements.

a. The Runway Field-Length Requirement 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, if installed, are operative.

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 requirements by the flight crew 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 flight crew 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 (NAVAIDs) and Aircraft Position Determination. Various landing system sensors (NAVAIDs) 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 (NAVAIDs) 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, NAVAIDs, or combination of NAVAIDs used, the NAVAIDs 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. US 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. US MLS systems are classified by Type, similar to ILS.

4.3.10.3 GNSS Landing System (GLS). GLS provides 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 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 touch down 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 SC159 MASPS). US GLS systems are classified by "Type" for each runway end served, similar to ILS (e.g., GLS II/D/2). 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 must 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 (e.g., multiple FMS with flight critical software and multiple IRS, ILS, and/or DGNSS inputs).

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 CAT III

RNP Type	Applicability/Operation (Approach segment)	Normal Performance (95%)	Containment Limit
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 120-29A)	(See AC 120-29A)
RNP levels as specified for Category II	Final approach/ initial missed approach (but not below 100' HAT)	(See AC 120-29A)	(See AC 120-29A)
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 touch down 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) x 2.

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

4.5.2 Non-Standard RNP Types. Non- Standard RNP Types are those RNP values other than as specified in 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.

<u>**Landing and Rollout Flight Path**</u>

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 the geometric center of the WGS-84 ellipsoid to define the geodesic plane of a precision final approach flight path to touch down and rollout. It is a point at the designated lateral center of the landing runway defined by latitude, longitude, ellipsoidal height, and orthometric height. The RDP is typically a surveyed reference point used to connect the approach flight path with the runway. The RDP may not be coincident with the designated runway threshold.

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

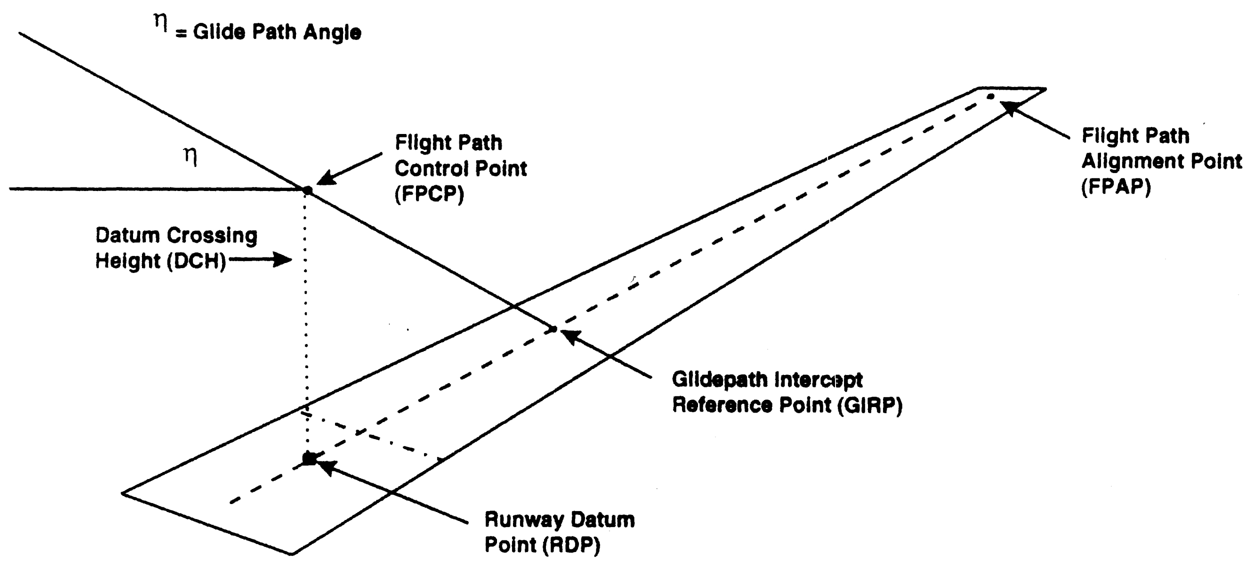
Flight Path Control Point (FPCP) - The FPCP is a calculated point located directly above the RDP. The FPCP is used to relate the vertical descent of the final approach flight path to the landing runway.

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 intended descent gradient for the final approach flight path of a precision approach procedure. It is measured from a horizontal plane that is parallel to the WGS-84 ellipsoid at the FPCP.

Glidepath Intercept Reference Point [GIRP] - The GIRP is the point at which the extention of the final approach path incercepts 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 required **GIRP**. Operational considerations include:

1) Path of wheels over threshold,

2) Need for coincidence with other aids and systems - visual and non-visual,

3) Runway characteristics (upslope and downslope, crown etc.),

4) Real, displaced and multiple thresholds,

5) Real clearways - stopways

Takeoff Flight Path

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

5 AIRBORNE SYSTEM REQUIREMENTS.

5.1 General.

5.1.1 Airborne Systems.

Airworthiness criteria for airborne systems intended to meet requirements of this AC are specified in paragraph 5.1.3 below or Appendix 2 for takeoff, and Appendix 3 for landing and rollout.

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.

Only the airborne equipment listed in this chapter needs to be operative for Category III operations. Airframe manufacturers and individual operators may include optional equipment as part of the Category III configuration, however, that equipment does not need to be operative to conduct a Category IIIa or IIIb approach unless required by that operator's Operations Specifications.

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., US 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-US facilities. Specific Navigation Services are addressed in Section 5.12.

5.1.3 Takeoff Guidance System Requirements.

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 V1 - 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.

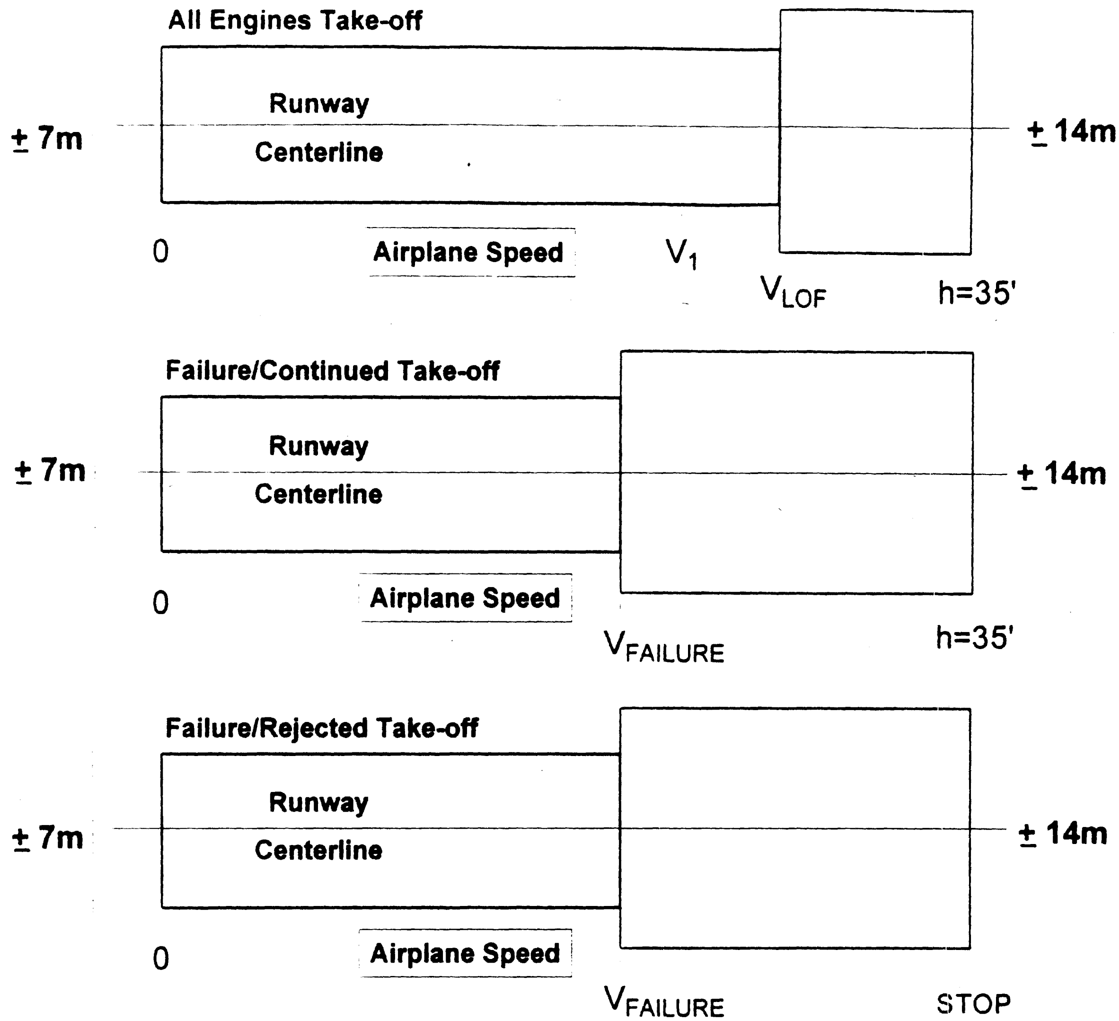


FIGURE 5.1.3-1.

5.2 Airborne Systems for Category III Minima Not Less than 600 RVR.

The following equipment in addition to the instrument and navigation equipment required by 14 CFR for IFR flight is the minimum aircraft equipment considered necessary for Category III:

1. A redundant flight control or guidance system, which meets the requirements of 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, or

b. A Fail Operational or Fail Passive flight guidance system providing suitable head-up or head-down guidance, and suitable monitoring capability, or

c. A hybrid 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 the requirements of 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 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 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.

9. Equipment which meets provisions of 5.3.1 below or equivalent, or a fail passive flight control system with automatic or manual guidance through touch down.

5.3.1 Airborne Systems for Category III Minima Not Less Than 300 RVR (75m). In addition to the aircraft equipment required for Category III at paragraph 5.2, the following equipment is required for Category III minima not less than 300 RVR (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 touch down , and in combination provide full fail operational capability, and

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

a. A flight guidance or automatic control system demonstrated to not have "hazardous characteristics", (system may be approved for RVR operations not less than 600 RVR), or

b. A Fail Passive flight guidance or automatic control system demonstrated in accordance with Appendix 3 or earlier equivalent criteria; (may be approved for operations not less than 300-RVR), or

c. A Fail Operational flight guidance, automatic control system, or hybrid system meeting the requirements of Appendix 3 (required for operations below 300 RVR)

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

4. Visibility minima of 300 ft. RVR 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.

5.4 Automatic Flight Control Systems and Automatic Landing Systems. Automatic Flight Control Systems or Autoland Systems considered acceptable for Category III, include those meeting pertinent criteria of Appendix 3, those meeting acceptable earlier FAA criteria referenced by an AFM or those meeting other equivalent criteria, such as JAR AWO, found acceptable to 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 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 flight crew 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 meet the requirements of 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 requirements 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 required 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 flight crews (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 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.

For hybrid systems, operational procedures following failure of the automatic system or flight guidance system prior to touch down 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 Cat 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 requirements, 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 IIIa either an Alert Height or a Decision Height may be used, as applicable to the operator's program and the type of fail operational or fail passive system used. For Category IIIb, 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, EADIs, primary flight displays, EHSIs, HSIs, 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 RA for radio altitude and BARO for barometric altitude, rather than operational designations such as DH or MDA. Use of the designation RA or BARO for reference setting controls does not preclude use of color changes or use of flashing symbology as the aircraft descends below the referenced value.

Situational information displays of navigation displacement must be available to both flight crew 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.

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 flight crew 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 touch down zone. Other alerts may be used when approved by the Administrator, if those alerts are consistent with that operators approved procedures and minima, and do not impair crew communication.

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 of 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 including instruments, radar altimeters, air data computers, inertial reference units, instrument switching, or capabilities such as flight deck night lighting, landing lights and taxi lights, position, turnoff, and recognition lights, or other low visibility related aircraft systems must meet appropriate criteria as specified in Appendix 3, in basic airworthiness requirements applicable to US certificated aircraft or equivalent, or acceptable earlier criteria authorized by FAA for aircraft previously demonstrated to be acceptable for Category III operation.

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 touch down. The go-around mode/capability should provide information for a safe discontinuance of the approach at any point to touch down, if activated prior to touch down. 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 touch down. Inadvertent selection of go-around after touch down 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 flight crew about appropriate auto brake settings to be used for landing or which provides landing distance information suitable for use by the flight crew 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 touch down.

5. A procedural means to assure a safe stop acceptable to FAA. However, a procedural means to assure a safe stop is not appropriate for minima less than 300 RVR (75 meters).

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 required 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 demonsrtated 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.

1. The AFM 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 captain and the aircraft dispatcher. Exceptions to criteria may be authorized 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 retrim 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).

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

2. Suitable information must be available to the flight crew at any time inflight, 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 (e.g., Appendix 3 Section 4.3).

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 Aircraft System Capability for Category III. Airworthiness demonstrations of aircraft and 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 flight crews 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 AFM provisions specified 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.

6.1.2 Crew Coordination. Appropriate procedures for crew coordination should be established so that each flight crew 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 crew members. Tasks should be accomplished consistent with the AFM provisions for the aircraft and each crew member position unless otherwise approved by the POI (e.g., duties of each pilot, monitored approach).

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 requirements 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 crew members 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 flight crews 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 for a Category IIIa landing (if applicable). 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 flight crew 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 touch down zone,
- "500 ft." above the touch down zone,
- "approaching minimums"
- "at 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 flight crew 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 flight crew. 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 accomplishment 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.

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 flight crew 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 crews 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 crews 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 Flight Crew Response to Non-Normal Events. Takeoff and landing weather minimums are intended for normal operations. When non-normal events occur, flight crews and aircraft dispatchers are expected to take the safest course of action to assure safe completion of the flight. Using emergency authority, crews 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, crews 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 crew members.

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 crews 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. Crews 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 flight crews 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 NAVAIDs, 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 V1, 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. AC 120-29 as amended provides the standard Category II and III approach and missed approach criteria not otherwise specified in FAA Order 8260.3 (TERPs). The criteria in AC 120-29 should be applied except where acceptable TERPs 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 Operations Specifications (e.g., RNP criteria).

6.2.5 Irregular Terrain Airports. Irregular terrain airports identified by an 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 flight crews 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 Cat 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).

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 crew member 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 crew members 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 NAVAIDs 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. NAVAIDs. 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. If non ground based systems (e.g., GNSS) are used, any characteristics or constraints regarding that method of navigation; must be addressed (e.g., waypoint use, integrity assurance).

2. Visual aids. Visual aids include approach lighting system, touch down 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. 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.

4. Weather Reporting. Weather reporting and transmissometers 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.

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

7.1.2 The Aircraft System. The training and qualification program should address the characteristics, capabilities, limitations, and proper use of each appropriate aircraft 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.

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 system or 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. Crews 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, crews should be aware of those effects and be familiar with proper settings for use of that equipment related to low visibility landing. 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.

7.1.3 Flight Procedures and Associated Information.

1. Operations Specification. Crews 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. Crews 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. Crews 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 transmissometers, 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. Crews 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. Crews should be familiar with the availability and limitations of visual references encountered, both on approach before and after Decision Height, if a Decision Height is applicable, particularly those procedures listed in section 6.2.7 above. Crews should be familiar with the expected visual references likely to be encountered if an Alert Height is used even though a visual reference requirement is not established. Crews 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 visual references where 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 showing expected visual references, computer based reproductions of expected visual references or other means acceptable to the FAA.

When a synthetic reference system such as "synthetic vision" or enhanced vision systems or independent landing monitors are used, crews 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. Crews 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.

6. Transfer of Control. Procedures should be addressed for transfer of control and transitioning 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 transitioning 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 crews should be familiar with the display limitations of these systems and expected crew actions in the event that the aircraft reaches or exceeds a display limit capability.

9. Contaminated Runways. Crews 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. Crews 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. Airplane System Failures. Crews should be familiar with the recognition and proper reaction to significant aircraft 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 crew response to failure after touch down should be addressed, particularly for Category III operations.

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 touch down. Crews 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, touch down zone lights, center line lights or any other discrepancies which could be pertinent to subsequent Category III operations.

7.2 Flight Training.

Flight training 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 flight crews 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, crew members are expected to perform their respective assignments or duties as applicable. In situations where crew members are being qualified, other than as part of the complete flight crew, 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 for Category III 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 touch down 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).

For low visibility takeoff (RVR less than 500 ft./150 m), where a flight guidance system is required, the following maneuvers and procedures should be addressed:

1. Normal takeoff,

2. Rejected takeoff from a point prior to V1 (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.

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 crew members 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 crew members 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 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 crews may not routinely see during normal line operations. Topics to be addressed for each pilot in command, second in command other crew member or aircraft dispatchers are those topics necessary for the performance of the assigned duties for each respective crew member.

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 touch down.

When takeoff minimums below RVR 500 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 V1. 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 headup 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 crew members 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 crews conducting Category III landings, or low visibility takeoff operations below RVR 500.

For automatic landing systems, as a minimum, crews should be exposed to automatic landing system operation and procedures during training or checking 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 crews 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 crews 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 crews and aircraft dispatchers can properly apply the provisions of Sections 10.8. For airlines that do not authorize the initiation of a Category III approach with an engine inoperative as an approved procedure, crews should at least be familiar with the provisions of Section 10.8.4 and 10.8.5 regarding an engine failure after passing the final approach fix. Additionally, crews 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, crew members 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 crew member 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 at RVRs below 500, crews should successfully demonstrate one takeoff in the event of an engine failure at, or after, V1 and one rejected takeoff with an engine failure or other appropriate failure near but prior to, V1.

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 flight crews 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 crew members are dual qualified as either captain or first officer for checking and performing the duties of the second in command or for crew members dual qualified between several aircraft types or variants, appropriate training and qualification must be completed to assure that each crew member 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 500 RVR, 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, flight crew 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 Regarding Use of Foreign Airports for Category III Operations or Low Visibility Takeoff. Operators authorized to conduct Category III operations or low visibility takeoffs below RVR 600 at foreign airports, which require procedures or limitations different than those applicable within the United States, should assure that flight crew 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 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;

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 Touch down 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)

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 touch down 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 1,200 ft. RVR 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 marshalling.

AC 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 Requirements.

8.6.1 Meteorological Services. Appropriate meteorological service (e.g., RVR, Altitude Settings, METARs, TAFs, Braking Action, NOTAMs, 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 Requirements.

8.6.2.1 RVR Availability. RVR availability requirements for touch down 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 requirement 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 transmissometer as applicable to the part of the runway used. For such operations, transmissometers not used are considered to be optional and advisory, unless the aircraft operation is planned to take place on the part of the runway where the MID or ROLLOUT transmissometer is located.

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 C056 (see Appendix 7). A pilot may assess visibility at the take off position in lieu of reported TDZ RVR (or equivalent) in accordance with the requirements detailed below:

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 300 RVR (90m), and

6) a report of the pilot's determination of visibility (PIREP) is forwarded to suitable ATS and dispatch facilities prior to departure (if an ATS facility or dispatch facility is available and providing services). A report of pilot visibility is intended to provide information for other operations, and is not intended to restrict the aircraft making the report.

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 NOTAMs. 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., NAVAIDs, 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, and 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.

NOTAMs for NAVAIDs, 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 flightcrews must appropriately respond to NOTAMs 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 alternate airport flight plan, and no other suitable airport facility is available). In such instances, crews 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 Alternates. In addition to criteria specified above, an airport used as an ETOPS Category III engine-inoperative alternate must meet the following criteria:

Sufficient information about pre-threshold terrain, missed approach path terrain, and obstructions must 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, up to a point at the end of the landing touch down zone (TDZ).

Sufficient meteorological and facility status information must be available so that a diverting flight crew 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 an ETOPS diversion.

For any alternate airports not routinely used by that operator (e.g., BIKF), sufficient information must be provided for aircraft dispatchers and flightcrews 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 windshear or turbulence characteristics, meteorological report, braking report, 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 Operations Specifications 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 touch down 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).

9 CONTINUING AIRWORTHINESS/MAINTENANCE REQUIREMENTS.

9.1 Maintenance Program Provisions. Typically, each operator should already have an approved continuous airworthiness maintenance program (CAMP) in place. The approved continuous airworthiness maintenance program for lower landing minima (LLM) should include any additional maintenance and administrative procedures. The LLM program is an extension of the CAMP. Emphasis is focused on maintaining and ensuring total system integrity and accuracy while conducting lower landing and takeoff operation. The program should ensure that the airborne equipment is maintained at an acceptable level of performance, reliability, and availability consistent with the Maintenance Review Board (MRB) or equivalent requirements. Maintenance personnel should be knowledgeable regarding the information contained in this AC and 14 CFR related to LLM.

9.2 Program Requirements. The maintenance criteria for LLM programs should be compatible with an operator's organization and existing maintenance program and the applicable FAR. The program should include Maintenance Review Board considerations and the airframe manufacturer's certification basis for conducting LLM operations. The LLM program should include:

- All maintenance procedures necessary to ensure continued.

- A procedure to revise and update the program.

- A method which identifies and records those persons [including contractors] who are currently involved in maintaining the program.

- An initial and recurrent training program. The program should include all operator and contract personnel. These persons should include, as the program applies to the duties: quality and reliability groups, maintenance personnel and maintenance control, incoming inspection and stores. The training should be performed in the classroom and in the airplane. Areas of training should include: Minimum Equipment List (MEL) application, information related to the different categories of operational authority (what lower weather minima is), general information from an operational stand point, and all other maintenance program requirements.

- Validation of each aircraft brought into the lower minimum program. Procedures should be established for ensuring certification and verification that each aircraft meets its type design lower minimum standards for systems and equipment (TC-STC) which include:

- Titles and numbers of all modifications, additions and changes which were made to qualify aircraft systems for LLM if other than TC.

- Identification of additional maintenance requirements which allows status change from one minimum to a lower/higher minimum.

- Discrepancy reporting procedures unique to the LLM program. These procedures must be identically described in maintenance documents and operations documents.

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

- Procedures which define, monitor and report chronic and repetitive discrepancies.

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

- Procedures which ensure the aircraft LLM system status is placarded properly and clearly documented in the aircraft log book under the direction of maintenance control and flight operations dispatch.

- Procedures to ensure the downgrade of an aircraft from LLM status when maintenance has been performed by persons not properly trained, qualified, or authorized.

- Procedures for periodic maintenance LLM systems ground check and an LLM systems flight check. For example, performed following a heavy maintenance check and prior to return to service.

- Should require, for an aircraft to remain in CAT II status, at least one satisfactory LLM approach must have been accomplished within 6 months unless a satisfactory complete LLM systems ground check has not been accomplished. A recording procedure for both satisfactory and unsatisfactory results should be included. Fleet sampling is not acceptable.

- Should require at least one satisfactory LLM CAT III/ autoland or a satisfactory complete LLM systems ground check accomplished within 30 days, for an aircraft to remain in CAT III/autoland status. A recording procedure for both satisfactory and unsatisfactory results should be included. Fleet sampling is not acceptable

9.3 Initial And Recurrent Maintenance Training. Operator and contract maintenance personnel which include mechanics and maintenance controllers should receive initial and recurrent training. The training curriculum should include specific aircraft systems and operator LLM policies and procedures. Recurrent training should be accomplished at least annually or when a person has not been involved in the maintenance of LLM systems within six months. Training should include classroom and hands-on aircraft training leading to a certification for LLM.

The training curriculum should include:

- Procedures for the use of outside vendor parts that ensures compatibility to program requirements and for establishing measures to control and account for parts overall quality assurance.

- 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.

- Procedures to assess, track and control the accomplishment of changes to components and/or systems, i.e., service bulletins, engineering orders, 14 CFR requirements and any other source to evaluate their effect on LLM systems and components.

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

- Procedures to evaluate, control, and test system and component software changes.

- Procedures within the minimum equipment list remarks section which identify LLM systems and components, specifying limitations and upgrading and downgrading.

- Procedures for identifying LLM components and systems as required inspection items (RII) thereby ensuring quality assurance whether performed in-house or by contract vendors.

9.4 Test Equipment/Calibration Standards. Test equipment may require re-evaluation to ensure it has the required accuracy and reliability to return systems and components to service following maintenance pursuant to aircraft status upgrade. A listing of all primary and secondary standards used to maintain test equipment which relate to LLM operations should be submitted to the FAA for determination of adequacy. 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 at all times.

9.5. Return To Service Procedures. Procedures should be included to upgrade and downgrade systems status concerning LLM. The method for controlling operational status of the aircraft should ensure that the flight crew, maintenance and inspection departments, dispatch and administrative personnel are aware of aircraft system status.

The minimum level of system testing must be specified for each component and system. UNLESS DEMONSTRATED AND CERTIFIED BY THE AIRFRAME MANUFACTURER, BUILT-IN-TEST-EQUIPMENT (BITE)/RETURN TO SERVICE (RTS) MAY NOT BE APPROPRIATE AS A RETURN TO SERVICE REQUIREMENT PURSUANT TO STATUS UPGRADE. If not demonstrated and certified IT MAY ONLY BE USED FOR FAULT ISOLATION AND TROUBLESHOOTING. The airframe manufacturer must certify that these tests will ensure the desired accuracy and integrity for LLM operations.

Contract facilities must follow the operator's FAA approved LLM maintenance program BEFORE approving the aircraft for return to service. The operator is responsible for ensuring contract personnel are appropriately trained, qualified, and authorized.

9.6 Periodic Aircraft System Evaluations. The operator must provide a method to continuously assess or periodically evaluate aircraft system performance to ensure satisfactory operation for those systems applicable to Category 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 30 days is typically an acceptable method for assuring satisfactory system operation.

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 is to be submitted to the certificate holding office. The following information should be reported:

a. The total number of satisfactory LLM approaches, actual and simulated to LLM minima by aircraft type.

b. The total number of unsatisfactory approaches and the reasons by appropriate category; aircraft equipment; ground facilities; ATC or other.

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

d. Reporting there after should be in accordance with the operators established reliability and 14 CFR reporting requirements.

9.8 Configuration Control/System Modifications. THE OPERATOR MUST ENSURE THAT ANY MODIFICATION TO SYSTEMS AND COMPONENTS APPROVED FOR LLM ARE NOT AFFECTED WHEN INCORPORATING SOFTWARE CHANGES, SERVICE BULLETINS, ADDITIONS, AND CHANGES TO LLM RELATED SYSTEMS. ANY CHANGE TO SYSTEM COMPONENTS REQUIRES FAA APPROVAL.

9.9 Records. The operator must 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 must have appropriate records and instructions for coordination of records with the operator.

10 APPROVAL OF UNITED STATES OPERATORS. Approval for Category I, II and III is through issuance of, or amendments to, Operations-Specifications. The authorizations, limitations, and provisions applicable to Category I and II operations are specified in Part C of the operations specifications. Sample Operations-Specifications are provided in Appendix 7.

Operations specifications authorizing reciprocating and turbopropeller-powered airplane Category I operations that use ICAO standard NAVAIDs and ASRs and PARs are normally approved by the certificate holding district office without further review and concurrence, following satisfactory completion of the pertinent items below. Category I turbojet, turbofan and propfan normally require regional flight standards review and concurrence before approval. All Category II operations and operations using NAVAIDs which are not ICAO-standard NAVAIDs (e.g., Loran C, ARA, OSAP and TLS) 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, must satisfactorily incorporate pertinent Category III provisions.

Information covered in ground training, and procedures addressed in flight training should be available to crews 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.

Crewmember duties during a the approach, flare, rollout, or missed approach should 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 crew member Category III qualification and recency must be established (see section 7.5).

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

10.3 Dispatch Planning (e.g., MEL, Alternate Airports, ETOPS). MEL and CDL provisions should be addressed, as necessary, for Category III operations. The 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 operations, a satisfactory method to address item 8.10 above should be demonstrated.

10.4 Formulation of Operations Specification Requirements (e.g., RVR limits, DH or AH, equipment requirements, field lengths). Proposed Operations Specifications should list pertinent approved RVR limits, DH or AH use provisions, "Inner Marker based DH or AH" provisions (if applicable), required transmissometers, 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 Category III). The operator's manuals, procedures, checklists, QRHs, MELs, dispatch procedures and other related flightcrew information must be shown to be consistent with the proposed Operations Specifications.

10.5 Operational/Airworthiness Demonstrations. Appropriate "airborne system suitability" and "operational use suitability" demonstrations must be completed as described in 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 AFMs referencing AC 120-28D as the criteria used as the basis for Cat III airworthiness demonstration already are considered to meet provisions of 10.5.1, and typically need only address provisions of 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 Operations Specifications 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 Ads updated with an amended type certificate (ATC) 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, HUDs, 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 ACs 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. CHDOs 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 Category IIIa or Category IIIb system installed in each aircraft type. 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) Touch down or Touch down and Rollout Performance. Describe whether or not the aircraft landed satisfactorily (within the desired touch down 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 touch down 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 touch down or touch down 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 1200 RVR (350 m) to begin a demonstration program, following successful demonstration that operator may be authorized to operate to minima of 700 RVR (200 m).

For Category III fail operational operations, where the operator was initially authorized 1200 RVR (350 m) to begin a demonstration program, following successful demonstration that operator may be authorized to operate to minima of 600 RVR (175 m) or 300 RVR (75 m) as applicable.

If the Category III rollout control system has been shown to meet the appropriate provisions of appendix 3, an applicant for Category IIIb initially authorized 600 RVR (175 m) may be authorized 300 RVR (100 m) at airports having suitable ground facilities.

Additional approvals for operations below 300 RVR (100 m) may be authorized in the future if the airplane is suitably equipped and operational experience indicates that the airborne and ground support equipment are compatible with the lower minima.

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 Operations Specifications. 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 Operations Specifications, 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 Operations Specification 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. CHDOs 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 Category III Alternates. 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, permitting an 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. Dispatch planning is based on aircraft configuration, reliability, and capability for "engine inoperative Category III" (see 10.8.2).

2. An engine fails en route, but prior to final approach (see 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 10.8.4).

4. An engine fails during approach after passing the Alert Height or Decision Height (see 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 Cat III landing at the "nearest suitable" airport in time (e.g., Does not require landing at the nearest suitable Cat III airport - section 121.565).

POIs should ensure that the following conditions are met:

1. Operations must be in accordance with the "engine inoperative Cat 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 to the aircraft dispatcher either by pre-determined certification listing or through appropriate engine-inoperative programming in automated flight planning and performance systems.

	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 II Navigation	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 of ICAO standard airway navigation facilities (VOR, VOR/DME, NDB).
Combiner	The element of the 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 (feet) of the Flight Path Control Point above the Runway Datum Point.
Decision Altitude	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)	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 touch down 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 US facilities. (Adapted from ICAO - IS&RP Annex 6)
Decision Height	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 flight crew and air traffic control can expect the aircraft to fly.
Enhanced Vision System	An electronic means to provide the flight crew with a synthetic image of the external scene.
Estimate of Position Uncertainty [EPU]	A measure based on a scale which conveys the current position estimation performance.
Extended Final Approach Segment	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 less than or equal to 1×10^{-9} per hour of flight, or per event (e.g., takeoff, landing)
Extremely Remote	A probability of occurrence greater than 1×10^{-9} but less than or equal to 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]	
Final Approach Fix (FAF)	
Final Approach Point (FAP)	
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 flight crew 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 Flight Path Alignment Point (FPAP) is used in conjunction with the Runway Datum Point (RDP) and the geometric center of the WGS-84 ellipsoid to define the geodesic plane of a precision final approach, landing and flight path. The FPAP 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	The accuracy with which the aircraft is controlled as measured by the indicated aircraft position with respect to the indicated command or desired position. It does not include blunder errors.
Glide Path Angle [GPA]	The glide path angle is an angle, defined at the Flight Path Control Point, that establishes the intended descent gradient for the final approach flight path of a precision approach procedure. It is measured from a horizontal plane that is parallel to the WGS-84 ellipsoid at the Flight Path Control Point.
Glide Path Intercept Waypoint (GPIWP)	The point at which the Final Approach Segment (FAS) projects to intercept the runway surface
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.
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 24 satellites in six orbital planes . The control segment consists of five monitor stations, three 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 flight crew 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 dis-similar 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.
Landing	For the purpose of this Advisory Circular, landing will begin at 100 feet, the DH or the AH to the first contact of the wheels with the runway.
Landing rollout	For the purpose of this Advisory Circular, 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	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	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 feet (2 m) 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

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	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)
Probable	A probability of occurrence greater than on the order of 1×10^{-5}
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.
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 Type (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 per cent 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.
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 Runway Datum Point (RDP) is used in conjunction with the Flight Path Alignment Point (FPAP) and the geometric center of the WGS-84 ellipsoid to define the geodesic plane of a precision final approach flight path to touch down and rollout. It is a point at the designated center of the landing runway defined by latitude, longitude, ellipsoidal height, and orthometric height. The RDP is a surveyed reference point used to connect the approach flight path with the runway. The RDP may not be coincident with the designated runway threshold.
Runway Segment	That segment of an approach from the Glidepath Intercept Waypoint (GPIWP) 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
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 99.99% 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	The first 3000 feet of usable runway for landing - unless otherwise specified the FAA.
Visual Guidance	Visual information the pilot derives from the observation of real world cues, outside the cockpit and used as the primary reference for aircraft control or flight path assessment

Acronyms

ACRONYM	EXPANSION
ADS	Automatic Dependent Surveillance
AFDS	Autopilot Flight Director System
AH	Alert Height
ANP	Actual Navigation Performance
APIWP	Approach Intercept Waypoint
ATC	Air Traffic Control
ATS	Air Traffic Services
CHDO	Certificate Holder District Office
CNS	Communication, Navigation and Surveillance
DA	Decision Altitude
DCH	Datum Crossing Height
DEP	Design Eye Position
DGNSS	Differential Global Satellite Navigation System
DA(H)	Decision Altitude(Height)
DH	Decision Height
DME	Distance Measuring Equipment
ECEF	Earth Centered Earth Fixed
EFAS	Extended Final Approach Segment
EPU	Estimated Position Uncertainty
FAF	Final Approach Fix
FAS	Final Approach Segment
FPAP	Flight Path Alignment Point
FPCP	Flight Path Control Point
FTE	Flight Technical Error
GLS	Global Positioning System Landing System
GNSS	Global Navigation Satellite System
GPA	Glide Path Angle
GPIWP	Glide Path Intercept Waypoint
GPS	Global Positioning System
HAA	Height Above Airpad
HAT	Height above Touch down
HUD	Head Up Display
IAW	In Accordance With
ILM	Independent Landing Monitor
ILS	Instrument Landing System
IM	Inner Marker
IMAS	Initial Missed Approach Segment
IMAWP	Initial Missed Approach Waypoint
LNAV	Lateral Navigation
LAD	Local Area Differential
MDA	Minimum Descent Altitude
MDA(H)	Minimum Descent Altitude(Height)
MDH	Minimum Descent Height - NOTE: MDH is not used for US Operations
MEL	Minimum Equipment List
MLS	Microwave Landing System
NOTAM	Notice to Airman
PF	Pilot Flying
PNF	Pilot Not Flying
POI	Principal Operations Inspector
RDP	Runway Datum Point
RNAV	Area Navigation
RNP	Required Navigation Performance
RWS	Runway Segment
SIAP	Standard Instrument Approach Procedure
STC	Supplemental Type Certificate
TC	Type Certificate
TDZ	Touch Down Zone
VNAV	Vertical Navigation
VOR	VHF Omni Range
WAD	Wide Area Differential
WAT	Weight, Altitude and Temperature

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

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.

References to JAA All Weather Operations Regulations are provided to facilitate the All Weather Operations Harmonization process. A reference to a JAR provision does not necessarily mean that the FAA and JAA requirements are <u>equivalent</u> but they are <u>related with similar intent</u>. The FAA typically may identify which JAR provisions are acceptable to FAA at the time a type certification basis is established.

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 §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 10.

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 flight crew 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 [PoC], or
- by a vision enhancement system. [PoC]

In addition to indications of the airplane position, the takeoff system should also compute and display command 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 guidance, 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 operations specification to visibility values not requiring command guidance, or

2) Based on authorizations requiring command guidance.

The airworthiness criteria for takeoff systems are based 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 with any failure or combination of failures not shown to be Extremely Improbable.

5. TYPES OF TAKEOFF SERVICES.

There are a number of navigation aids which may support aircraft systems in providing guidance to the flight crew 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 advisory circular. 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 8.1 of this advisory circular. These standards should be considered when demonstrating aircraft system operation.

5.3 GNSS [PoC].

This appendix section is not intended to provide an acceptable means of compliance for airworthiness approval of GNSS based systems. Currently approved systems are ILS or MLS based. The application of new technologies and systems will require an overall assessment of the integration of the airplane components with other elements (e.g., new ground based aids, satellite systems, advanced radar mapping systems, enhanced vision sensor systems etc.) to ensure that the overall safety of the use of these systems low visibility conditions is acceptable. This GNSS section is included to show the inherent differences between conventional ILS/MLS based systems and 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 GNSS Flight Path Definition [PoC].

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.

The required lateral path is not inherent in the design of the GNSS based Takeoff System, therefore the airplane navigation and flight guidance system will require specification of earth referenced waypoints to define the required path, which is coincident with the runway centerline.

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 advisory circular, *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 an Takeoff System should be addressed as part of the certification process. The flight crew should not be able to modify information in the data base which relates to the definition of the required flight path.

5.3.2 GNSS Airplane Position Determination [PoC].

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) [PoC]

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 [PoC]

Differential augmentation uses a GNSS receiver at a known (surveyed) point on the ground to provide corrections to the individual satellite pseudo-range data.

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 [PoC]

Local Area Differential (LAD) augmentation consists of a ground based GNSS receiver located in the area of the airport which provides differential coverage runways at that airport.

5.4 Other.

5.4.1 Datalink [PoC].
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 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 system is established.

6. BASIC AIRWORTHINESS REQUIREMENTS.

6.1 General Takeoff System Requirements.

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 flight crew 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 etc.). 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 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 overshoots or oscillations around the centerline are considered acceptable.

The performance envelope and conditions for evaluating takeoff systems for the following scenarios are described in Section 5.1.3 of this advisory circular (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 Vmcg - 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 7 meters 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 25-7. The takeoff system should provide required tracking performance with Satisfactory workload and pilot compensation, under all foreseeable normal conditions. It is 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 system shall provide guidance information, 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 as guidance for the application of 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.

To the maximum extent possible, failures that would result in unsafe conditions should be detected by the takeoff system and promptly annunciated to the pilot. Unsafe conditions include the airplane violating the lateral confines of the runway while on the ground, and rotation at an unsafe speed, pitch rate or pitch angle.

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 takeoff guidance 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 probability of the flight guidance system generating misleading information that could lead to an unsafe condition shall be Improbable when the flight crew 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 flight guidance system generating misleading information that would be hazardous 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.

The loss of an electrical source or (e.g., as a result of engine failure) shall not result in the guidance to either pilot being removed.

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 Requirements. 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 flight crew. 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 Requirements.

System design or use should not degrade the flight crews 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, Vspeed 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 Requirements. 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 Requirements.

The takeoff system must alert the flight crew 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 crew member, and compatible with the alerting philosophy of the airplane. The alerts should not result in conflicts with the alert inhibit philosophy developed to reduce high speed aborts.

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

d) Engine failure

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.

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).

6.4.3.5 Engine Failures.

Engine alerts, to include the propeller system, if applicable, should be consistent with the overall flight deck design philosophy. Engine failures shall be annunciated in a manner that provides appropriate aircrew recognition and ensures the crew has adequate awareness to take appropriate. Annunciations should be consistent with overall cockpit design philosophy, clearly indicate which engine has failed, should not cause any confusion, and should not lead to an inadvertent abort. Aircrew awareness of the engine failure should be appropriately provided for subsequent portions of the operation where the failure may be a factor.

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 on how the performance, integrity and availability "requirements" of the non-airplane elements will be ensured. Ensurance can be addressed by compliance with ICAO SARPs (or equivalent State Standard) or by reference to an acceptable standard for the performance of any navigation service.

The plan for certification shall describe 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.

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-airplane elements of the system and how these assumptions and considerations relate to the airplane system certification plan.

7.1 Performance Evaluation.

The performance of the airplane and its systems must 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 with a satisfactory level of workload and pilot compensation, as defined by the FAA Handling Quality Rating System (HQRS) found in AC 25-7.

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 flight crew 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):

- 20 normal, all-engine takeoffs.

- 10 completed takeoffs, with simulated engine failure at or after the appropriate Vef for the minimum V1 for the airplane. All critical cases must be considered.

- 10 rejected takeoffs, some with simulated engine failure just prior to V1, some with simulated engine failure at V1 and at least one run with simulated engine failure at a critical speed less than Vmcg

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 150% of the winds 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 flight crew to react in an inappropriate manner.

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, Vspeed 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 using manual control with takeoff (or command) and guidance, the set of subject pilots provided by the applicant must have relevant variability of experience (e.g., experience with HUD, Capt/FO, experience in type). These subject pilots must not have special experience that invalidates the test (e.g., not special recent training to cope with the failures, beyond what a line pilot would be expected to have). The set of pilots provided by the certifying authorities will not be limited by the aforementioned variables. Failure cases must be spontaneous and unexpected on the subject'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 25.1329-1A to meet the requirements of section 25.1309.

In showing compliance with airplane systems 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 the 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 advisory circular).

Documented conclusions of the safety analysis shall include:

A Functional Hazard Assessment (FHA), conducted in accordance with section 25.1309, will determine potential hazards that are either induced or aggravated by system malfunctions. The FHA determines the necessity for Fault Tree Analysis of particular functions, and defines the upper level events in the fault trees.

A fault tree analysis, demonstrated compliance, and probability requirements for significant functional hazards.

A list of all alleviating flight crew actions, that were considered in the safety analysis, and must be validated during testing for incorporation in the airplane flight manual procedures section or for inclusion in type-specific training.

A list of all maintenance procedures required to ensure safety, such as certification maintenance requirements (CMR), periodic checks, and so on.

8. AIRBORNE SYSTEM REQUIREMENTS.

8.1 General Requirements.

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 Title 14 of the Code of Federal Regulations (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 §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 situational 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 Captains 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 requires an overall assessment of the integration of the airplane components with other elements (e.g., ground based aids, satellite systems, advanced radar mapping systems, enhanced vision sensor systems, as applicable) 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 advisory circular.

8.4.2 On Board Database.

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 flight crew 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.

A data link may be used to provide data to the airplane to provide the accuracy necessary to define the takeoff flight path. 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:

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.

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.

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 flight crew with an enhanced view of the scene outside the airplane (e.g., radar) may be considered for airworthiness approval. However, this Appendix does not comprehensively address a means of compliance for airworthiness approval of such Enhanced Vision Systems. Performance must be demonstrated to be acceptable to the FAA through proof of concept testing **[PoC]**, during which specific airworthiness and operation 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 for a takeoff system are provided in Appendix 6.

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

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 Advisory Circular. 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 120-29A, 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.

References to JAA All Weather Operations Regulations are provided to facilitate the All Weather Operations Harmonization process. A reference to a JAR provision does not necessarily mean that the FAA and JAA requirements are equivalent but they are related with similar intent. The FAA typically may identify which JAR provisions are acceptable to FAA at the time a type certification basis is established.

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 advisory circular 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, Global Navigation Satellite System (GNSS), Inertial information, Local Area Differential GNSS, or 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),

- on-board navigation system computations with corresponding displays of position and reference path [PoC], or

- by a vision enhancement system. [PoC]

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

NOTE: The following engine inoperative capabilities may be demonstrated, for each 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.

The following definitions can be used for the operations described above.

Landing - for the purpose of this Appendix, landing begins at 100 ft. and continues 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.

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.

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 GNSS [PoC]. This appendix section is not intended to provide a comprehensive means of compliance for airworthiness approval of GNSS based systems. Currently approved systems are ILS or MLS based. The application of new technologies and systems will require an overall assessment of the integration of the airplane components with other elements (e.g., new ground based aids, satellite systems, advanced radar mapping systems, enhanced vision sensor systems) to ensure that the overall safety of the use of these systems for Category III. This GNSS section is included to identify important differences between conventional ILS/MLS based systems and GNSS based systems that 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 GNSS Flight Path Definition [PoC]. 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.

The required flight path is not inherent in the design of the GNSS based Landing and Rollout System, therefore the airplane navigation and flight guidance system must specify a sequence of earth referenced waypoints to define the required flight path.

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 advisory circular 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 an 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 GNSS Airplane Position Determination [PoC]

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) [PoC]

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 [PoC]

Differential augmentation uses a GNSS receiver at a known (surveyed) point on the ground to provide corrections to the individual satellite pseudo-range data.

If a ground based GNSS receiver 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 will have to be established.

The role of the differential station in the landing 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 .[PoC]

Local Area Differential (LAD) augmentation consists of a ground based GNSS receiver located in the area of the airport which provides differential coverage runways at that airport.

Wide Area Differential Augmentation [PoC]

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 [PoC]. 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 US, or international standards for data link ground systems are established.

6. BASIC AIRWORTHINESS REQUIREMENTS. 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 6.1.1 below) are the same for landing systems with automatic flight control, and systems with manual control and command 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 Requirements.

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 120-29A, 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 landing and rollout using command guidance, may not be less than that achieved in an equivalent 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 under automatic or command guidance control.

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 guidance provided during the landing and rollout should be consistent with manual flight control 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 (e.g., Go-around), 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 control or command guidance actions of the system and the resulting airplane flight path shall not contain unusual features liable 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 Requirements. The applicant shall establish acceptable approach performance to the criteria contained in AC 120-29A, 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 should be conducted to the point where a smooth transition is made to the landing.

Prior to touch down, the system may enter an align mode to correct for crosswind effects. This mode, if provided, must be annunciated to the flightcrew and should operate in a manner consistent with a pilots manual technique for crosswind landings using the wing low side slip procedure.

The landing flare to touch down should reduce the airplane sink rate to a value and in a manner, that is compatible with normal flight operations.

The automatic flight control system should provide de-rotation, consistent with manual operation. Manual rollout systems are not required to provide de-rotation. Systems which provide de-rotation (automatic or guidance) 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 manual pilot operation and not require excessive skill or crew workload to accomplish the operation.

6.3.1 Landing System Performance. All types of low visibility landing systems, whether they use automatic flight control, manual control with command guidance, or hybrid, under the conditions for which their use is to be approved, shall be demonstrated to achieve the performance accuracy with the prescribed probabilities as described below. The values may be varied where characteristics of a particular airplane justify such variation.

(a) Longitudinal touch down earlier than a point on the runway 200 ft. (60m) from the threshold to a probability of 1 x 10-6;

(b) Longitudinal touch down beyond the end of the touch down zone lighting, 2700 ft.(823 m) from threshold to a probability of 1 x 10-6;

(c) Lateral touch down with the outboard landing gear more than 70 ft. (21.3 m) from runway centerline to a probability of 1 x 10-6.

(These values assume a 150 ft. (45.7 m) runway. The lateral touch down performance limit may be appropriately increased if operation is limited to wider runways;

(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 Title 14 of the Code of Federal Regulations (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 of FAR/JAR 25.485 and the worst combination of loads which are likely to arise during a lateral drift landing. In the absence of a more rational analysis of this condition, the following must be investigated:

(A) A vertical load equal to 75% of the maximum ground reaction of FAR/JAR 25.473 must be considered in combination with a drag and side load of 40% and 25%, respectively, of that vertical load.

(B) The shock absorber and tire deflections must be assumed to be 75% of the deflection corresponding to the maximum ground reaction of FAR/JAR 25.473 (a)(1)(ii). This load case need not be combined with flat tires.

(e) Bank angle resulting in hazard to the airplane to a probability of 1 x 10-7. A hazard to the airplane is interpreted to mean a bank angle resulting in any part of the wing 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. This requirement applies to both manual and autothrottle operations.

NOTE: This criteria is not specific to low visibility systems, but must be met by low visibility systems.

6.3.3 Rollout System Performance.

(a) The rollout system, if included, should control the airplane, in the case of an automatic flight control system, or provide 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. The following performance must be investigated to ensure the rollout system will:

(1) Cause the airplane to capture the runway/localizer centerline in a smooth and predictable manner. Minor oscillations around the localizer centerline are acceptable. Undamped or divergent oscillations are not acceptable

(2) Promptly correct any lateral movement away from the runway centerline in a positive manner.

(3) Cause the airplane to 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. This point of intercept should be sufficiently before the end of the runway to permit the system to capture the centerline.

(b) The rollout system performance is referenced to the center line 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 converge on the intended path in a mild and predictable manner. Minor overshoots are considered acceptable, but sustained or divergent oscillations are unsatisfactory.

(c) The normal rollout system performance should not cause the outboard tires to deviate from the runway centerline by 70 ft. (21.3 m) from the point of touch down to a safe taxi speed, more often than once in one million (10^6) landings.

(d) 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. (45.7 m) runway width. The rollout performance limit may be appropriately increased if operation is limited to wider runways.

> **NOTE: 70 ft.(21.3 m) deviation from centerline is equivalent to outboard tires at 5 ft. (1.5 m) within the edge of a 150 ft. (45.7 m) 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, DGPS, GNSS - ground, airplane and space elements etc.)

f. Approach airspeed and variations in approach airspeed.

g. Airport conditions (density altitude, 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 60 m prior to the threshold; or

c. Sea-wall - 6 m (20 ft.) step up to threshold elevation at a point 60 m 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 advisory circular).

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 positions;

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:

1. Information on height loss as a function of go-around initiation altitude, and

2. Performance information allowing the operator to determine that safe obstacle clearance can be maintained during a go around with an engine failure, or

3. A method to assess and extend applicability of engine inoperative takeoff performance obstacle clearance determinations for a balked landing or go-around event, or

4. For aircraft certificated by the JAA, information on the standard climb gradient achievable with an engine inoperative in the applicable configuration and with applicable configuration changes. (NOTE: for use of this method, the operator must in turn show that the standard gradient shown during airworthiness demonstration assures engine inoperative obstacle clearance for a balked landing at the end of the touch down zone for each runway served.)

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 as guidance for the application of section 25.1309 to Landing Systems:

For Fail Passive landing systems after beginning the final approach, any malfunction or any combination of malfunctions that could prevent a safe landing or go around must be considered at least Hazardous, and must be detected and annunciated as a warning to the flightcrew, unless shown to be Extremely Improbable, to ensure immediate corrective action. Flightcrew corrective actions shall be consistent with the requirements of section 25.1309.

Prior to 200 ft. HAT, the Fail Operational landing system shall detect and annunciate any failure condition not shown to be Extremely Improbable that could prevent a safe landing or go around. Below 200 ft. HAT, any single failure, and any combination of malfunctions not shown to be Extremely Improbable, must not prevent the Fail Operational landing system from performing a safe landing on the runway.

Below 200 ft. HAT, malfunctions of the Fail Operational landing system that would require flightcrew intervention to ensure safe landing or go around must be considered at least Hazardous, and must be detected and annunciated as a warning to the flightcrew to ensure immediate corrective action. Flightcrew corrective actions must be shown to be consistent with the requirements of section 25.1309.

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. (1000 m) 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. (21 m) from runway centerline.

(These values assume a 150 ft. (45 m) 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 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 of FAR/JAR 25.485 and the worst combination of loads which are likely to arise during a lateral drift landing. In the absence of a more rational analysis of this condition, the following must be investigated:

(A) A vertical load equal to 75% of the maximum ground reaction of FAR/JAR 25.473 must be considered in combination with a drag and side load of 40% and 25%, respectively, of that vertical load.

(B) The shock absorber and tire deflections must be assumed to be 75% of the deflection corresponding to the maximum ground reaction of FAR/JAR 25.473 (a)(1)(ii). This load case need not be combined with flat tires.

(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 control, or guidance information for the pilot, 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 as guidance for the application of section 25.1309 to Landing Systems:

The Fail Operational rollout system must meet the safe rollout performance requirements of appendix section 6.3.3 (i.e. no lateral deviation greater than 70 ft. (21.3 m) from centerline) after any single malfunction, or after any combination of malfunctions not shown to be Extremely Remote. The wheel deviation occurrence rate requirement which applies to a normal system (once in one million (10^6) landings) does not apply to a system with the single failures described above. Malfunction cases may be considered under nominal environmental conditions.

Below 200 ft. HAT, unannunciated malfunctions that would prevent a safe rollout must be shown to be Extremely Improbable.

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.

After touch down, loss of the Fail Passive automatic rollout function shall cause the automatic flight control system to disconnect. Whenever the Fail Passive guidance function for manual rollout does not provide valid guidance, it shall be annunciated to both pilots, and the guidance removed. The removal of guidance, alone, is not adequate annunciation. The loss of a Fail Passive rollout system after touch down shall be Improbable.

With malfunctions that only affect low speed directional control (speeds below which rudder is ineffective for steering), the rollout system performance should not cause the airplane wheels to exceed the lateral confines of the runway from the point of touch down, to a safe taxi speed, more often than once in ten million (10^7) landings. A Safe Taxi Speed is a speed at which the pilot can resume manual control to 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.

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.

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% (i.e. the combination of failures in the airplane approach and landing system and the incidence of unsatisfactory performance shall not result in a go-around rate greater than 5%) for approaches conducted in the airplane. Compliance with this requirement 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. AGL on approach due to an airplane failure condition should be Infrequent (i.e. 1 per 1000 approaches).

For a Fail Operational system, the probability of total loss of the landing system with appropriate annunciation below 200 ft. HAT on approach must be Extremely Remote (and without annunciation shall be Extremely Improbable, refer to section 6.4.1 of this appendix).

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. 1 per 1000 approaches), and the probability of total loss of rollout capability should be Extremely Remote, considering loss or failure of the rollout system.

6.6 Go-Around Requirements.

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 go-around from a low altitude may result in inadvertent runway contact, the safety of the procedure should be established giving consideration to at least the following:

a. The guidance information and control provided by the go-around mode, if provided, should be retained and be shown to have safe and acceptable characteristics throughout the maneuver,

b. 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.

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.

Height loss from a range of altitudes during the approach and flare should be determined when under automatic control and when using the landing guidance system as appropriate.

a. Height losses may be determined by flight testing (typically 10 go-arounds) supported by simulation.

b. 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.

c. Normal procedures for a go-around with all engines operating should be followed.

6.7 Automatic Braking System Requirements.

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 Requirements. 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 Requirements. This section identifies requirements for basic situational and guidance 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 approach identifier/frequency, and selected navigation source)

2) Indication of the position of the aircraft with respect to the intended path (e.g., situational information localizer and glide path, or equivalent).

6.8.2 Annunciation Requirements.

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 them to take appropriate corrective action. A warning indication must be provided if immediate corrective action is required. An analysis must 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 the worst case ambient noise conditions, but not so loud and intrusive as to interfere with the crew taking the required corrective action. Visual warnings, such as lights or alphanumeric messages, must be distinct and conspicuously located in the primary field of view for both pilots.

The loss of a Fail Passive or Fail Operational system, after beginning the final approach, shall be annunciated. Whenever a Fail Passive guidance function (for manual control) does not provide valid guidance, it shall be annunciated to both pilots, and the guidance removed. The removal of guidance, alone, is not adequate annunciation.

Below the Alert Height, a reversion (or degradation) of the Fail Operational system to Fail Passive capability shall not be annunciated.

6.8.3.2 Cautions

A caution is required whenever immediate crew awareness is required and timely subsequent crew action will 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.

During final approach, but above the Decision Height, a Fail Passive landing system, or landing and rollout system, shall alert the flightcrew to any malfunction or condition that would affect the ability of the system to support the operation.

After initiation of the final approach, a Fail Passive command guidance systems (HUD guidance for example), shall provide a clear, distinct and unmistakable indication to both pilots for any malfunction or condition that would affect the ability of the system to support the operation.

During final approach, but above 200 ft. HAT, a Fail Operational landing and rollout system (Fail Operational or Fail Passive rollout) shall alert the flightcrew to any malfunction or condition that would affect the ability of the system to support the operation, and any malfunction that degrades the landing system from a Fail Operational to a Fail Passive landing system.

Below 200 ft. HAT and throughout the rollout phase, Fail Operational landing systems shall suppress alerts for malfunctions that reduce the landing system to a Fail Passive landing system.

Deviation alerting - The FAA does not require automatic alerting of excessive deviation, but will approve systems which meet appropriate criteria. 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 is provided, its use must not cause excessive nuisance alerts.

For systems demonstrated to meet criteria for Category II, compliance with the following criteria, from JAA/AWO 236, is an acceptable means of compliance, but is not a required means of compliance:

a) For systems meeting the AWO 236 criteria, excess-deviation alerts should operate when the deviation from the ILS or MLS 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 available in these conditions.

b) For systems meeting the AWO 236 criteria, excess-deviation alerts should be set to operate with a delay of nor more than one (1) second from the time that the deviation thresholds are exceeded.

c) For systems meeting the AWO 236 criteria, excess-deviation alerts should be active at least from 300 ft. (90 m) HAT to the decision height, but the glide path alert may be discontinued below 100 ft. (30 m) 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 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 affecting the intended landing operation must be indicated to the flightcrew as an advisory, without flightcrew action.

A means shall be provided to advise the flightcrew of failed airplane system elements that affect the decision to continue to the destination or divert to an alternate.

During the approach, an indication of a failure in each non-selected airplane system element must be provided to the flightcrew as an indication of system status; it should not produce a caution or warning.

System Status indications should be identified by names that are different than operational authorization categories (e.g., use names such as "LAND 3", or "DUAL", - do not use CAT I, II, III)

6.8.3.5 Engine Failure Annunciations with use of Low Visibility Landing Systems. For approach, landing, and rollout, engine failures, including those involving propeller systems, if applicable, shall be annunciated in a manner that provides appropriate aircrew recognition and ensures the crew has adequate awareness to take appropriate action for the current phase and subsequent phases of the operation being conducted. Annunciations should be consistent with overall cockpit design philosophy, clearly indicate which engine has failed, should not cause any confusion, and should not lead to an inadvertent or inappropriate go-around. Aircrew awareness of the engine failure should be appropriately provided for subsequent portions of the operation where the failure may be a factor. The following outlines the operating philosophy relevant to these annunciations.

a. Above decision or alert height, engine failures will be annunciated at all times in a manner which will provide immediate flightcrew awareness and allow the crew to take appropriate action.

b. At touch down and throughout the rollout, engine failures will be annunciated in a manner which will provide immediate flightcrew awareness and allow the crew to take appropriate action. If an engine failure has occurred prior to touch down, but was not annunciated due to inhibits, it must be annunciated at touch down.

c. Below 200 ft. HAT (or the alert height demonstrated in certification, which ever is higher) to touch down for any portion where a go-around is required in the event of an engine loss, engine failures will be annunciated at all times in a manner which will provide immediate flightcrew awareness and allow the crew to take appropriate action.

d. Below 200 ft. HAT (or the alert height demonstrated in certification, which ever is higher), for aircraft that are expected to continue to land with loss of an engine during this phase, engine failure annunciations may be inhibited until touch down. If engine failures are annunciated in these cases, the annunciation must not cause confusion or lead to an inadvertent go-around.

All references to engine failures include failures of the propeller and automatic feathering systems, as applicable.

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, GNSS Landing System (GNSS)).

6.9.1 General Requirements. 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 audio idents) 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 acceptable 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, GNSS 'path identifier') shall be unambiguously indicated in a position readily accessible and visible to each pilot;

A common set of mode ARM and ACTIVE indications (e.g., LOC and GS) is preferred for ILS, MLS and GNSS 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 require alternate airports for takeoff, en route diversion and landing. These alternate airports may have different landing systems. Flight operations may be planned, released and conducted on the basis of using one or more landing systems.

The capability of each element of a multi-mode landing system shall be available to the flightcrew to support dispatch of the airplane.

A failure of each element of a multi-mode landing system must be indicated to the flightcrew as an advisory, without pilot action, during en route operation.

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 during an approach and landing shall be available to the flightcrew as an advisory but should not produce a caution or warning. These advisories may be inhibited at the Alert Height, if appropriate to the operation.

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, 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).

Touch down footprints, sink rates and attitude requirements for systems with manual control and command guidance must be met as for systems with automatic flight control.

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 information 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 information is based upon the presence of adequate outside visual references for the flightcrew to safely continue the operation. The airworthiness demonstration will include the loss of guidance.

For rollout systems with command guidance, it shall be demonstrated that a safe rollout can be achieved with a Satisfactory level of workload and pilot compensation following a failure, using the FAA Handling Quality Rating System (HQRS) found in AC 25-7, with and without external visual references.

For the evaluation of low visibility systems with manual control and guidance, the set of subject pilots provided by the applicant must have relevant variability of experience (e.g., experience with HUD, Capt/FO, experience in type). These subject pilots must not have special experience that invalidates the test (e.g., not special recent training to cope with the failures, beyond what a line pilot would be expected to have). The set of pilots provided by the certifying authorities will not be limited by the aforementioned variables. Failure cases must be spontaneous and unexpected on the subject's part.

For the initial certification of a landing and rollout system comprised of manual control and command guidance (e.g., HUD guidance system) in a new type airplane, at least 1,000 simulated landings and at least 100 actual landings will be 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, pilots of varying background and experience level should be used in the flight and simulation programs. They should have appropriate qualifications and be given training in the use of the landing system similar to that expected for line pilots. After approximately ten consecutive approaches, each pilot should be given an appropriate rest break.

When simulation is used in the establishment of the density altitude demonstration value of the landing and rollout system, it must be accompanied with sufficient flight test demonstrations. Due to the uncertainties in the fidelity of simulations used to represent performance in high density altitude operations, the Figure 7.1.1-1 and accompanying table identify the relationship between the demonstrated density altitude which could be noted in the AFM and the altitude which is actually demonstrated by flight evaluation - when supported by validated simulation.

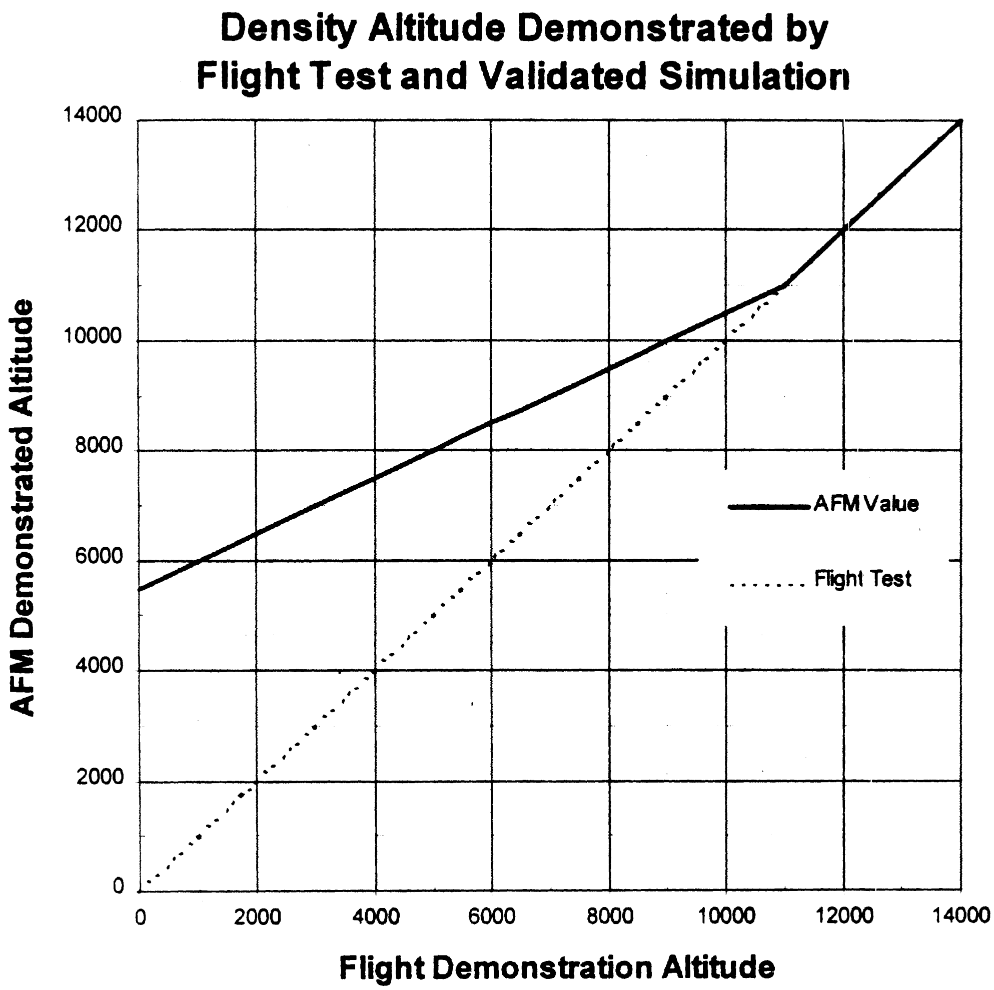


Figure 7.1.1-1

AFM Demonstrated Altitude Shown by Validated Simulation (feet)	Minimum Required Density Altitude of Flight Test Demonstration (feet)
5,500	0
6,000	1,000
6,500	2,000
7,000	3,000
8,000	5,000
9,000	7,000
10,000	9,000
11,000	11,000

Unlike operational demonstrations, this flight test demonstration of a higher density altitude necessitates the use of an instrumented airplane, capable of recording the airplanes trajectory, runway touch down point and rates, atmospheric conditions (temperature, atmospheric pressure, wind velocity and direction) as well as the powerplant and airplane parameters. The recorded flight test data are required to verify the simulated performance of the landing system, including its flare control laws and automatic throttle control laws. If discrepancies in the simulation results are found, the simulation must be corrected and accomplished again to demonstrate performance at the AFM Demonstration Altitude. If approved simulation data cannot be obtained, flight test results alone, based on approximately ten to fifteen landings at the demonstration value, can be used to establish the AFM Demonstration Altitude.

The AFM will state the density altitude values at which the automatic landing system was demonstrated by validated simulation and by flight test.

7.1.1 Validation of the Simulator.

The certification process for systems designed for Category III operations requires the use of a high fidelity simulator. A simulator is capable of varying one parameter at a time, and is the ideal tool to examine the effects of wind and turbulence upon the approach and landing performance.

Advisory Circular AC 120-40B (7/29/91) Airplane Simulator Qualification provides a means to qualify simulators for training of pilots. Meeting these requirements provides a known basis for acceptance of simulation capability. Meeting the requirements of AC 120-40B is optional. In addition, the FAA reviews simulators on a case by case basis considering at least the following:

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) source of aerodynamic performance and handling quality data used,

4) visual system fidelity and layout,

5) environmental models and methods of model input to equations of motion,

6) adverse weather models (e.g., visual reference fog models, runway friction)

7) irregular terrain models,

8) altitude, temperature effects.

A high degree of fidelity is required in all component parts of the simulation including: longitudinal, lateral and directional stability (static and dynamic), ground effect during takeoffs and landings, rollout, propulsion system, (especially if a turbo-propeller is installed), flying qualities, tracking tasks, force characteristics of the flight controls (yoke/wheel, rudder, brakes) and performance of the airplane. The fidelity of the simulator can be demonstrated using matching time histories obtained from flight test. These data will be considered part of the type certificate data.

When simulation is used for demonstration of manual systems with command guidance, suitable simulation fidelity must be addressed (e.g., visual references, system interfaces, motion base, "ground effect" aerodynamics, wind/turbulence model interface with the simulation, landing gear and ground handling dynamics, stability derivative estimates and flight control responses suited to alignment and flare control tasks, fog/visibility restriction models). Typically, training simulators do not have suitable fidelity in each area, and may not acceptable without modification for such use.

7.1.2 Simulations for Automatic System Performance Demonstration.

The certification process for systems designed for Category III operations typically requires the use of a high fidelity fast time simulation for assessment of automatic systems. The FAA reviews simulation capability on a case by case basis considering at least the following:

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) 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 equations of motion,

6) adverse weather models (e.g., turbulence, wind gradients, wind models)

7) irregular terrain models,

8) altitude, temperature effects.

Fidelity of the aerodynamic model are needed, notably for the ground effect, propulsion effects, touch down dynamics, de-rotation, and landing gear models if required for ground rollout characteristics. The fidelity of the simulator can be demonstrated using matching time histories obtained from flight test. These data may be considered as part of the type certificate data.

7.1.3 Flight Test Performance Demonstration. A test airplane equipped with special instrumentation, can be used, to record the necessary low altitude quantitative data, which are used for correlation with the simulator used for the Monte Carlo study and failure demonstrations. The performance parameters of interest include: vertical and lateral flight path tracking, height above terrain, longitudinal and lateral runway touch down point (this requires special instrumentation capable of recording aerodynamic parameters, accelerations, airspeed and surface winds at the time of touch down). Also recorded are heading, altitude, control surface positions, command guidance, sink rate at touch down (for structural limit load) wing tip ground contact, slip angle at touch down (for gear/tire load) and the lateral deviation from runway centerline during rollout.

It should be an objective of the flight test program to demonstrate the performance of the system to 100% of the wind limit values used for statistical performance. The data taken during flight test should be used to validate the simulation. The simulation can be considered validated if four landings are accomplished during flight test at least 80% of the limit value and best effort has been made to achieve the full value and it can be shown that the landing system is robust enough at and close to the desired AFM wind limits.

7.1.4 Demonstration of Approach and Automatic Landing with an Inoperative Engine.

Identification of a critical engine should consider the transient and steady state effects on performance, handling, loss of systems, and landing status. More than one engine may be critical for different reasons.

If the airplane configuration and operation are the same as that used in the performance demonstration of section 6.3.1 for all engine operation, compliance may be demonstrated by, typically, 10 to 15 landings.

If the airplane configuration or operation is changed significantly from the all engine operating case, compliance may be demonstrated by statistical analysis supported by flight test, and the effect on landing distance must be considered.

To aid planning for landing with an inoperative engine, appropriate procedures, performance, and obstacle clearance information will need to be established for a safe go-around at any point in the approach.

For the purposes of this requirement, demonstration of landing and go-around performance in the event of a second engine failure need not be considered.

If compliance is established, a statement shall be included in the Non-normal Procedures, or equivalent section of the Flight Manual, that approach and automatic landing made with an engine inoperative have been satisfactorily demonstrated, together with the conditions under which that demonstration was made.

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 automatic landing and rollout, or landing and rollout using manual systems with command guidance, may not be less than that achieved in manual landing. 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 systems.

In showing compliance with airplane systems performance and failure requirements, the probabilities of performance or failure effects may not be factored by the proportion of approaches which are made in low visibility conditions.

The effect of the failures of the navigation facilities must be considered taking into account ICAO and other pertinent State criteria.

Documented conclusions of the safety analysis shall include:

A summary of results from the fault tree analysis, demonstrated compliance, and probability requirements for significant functional hazards.

A list of all alleviating flightcrew actions, that were considered in the safety analysis, and must be validated during testing for incorporation in the airplane flight manual procedures section or for inclusion in type-specific training.

A list of all maintenance procedures required to ensure safety, such as certification maintenance requirements (CMR), periodic checks, and so on.

Applicable limitations

Equipment required to dispatch the aircraft and start the approach.

Non normal procedures

8. AIRBORNE SYSTEM REQUIREMENTS.

The airborne system should be shown to meet the performance, integrity and availability requirements identified previously for the type(s) of operation for which approval is sought.

Individual Category III airborne systems shall comply with the pertinent sections of this appendix and the specific requirements which follow.

8.1 Automatic Flight Control Systems.

When established on the final approach path below 1000 ft., 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 out-of-trim forces that might lead to an unacceptable flight path disturbance.

It must be possible for the flightcrew to disengage the automatic landing system by applying a force to the control column or control stick. This force should be high enough to preclude inadvertent disengagement, but low enough to be applied with one hand.

Following a failure or inadvertent disconnect of the automatic pilot, or loss of the automatic landing mode, when it is necessary for the 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 crew member, the warning must sound for a period long enough to ensure that it is heard and recognized by other crew members, and continue until silenced by one of the pilots with the automatic pilot quick release control, which is mounted on the control wheel/stick.

Below 200 ft. HAT, for a fail operational landing system, any system failure (Extremely Remote) which could result in an unsafe condition shall be annunciated by disconnecting the automatic flight control system passively.

8.2 Autothrottle Systems.

It must be possible to override the automatic throttle (when provided) without using excessive force.

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 an excessive workload in conditions for which the system is to be demonstrated;

(2) With manual control of throttles, the touch down performance limits are achieved both for normal autopilot operations and during takeover to manual HUD control

A automatic throttle system must provide safe operation taking into account the factors listed in AC Section 7.1 Landing and Rollout Criteria. 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 the 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.

An indication of automatic throttle engagement must be provided.

An appropriate alert or warning of automatic throttle failure must be provided.

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.

8.3 Head Up Guidance.

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.

The work load associated with use of the HUD must be considered in showing compliance with the minimum flightcrew requirements found in section 25.1523.

The HUD installation and display presentation must not significantly obscure the pilot's view through the cockpit window.

For control of approach, landing and rollout flight path, the HUD must provide sufficient guidance information 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 or to make a go-around without reference to other cockpit displays.

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 there are compensating features for displaying them elsewhere.

If the landing and rollout system is designed as a single HUD configuration, the HUD shall be installed for the Captain's crew station.

For dual HUD configurations, only the Pilot Flying (PF) should use a HUD during the approach, since the Pilot Not Flying (PNF) must monitor the approach, engines and alerts. While the head down instrumentation is primary for the PNF, the PNF HUD may be deployed.

The HUD guidance must not require exceptional piloting skill to achieve the required performance.

If the automatic flight control system is used to control the flight path of the airplane during the initial approach (i.e. to intercept and establish the approach path), the point at which the transition from automatic to manual flight takes place shall be identified and used for the performance demonstration.

Any transition from automatic flight control to manual control with HUD command guidance must not require exceptional piloting skill, alertness, strength or excessive workload.

If the HUD fails at any time during a go-around (G/A), the pilot must be able to revert to the head down instrumentation to complete the maneuver without loss of performance.

Demonstration of landing and go-around (G/A) cases from at least 50 ft. HAT for the HUD system is necessary. Demonstrations are required in conditions without external visual references, and when external visual references and instrument references disagree (e.g., localizer centering errors).

For control of ground roll, if rollout guidance is provided on the HUD, it must enable the pilot to control the airplane along the runway after touch down within the prescribed limits. Generally, rollout 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 situational information, in lieu of command guidance, requires a successful proof of concept evaluation. [PoC]

After touch down, loss of the Fail Passive command guidance rollout system (i.e. with manual control), shall be annunciated with an appropriate visual alert and removal of the command guidance.

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 are provided to the flightcrew to ensure a safe operation.

8) The combined elements of the system are demonstrated to meet the required Fail Operational criteria necessary to support the operation (refer to Section 4 of the advisory circular)

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).

8.4.2 Hybrid System Go Around Capability.

Demonstration of landing and go-around (G/A) cases from at least 50 ft. AGL for each element of hybrid system is necessary. Demonstrations are required both in conditions without external visual references, and with the presence of external visual references that disagree with instrument references (e.g., localizer centering errors).

8.4.3 Hybrid System Transition From Automatic to Manual Flight.

Demonstration of a safe takeover to a go-around, and a safe takeover to a "continuation to land" within the established touch down footprint is necessary. Appropriate time delays for the transition should be demonstrated.

8.4.4 Hybrid System Pilot Not Flying (PNF).

The pilot not flying (PNF) must have suitable information provided to accomplish appropriate duties, be an integral part of the crew, and safely deal with immediate or subtle incapacitation of the Pilot Flying (PF).

8.5 Satellite Based Landing Systems [PoC].

This appendix is intended to provide criteria but not an acceptable means of compliance for airworthiness approval of GNSS based systems. Currently approved systems are ILS or MLS based. The application of new technologies and systems will require an overall assessment of the integration of the airplane components with other elements (e.g., new ground based aids, satellite systems, advanced radar mapping systems, enhanced vision sensor systems) 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 equivalent to the overall performance, integrity and availability provided by ILS to support Category III operations.

The following requirements will apply to Approach and Landing Systems using GNSS:

Prior to departure, the crew must be able to determine the expected status of the GNSS service at the time the airplane arrives at the destination or alternate airport which may experience low visibility conditions.

En route, the crew must be able to determine the current status of the GNSS service at the destination or alternate airport which may experience low visibility conditions.

During the approach, the flightcrew must be informed if the landing system can not support the required performance and integrity - including the GNSS service. This item should include the assessment of satellite vehicle failures and the effect of satellite vehicle geometry on the required performance and integrity.

The GNSS system assessment will include the failure mode detection coverage and adequacy of monitors and associated alarm times. The Landing and Rollout System performance, failure detection and annunciation mechanism shall be designed based upon on ICAO Standards and Recommended Practices, or agreed State criteria.

The effect of airplane maneuvers on the reception of signals must be considered as necessary to maintain the required performance and integrity. 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 advisory circular.

8.5.2 Aircraft Database.

The required flight path could be stored in an aircraft database for recall and incorporation into the flight guidance and/or control system when required to conduct the 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.

The flightcrew shall not be able to modify information in the data base which relates to the definition of the required flight path.

8.5.3 Differential Augmentation.

Differential augmentation uses a satellite receiver at a known (surveyed) point on the ground to provide corrections to the individual satellite pseudo-range data.

If a ground based satellite receiver 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 will have to be established.

The role of the differential station in the landing system will have to be addressed as part of 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 will have to 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 [PoC].

The Enhanced Vision System concept is to use airplane sensors which penetrate visibility restrictions and provide the flightcrew with an enhanced view of the scene outside the airplane (e.g., radar).

This appendix section is not intended to provide an acceptable means of compliance for airworthiness approval of Enhanced Vision Systems. Criteria for approval of the enhanced vision system must match its intended use, whether for assessing integrity (an independent landing monitor), for providing flight guidance, or both. Whatever the intended function of the Enhanced/Synthetic Vision system, its performance must be demonstrated to be acceptable to the FAA through proof of concept testing **[PoC]**, during which specific airworthiness and operation criteria will be developed. The fidelity, alignment and real time response of the enhanced view must be shown to be appropriate for the intended application

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 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).

Applicable atmospheric conditions under which the system was demonstrated (e.g., demonstrated headwind, crosswind, tailwind) as follows:

a) in the Limitations Section. - the wind values used for statistical analysis supported by flight evaluation which apply to landing systems used during low visibility operations

b) in the Normal Operations, or equivalent section, the wind experienced during the flight demonstration as Demonstrated Winds. (Provided for information only)

c) For non-landing systems (i.e. system performance not supported by statistical analysis):

d) FAA - does not apply a limitation unless unacceptable system characteristics dictate a limitation - the demonstrated value for the basic airplane is included in the AFM for information.

5) For a landing or landing and rollout system meeting provisions of Appendix 3, 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."

Examples of general AFM considerations and specific AFM 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 windshear 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 windshear component is that portion which effects the air mass moving along the ground (i.e., ground friction). The magnitude of the shear is defined by the following expression:

$V_{wref} = 0.204 * V_{20} * \ln((h + 0.15)/0.15)$

where V_{wref} is the mean wind speed measured at h ft. and 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:

$$\Phi_W(\Omega) = \frac{\sigma_W{}^2 L_W}{2\pi} \; \frac{1 + \frac{8}{3}(1.339\, L_W\Omega)^2}{\left(1+(1.339\, L_W\Omega)^2\right)^{11/6}}$$

where:

W = spectral density in $(\text{ft./sec})^2$

W = root mean square (rms) turbulence magnitude = $0.1061 V_{20}$

L_W = scale length = h (for h < 1000 ft.)

= spatial frequency in radians/ft.

Note: = $/V_T$, where

= temporal frequency in radians/sec

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:

$$\Phi_u(\Omega) = \frac{\sigma_u^{\,2} L_u}{\pi} \; \frac{1}{(1 + (1.339\, L_u \Omega)^2)^{5/6}}$$

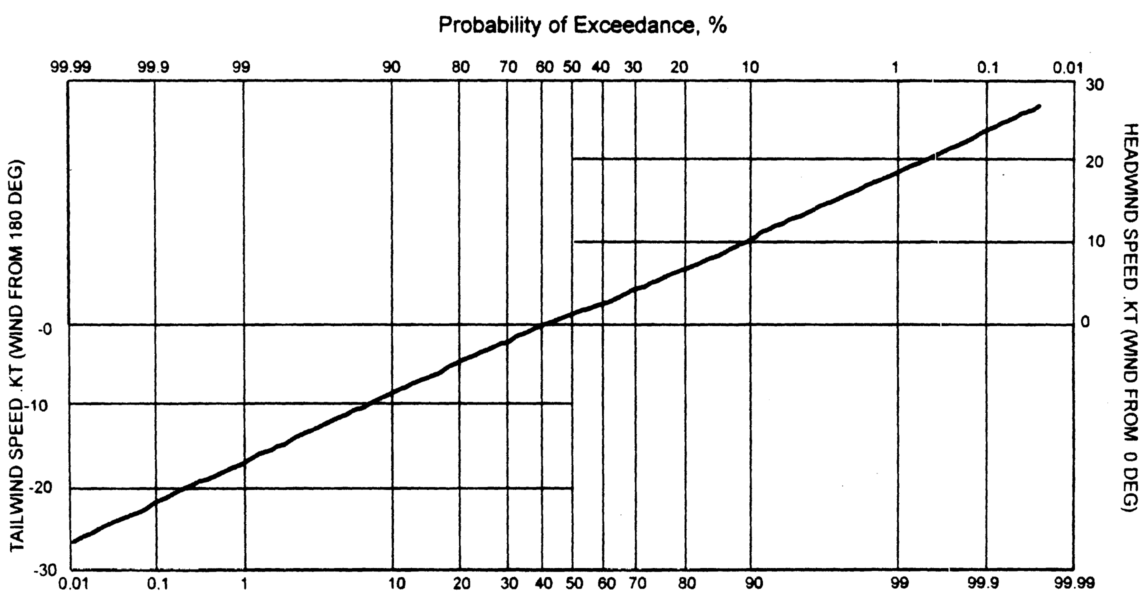
Lateral Component:

$$\Phi_V(\Omega) = \frac{\sigma_V^{\,2} L_V}{2\pi} \; \frac{1 + \frac{8}{3}(1.339\, L_V \Omega)^2}{(1 + (1.339\, L_V \Omega)^2)^{11/6}}$$

where

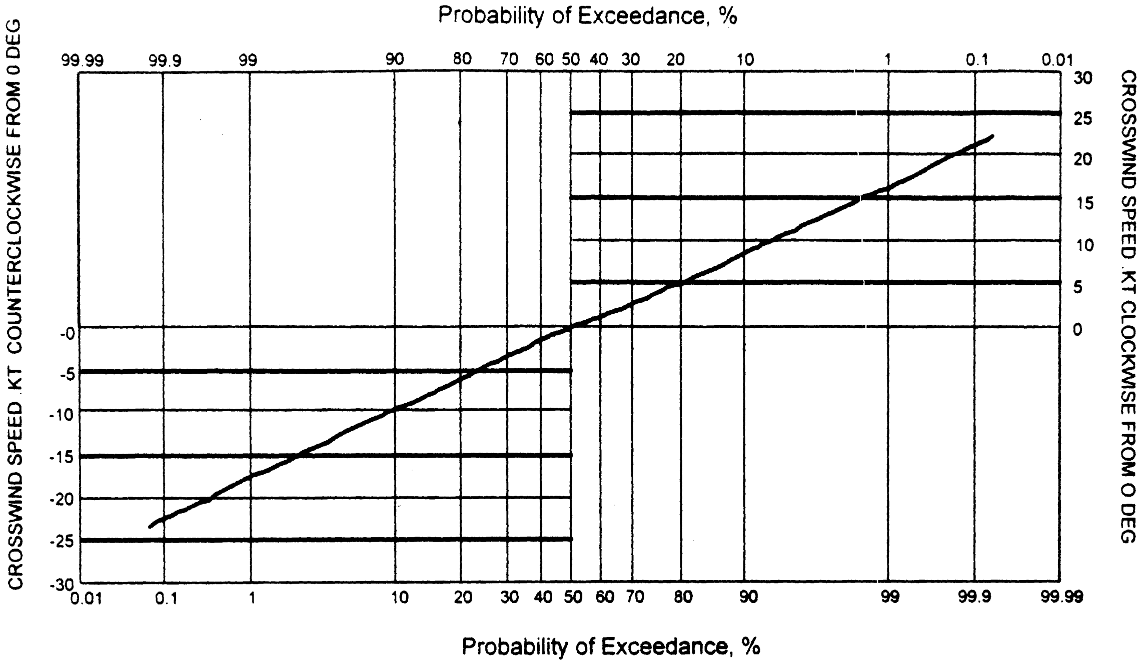
$u = v = w.f(h)^3$ see Figure A4-6, f(h) is defined in Figure A4-5.

$L_u = L_V = L_W.f(h)^3$ see Figure A4-6, f(h) is defined in Figure A4-5.



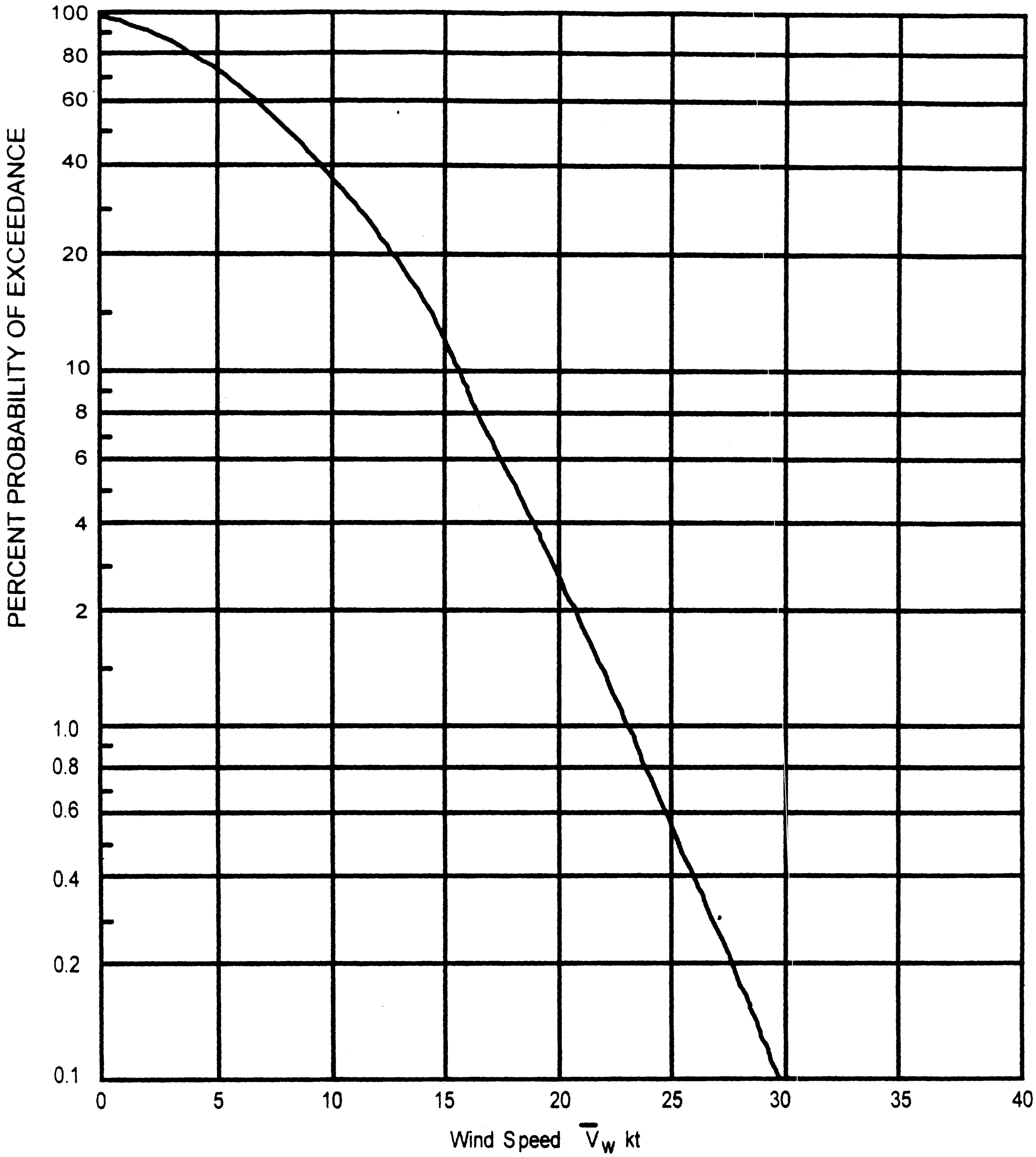
HEADWIND-TAILWIND DESCRIPTION

Figure A4-1



CROSSWIND DESCRIPTION

Figure A4-2



ANNUAL PERCENT PROBABILITY OF MEAN WIND SPEED-EQUALING OR EXCEEDING GIVEN VALUES

Figure A4-3

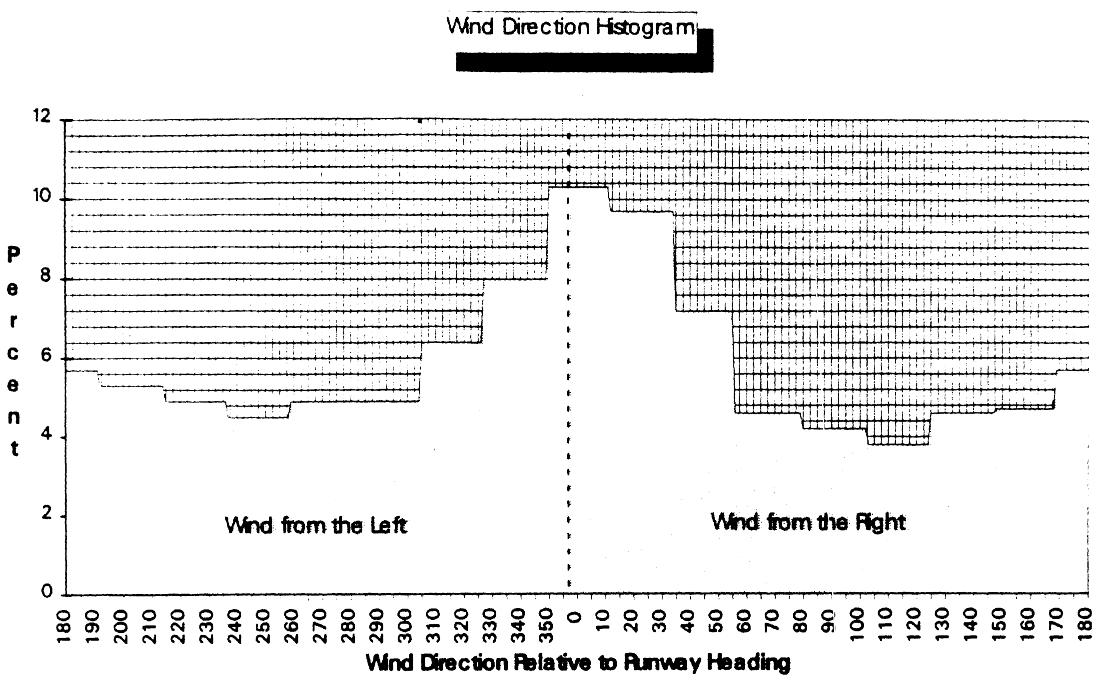
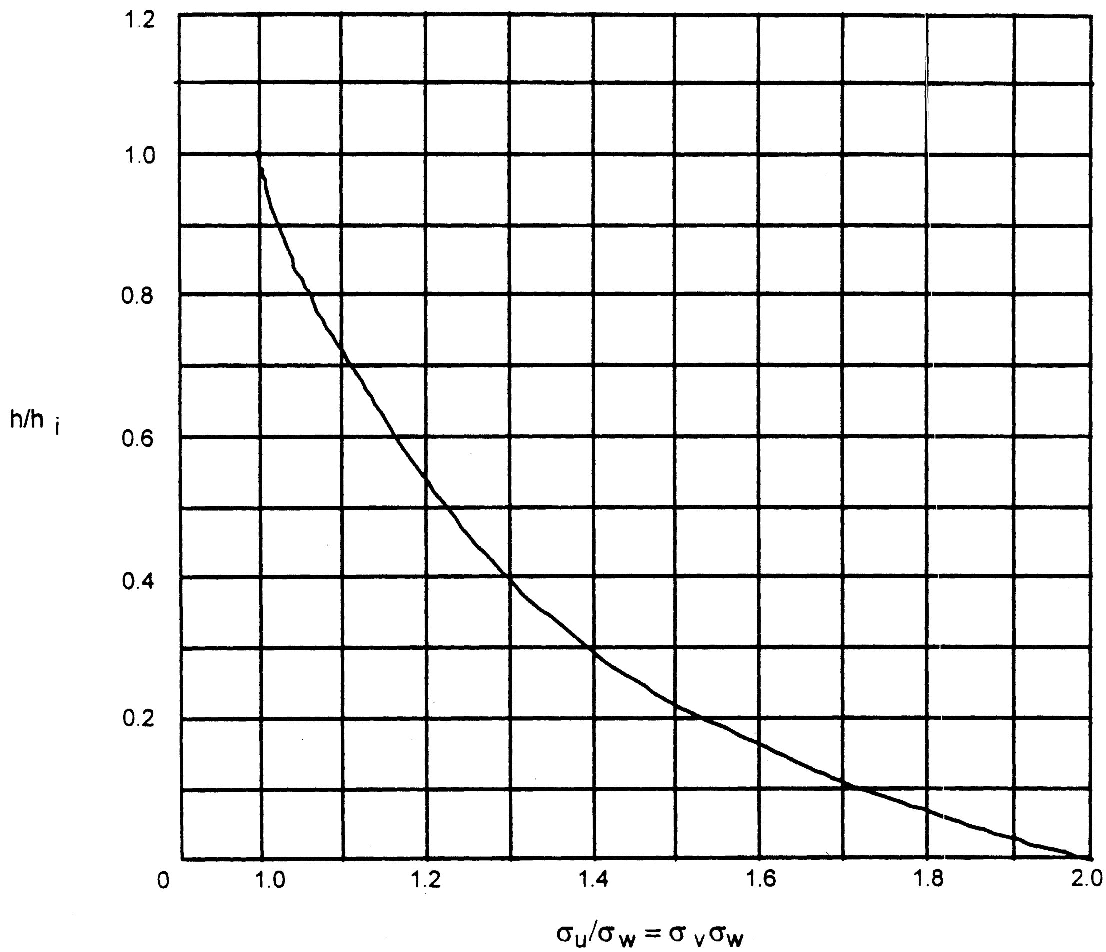

Wind Direction Histogram
Percent
12
10
8
6
4
2
0
Wind from the Left
Wind from the Right
180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
Wind Direction Relative to Runway Heading

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

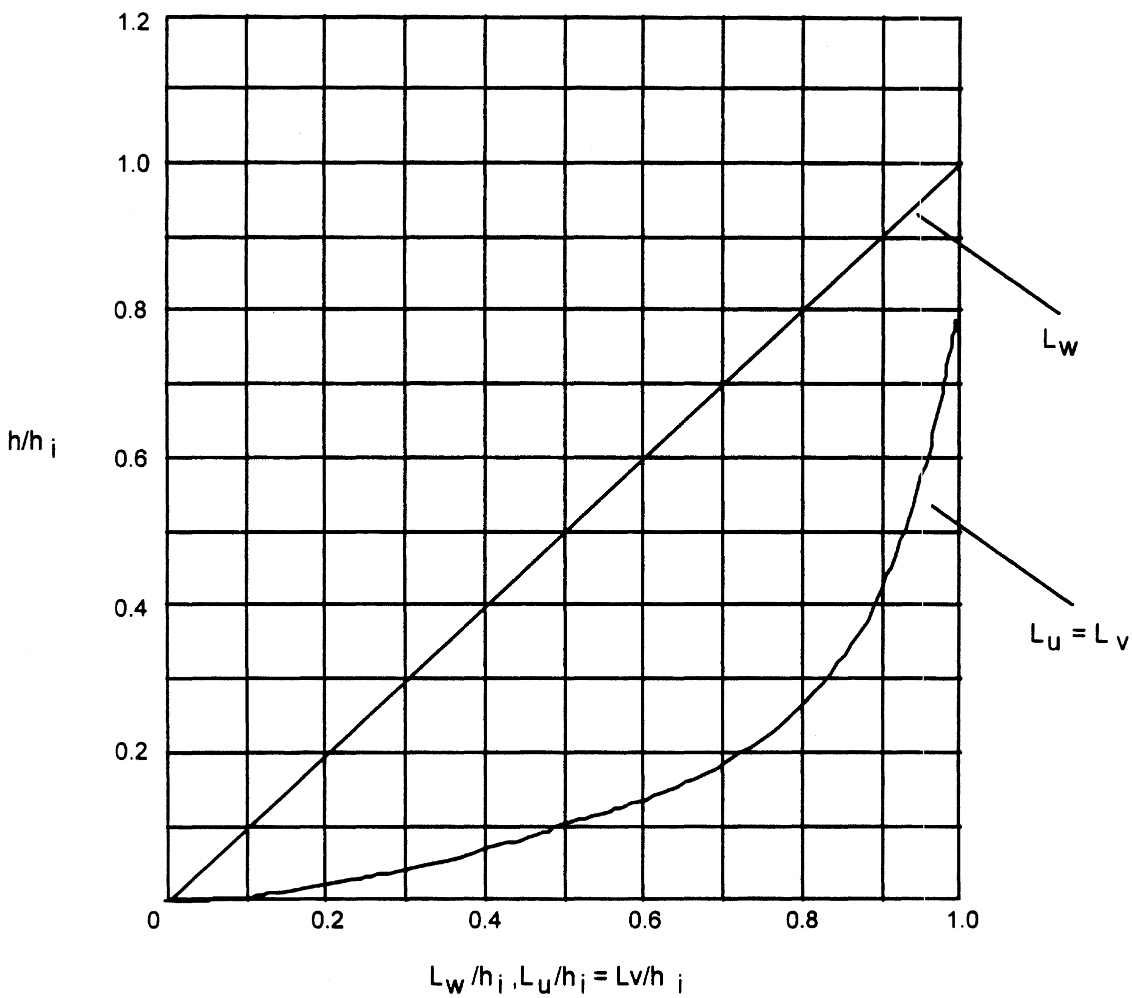
Figure A4-5

$$L_w = \begin{cases} h, & h < h_i \\ d, & h = h_i \end{cases}$$

$$L_u = \begin{cases} L_w \left(\dfrac{\sigma_u}{\sigma_w}\right)^3 = \dfrac{h}{[0.177 + 0.823\, h/h_i]^{1.2}} & h < h_i \\ d & h \geq h_i \end{cases}$$

$$L_v = L_u$$

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 6 m (20 ft.) and 10 m (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:

$u = 0.43\ U \log_{10}(z) + 0.57\ U$ .....(1)

where u is the mean wind speed at height z meters (z 1m),
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:

$$\Phi(\Omega) = \frac{2\sigma^2}{\pi}\,\frac{L}{1 + \Omega^2 L^2} \qquad .....(2)]$$

where

() = a spectral density in $(\text{meters/sec})^2$ per (radian/meter).

= root mean square (rms) turbulence intensity = 0.15 U

L = scale length = 183 m (600 ft.)

= 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:

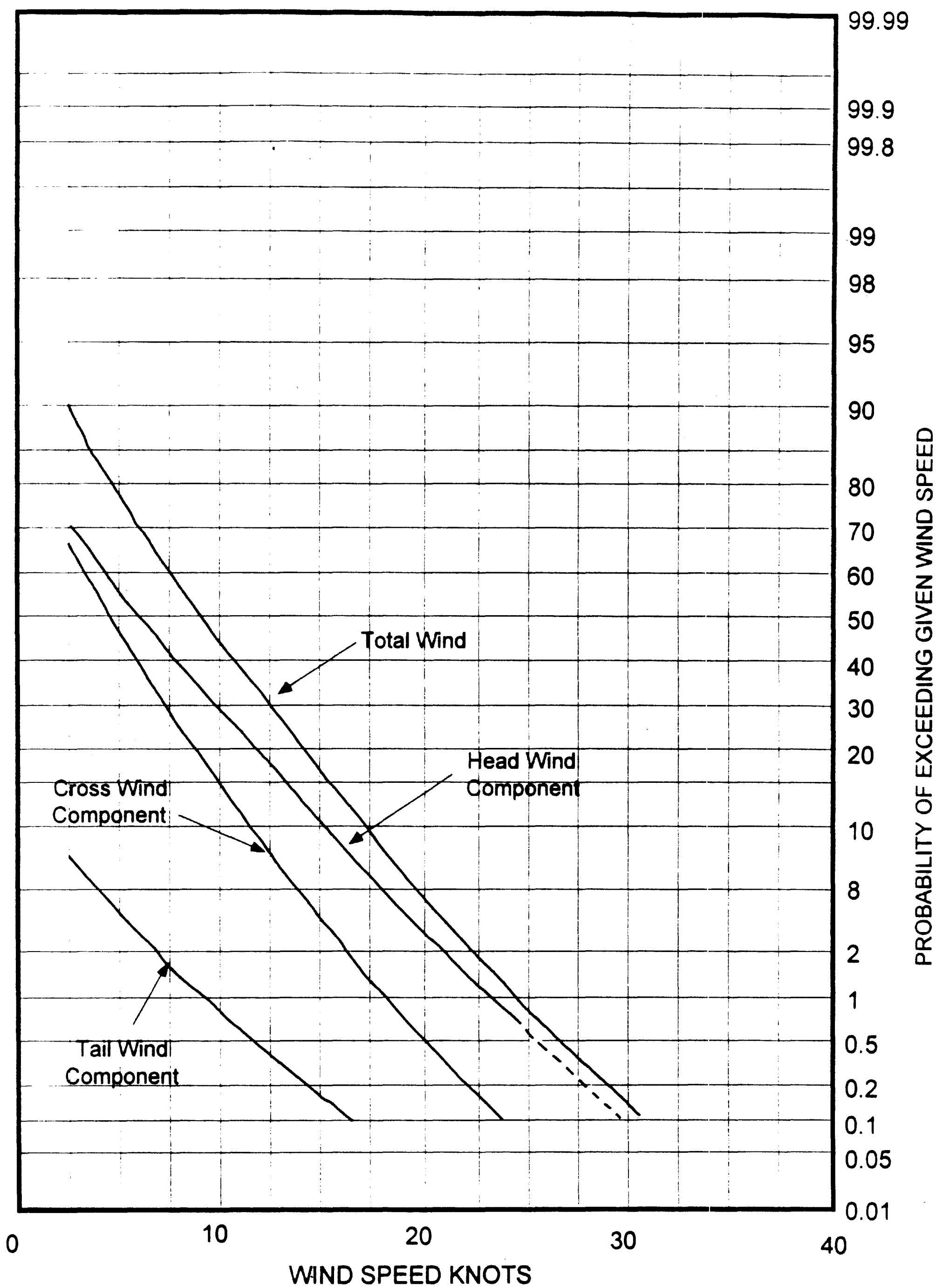
= 1.5 knots with L = 9.2 m (30 ft.)

or alternatively

= 0.09 U with L = 4.6m (15 ft.) when z < 9.2 m (30 ft.)

and

L = 0.5 z when 9.2 < z < 305 m (30 < z < 1000 ft.)



Cumulative probability of reported Mean Wind, and Head Wind, Tail Wind and 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. AIRWORTHINESS DEMONSTRATION OF DECELERATION & BRAKING SYSTEMS OR DISPLAYS.

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APPENDIX 6. AFM PROVISIONS AND SAMPLE AFM WORDING

1.0 GENERAL AFM PROVISION CONSIDERATIONS:

1.1 AFM Should state......... Equipment considered as part of evaluation

1.2 AFM should not state........ Operating minima, limitations for things/conditions not evaluated...

2.0 SPECIFIC EXAMPLES OF AFM PROVISIONS:

2.1 TAKEOFF SYSTEMS

<example>

2.2 LANDING SYSTEMS

2.2.1 FAIL OP AUTOLAND WITH FAIL OP ROLLOUT

<example>

2.2.2 FAIL OP AUTOLAND WITH FAIL PASSIVE ROLLOUT

<example>

2.2.3 FAIL PASSIVE AUTOLAND WITHOUT ROLLOUT

<example>

2.2.4 FAIL PASSIVE AUTOLAND WITH FAIL PASSIVE ROLLOUT

<example>

2.2.5 ENGINE INOPERATIVE AUTOLAND

<example>

2.2.6 HUD (FAIL PASSIVE)

<example>

2.2.7 HYBRID FAIL OP HUD/AUTOLAND

<example>

2.3 NAVAIDs DEMONSTRATED. The type of navigation facilities used as a basis for certification. 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.

2.3.1 For ILS, the Airplane Flight Manual should typically state: "Demonstrated performance was predicated upon the use of an ILS facility with performance and integrity equivalent to, or better than, an ICAO Annex 10 Facility Performance Category II facility, or a United States Type II or Type III ILS, or equivalent."

2.3.2 For MLS, the Airplane Flight Manual typically should state: "Demonstrated performance was predicated upon the use of an MLS facility with performance and integrity equivalent to, or better than, an ICAO Annex 10 Facility Performance Category II facility, or a United States Type II or Type III MLS, or equivalent."

2.4 MISCELLANEOUS PROVISIONS. The Airplane Flight Manual shall contain the following information:

1) Any conditions or constraints on landing performance with regard to Airport conditions (e.g., elevation, ambient temperature, runway slope and ground profile under the approach path).

2) The Airplane Flight Manual should specify the criteria used for the demonstration of the system, acceptable normal and non-normal procedures, the demonstrated configurations, and types of facilities used, and any constraints or limitations necessary for safe operation.

The AFM should not specify either a DH or RVR constraint. The AFM may specify the alert height demonstrated and the criteria used. [If necessary for manually flown systems using visual reference (e.g., HUD), the AFM (in section 3 or equivalent) may include a statement such as "was demonstrated based on a minimum visual segment of 'XXX (ft./m.)' at 'YY' (ft.) above TDZ"].

It is recommended that the AFM state the relevant paragraphs of 120-28D that has been met. The AFM should not include visual segment specifications.

3) Information should be provided to the flight crew regarding atmospheric conditions under which the system was demonstrated (e.g., headwind, crosswind, tailwind). The AFM should contain a statement that "Credit may not be predicated on the use of <type of system> if conditions exceed those for which the system was certificated."

4) The height losses for go-around initiation heights below 100 ft., determined in accordance with section 6.6 of appendix 3.

APPENDIX 7. STANDARD OPSPECS - GENERAL.

This appendix provides samples of standard operations specifications (Opspecs) paragraphs typically issued for operations described in this Advisory Circular. Opspecs are developed by the Flight Standards Service At Washington headquarters. Opspecs specify limitations, conditions, and other provisions which operators must comply with. Opspecs are normally coordinated with industry to ensure a mutual and clear understanding and the effect they will have on operations. After appropriate coordination has been completed, drafts of the new standard paragraphs, or amendments to existing paragraphs are finalized and incorporated into the Opspecs program.

Through the use of standard Opspecs paragraphs, the FAA and industry are ensured that air carriers conducting comparable operations with comparable equipment are held to the same standards. Occasionally, a situation may occur in which it becomes necessary to issue an operator an Opspecs paragraph that is nonstandard because of a unique situation not provided for in the standard paragraphs. Nonstandard Opspecs paragraphs may not be less restrictive than, nor contrary to, the provisions in standard paragraphs. In those cases when a nonstandard paragraph is more restrictive than the standard paragraph, justifiable reasons must exist, since the operator could be placed at a competitive disadvantage.

APPENDIX 7. LIST OF SAMPLE OPERATIONS SPECIFICATIONS

The following Standard OpSpec paragraphs are provided:

Part A - General

A002 Definitions and Abbreviations

Part C - Airplane Terminal instrument Procedures and Airport Authorizations and Limitations

C051 Terminal Instrument Procedures

C055 Alternate Airport IFR Weather Minimums

C056 IFR Takeoff Minimums, Part 121 Operations -- All Airports

C060 Category III Instrument Approach and Landing Operations

Part 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 200 ft. (60m) and with either a visibility not less than 2400 ft. (800m), or a Runway Visual Range not less than 1800 ft. (550m).
Category II	A precision instrument approach and landing with a decision height lower than 200 ft. (60m) but not lower than 100 ft. (30m) and a Runway Visual Range not less than 1200 ft. (350m).
Category IIIa	A precision instrument approach and landing with a decision height lower than 100 ft. (30m), or no decision height and a Runway Visual Range not less than 700 ft. (200m).
Category IIIb	A precision instrument approach and landing with a decision height lower than 50 ft. (15m), or no decision height and a Runway Visual Range less than 700 ft. (200m) but not less than 150 ft. (50m).
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 Redispatch or Re-release En Route. The term "planned redispatch 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 redispatched or re-released inflight in accordance with 14 CFR part 121, section 121.631(c) to a destination airport other than the destination airport specified in the original dispatch or release.

C051. Terminal Instrument Procedures **Control: 1/11/88**
Revision: 010

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 of the Code of Federal Regulations (14 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.

(4) At 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) ICAO Document 8168-OPS, Procedures for Air Navigation Services-Aircraft Operations (PANS-OPS), Volume II, or Joint Aviation Authorities (JAR-OPS1).

b. 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.

c. 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.

d. 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.

RVR FEET	WHEN RVR IS NOT AVAILABLE METERS	METEOROLOGICAL VISIBILITY STATUTE MILES METERS NAUTICAL MILES
300 ft.	75 m.	1/4 sm. 400m 1/4 nm
400 ft.	120 m.	3/8 sm. 600m 3/8 nm
500 ft.	150 m.	1/2 sm. 800 m 1/2 nm
600 ft.	175 m.	5/8 sm. 1000 m 5/8 nm
700 ft.	200 m.	3/4 sm. 1200 m 7/10 nm
1000 ft.	300 m.	7/8 sm. 1400 m 7/8 nm
1200 ft.	350 m.	1 sm. 1600 m 9/10 nm
1600 ft.	500 m.	1 1/8 sm. 1800 m 1 1/8 nm
1800 ft.	550 m.	1 1/4 sm. 2000 m 1 1/10 nm
2000 ft.	600 m.	1 1/2 sm. 2400 m 1 3/10 nm
2100 ft.	650 m.	1 3/4 sm. 2800 m 1 1/2 nm
2400 ft.	750 m.	2 sm. 3200 m 1 3/4 nm
4000 ft.	1200 m.	2 1/4 sm. 3600 m 2 nm
4500 ft.	1400 m.	2 1/2 sm. 4000 m 2 2/10 nm
5000 ft.	1500 m.	2 3/4 sm. 4400 m 2 4/10 nm
6000 ft.	1800 m.	3 sm. 4800 m 2 6/10 nm

e. 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 using the following table.

	DAY	NIGHT
HI 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.

1. **Issued by the Federal Aviation Administration.**
2. **These Operations Specifications are approved by direction of the Administrator.**

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Principal Inspector

3. **Date Approval is effective:**

Amendment No.:

4. **I hereby accept and receive the Operations Specifications in this paragraph.**

(Name) (Title) Date:

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 flight crew 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 C055)		
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 III procedures, a ceiling of at least 200 ft. HAT , or For Category II procedures, a ceiling of at least 300 ft. HAT.	For Category III procedures, a visibility of at least 1800 RVR, or For Category II procedures, a visibility of at least 4000 RVR.

Print Date:

CERTIFICATE NO.:
XXXXX AIRLINES INC.

U.S. Department
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Federal Aviation
Administration

Operations Specifications

Form Approved
OMB No. 2120-00028

C056. IFR Takeoff Minimums, Part 121 Airplane Operations - All Airports **Control: 10/05/9** **Revision: 01**

Standard takeoff minimums are defined as 1 statute mile visibility or RVR 5000 for airplanes having

Two 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 Touch down 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 Touch down Zone RVR report, if available, is controlling.

c. 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 RVR 1/4 statute mile or Touch down Zone RVR 1600, provided at least one of the following visual aids is available. The Touch down Zone RVR report, if available, is controlling. The Mid RVR report may be substituted for the Touch down Zone RVR report if the Touch down 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 RVR 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) Touch down Zone RVR 1000 (beginning of takeoff run) and Rollout RVR 1000, provided one of the following visual aids are available.

(a) Operative runway centerline lights (CL).

(b) Runway centerline markings (RCLM).

(c) 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 touch down zone RVR report if a touch down zone report is not available or a Rollout RVR report if a Rollout RVR report is not available.

(3) Touch down 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 Touch down 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.

d. At foreign airports which have runway lighting systems equivalent to U.S. standards, takeoff is authorized with a reported Touch down 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 c(1) or (2), as appropriate, apply.

e. In circumstances when the Touch down 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 Touch down Zone RVR report required by this paragraph. provided that:

(1) The pilot has completed 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.

Optional paragraph C056 f - Takeoff Guidance Systems - All Airports

f. Additional Provisions:

(1) Not withstanding the lower than standard takeoff minimums specified in subparagraph c. above, 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.

(A) Special Provisions And Conditions:

(1) Operative Runway Centerline Lights (CL).

(2) Operative High Intensity Runway Lights (HIRL).

(3) Serviceable Runway Centerline Markings (RCLM).

(4) Front course guidance from the localizer must be available and used (if applicable to guidance systems used).

(5) THE reported crosswind component shall not exceed 10 knots.

(6) OPERATIVE touch down 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 the subparagraph.

(7) The pilot in command and the second in command have completed the certificate holders approved training program for these operations.

(8) 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.

(B) Authorized Airplane. The certificate holder is authorized to use the following takeoff minimums for airplanes listed below:
zzz

AIRPLANE MAKE/MODEL/SERIES	LOWEST AUTHORIZED RVR	REQUIRED TAKEOFF GUIDANCE SYSTEM

1. Issued by the Federal Aviation Administration.
2. These Operations Specifications are approved by direction of the Administrator.

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Principal Inspector

3. Date Approval is effective:

Amendment No.:

4. I hereby accept and receive the Operations Specifications in this paragraph.

(Name) (Title) Date:

C060 Category III Instrument Approach and Landing Operations **Control: 10/05/90**

Revision: 011

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 straight-in approach and 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 (Make/Model/Series) DH Lowest Authorized RVR

2. Category III Fail-Operational Operations
Airplane (Make/Model/Series) 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 regulations 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 RVR 600.

Airplane Make/Model/Series.	Additional Airborne Equipment

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 RVR 600 (175 meters), the Touch down Zone, Mid, and Rollout RVR reporting systems are required and must be used. Touch down 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 RVR 600 (175 meters) using fail-passive rollout control systems, the Touch down 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 RVR 600 (175 meters) using fail-operational rollout control systems, the Touch down Zone, Mid, and Rollout RV 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 RVR 1800.

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 RVR 600 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	**REQUIRED FIELD LENGTH FACTOR**	**Equipment and special limitations**

f. Missed Approach Requirements.

(1) For Category III approaches with a fail-passive flight control system, a missed approach shall be initiated when any of the following conditions exist:

(a) At the DH, if the pilot has not established sufficient visual reference with the touch down zone or touch down zone lights to verify that the aircraft will touch down in the touch down zone.

(b) 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.

(c) When a failure in the fail-passive flight control system occurs prior to touch down.

(d) If the pilot determines that touch down cannot be safely accomplished within the touch down zone.

(e) When any of the required elements of the ground system becomes inoperative before arriving at DH. However, Category III approaches and landings may be continued if sequence flashers or the approach light system are inoperative.

(2) For fail-operational Category III approaches with a rollout control system a missed approach will be initiated when any of the following conditions exist:

(a) Unless a fail-passive rollout control system is used for RVR 600 operations, or a fail-operational rollout control system is used for operations with minimums below RVR 600, a missed approach is required upon reaching the AH/DH if the latest reported controlling RVR is below the applicable minimums.

(b) At the DH, when a DH is used, if the pilot has not established sufficient visual reference with the touch down zone or touch down zone lights to verify that the aircraft will touch down in the touch down zone.

(c) If, after passing the DH when a DH is used, 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) If the pilot determines that touch down cannot be safely accomplished within the touch down zone.

(e) When a failure occurs in one of the required systems in the aircraft before reaching the AH/DH.

(f) Before reaching the AH or DH, as applicable, any of the required elements of the ground system becomes inoperative. However, Category III approaches and landings may be continued if sequence flashers or the approach lights are inoperative.

(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

1. Issued by the Federal Aviation Administration.
2. These Operations Specifications are approved by direction of the Administrator.

Principal Inspector

3. Date Approval is effective:

Amendment No.:

4. I hereby accept and receive the Operations Specifications in this paragraph.

(Name) (Title) Date:

APPENDIX 8 IRREGULAR TERRAIN ASSESSMENT

The following information describes the evaluation process, procedures, and criteria applicable to approval of autoland systems for Category III minima at airports identified in the CAT II/III Status List as having irregular underlying approach terrain. .

Background. FAA engineering type design of autoland systems (14 CFR part 25, AC 20-57A, and this Advisory Circular) provides for generic performance evaluation of autoland capability through testing at a few particular locations to verify computer and design analysis. When an aircraft is type certificated (or STC'd) for autoland, it is not the intent, nor is it practical that each model of aircraft, autopilot, radar altimeter etc., be tested at each conceivable location, domestic and foreign, that it could be used in operation. Further, ILS system performance itself may vary somewhat from location to location or time to time due to reflective interference, ATC critical area procedures, etc. The result is that in spite of the manufacturer's thorough design, careful testing and type certification by FAA engineering, and frequent flight inspection by FAA or foreign authorities, specific operational review and approval of particular aircraft type/site autoland performance is necessary when minima are predicated on autoland use. This is especially important at airports with irregular pre-threshold terrain. At "normal" airports/runways (e.g., not restricted in Section 4 of the CAT II/III Status List) this review and approval process can be as simple as verifying the carriers reports of a small number of "line autolands" in better than Cat II weather conditions if the approval is for a follow-on airline starting service at a location previously found suitable for a particular type aircraft. On the other hand, if the request is for the first of an aircraft type to base Cat III minima on having autoland at a "special terrain" airport, then a thorough 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/autopilot/site performance, this summary represents a typical approach that may successfully be used. It is not a definitive treatment, exclusive method, or all encompassing in scope. In certain cases, credit may be applied for relevant testing by the manufacturer, performance at similar locations, etc. (e.g., subsequent special terrain airport approvals). By the same token, certain aircraft/autoland combinations may require more extensive testing, where the aircraft has peculiar characteristics (RA trips due to unlock, inappropriate auto throttle response, inconsistent flare or overflare tendency, etc.) at a particular site. In all cases, before establishing test requirements with a carrier for special terrain airports, the proposed evaluation plan should be coordinated with AFS-400. This must be done prior to agreement by the Principal Operations Inspector, Principal Avionics Inspector with the relevant carrier on testing to be done and data to be collected. Resources available to the PI's and regions in addition to AFS-400 to consult on development of draft plans include the transport directorate AEG's, or the Aircraft Certification's NRS for AFCS.

CAT III EVALUATION PROCESS FOR SPECIAL TERRAIN AIRPORTS

Case I - First of a Model at 1st Special Terrain Airport (e.g., L1011 - first approval of SEA 16R - not previously approved at CVG, MSP, PIT).

A. Test program objective. Assess and verify normal autoland performance from an operational perspective, and identify miscellaneous factors needed for a safe Cat III operation (e.g., alert height identification).

B. Procedure. Perform autoland (at least 4-6) in full operational configuration, using routine line maintenance (not specially tweaked aircraft) in typical atmospheric conditions (e.g., not dead-calm at 5 a.m.) of wind and turbulence. If the system is susceptible to weak performance (e.g., float in tailwind conditions) attempt to pick a time frame that allows the evaluation to take place on a day in which the system is put to fair test of crosswind, tailwind, headwind, wind gradient at altitude etc., or whatever the critical condition is believed to be while still observing AFM limits.

C. Observation. Review Glide Slope displacement, proper flare initiation altitude and mode switching, touch down point (generally within Appendix 3, Paragraph 6.3.1 of this AC), sink rate at touch down and "quality" of flare (continuous, no nose down tendency, no oscillation, proper throttle retard, no abrupt initiation, etc.). A person qualified on autoland and experienced in assessing autoland performance should be used to do these evaluations as the FAA observer (e.g., APM's of Cat III carriers, AFS-400, AEG reps., NRS).

D. 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:

1) Using specially modified DFDR having following parameters at high sample rate (rate > 1 sec):

pitch attitude
glide slope error
radio altitude
baro altitude
elevator command
throttle position
vertical speed
radio altitude rate (h)
airspeed

plus manual observation of touch down point (lateral, longitudinal) wind profile from 1000 ft. to surface from INS that reads winds at approach speeds (e.g., not inhibited below 150 kts).

2) Review of manufacture's data from autoland development flight testing at the particular site, confirmed by observations in the evaluation flight series.

3) Photo recording of pertinent instruments or outside view with video camera allowing post flight replay and review.

E. Data review and post flight analysis. Review flare profile to ensure:

continuous pitch changes - no nose down, abrupt flare, overflare, underflare, float, or other characteristic that a line pilot could interpret as failure of the autoland and be encouraged to disconnect,

appropriate throttle retard - no reversal of retard, early retard, failure to retard, pitch/throttle coupling, etc.,

appropriate speed decay in flare (e.g., no unusually high pitch attitude risking tail strike) no excessive float if above "v" ref at flare initiation, etc.

Review crosswind alignment (if applicable): Assess crosswind (forward slip) alignment, if applicable, to be sure that appropriate RA triggering occurs even though terrain is irregular (e.g., completion of align prior to flare).

Miscellaneous Issues. Determine if inner marker will be adequate or necessary for definition of alert height, if a 50 ft. DH is needed, will the variability of the RA displays in the last stages of the approach permit its stabilization for a long enough period to define the 50 ft. DH point.

Determine if special training or constraints are needed to accommodate peculiar characteristics (e.g., visual ref. required at flare initiation - 50 ft. DH - for the A300 due to a double flare characteristic).

Resolve any anomalies occurring during test (e.g., if autopilot trips occur, firm landings, poor flares occur) more tests may be needed to clearly identify and resolve the problem. Otherwise, approval should not be made or expected when AFS-400 reviews the data.

Case II - First of a Model at Subsequent Special Terrain Airports (e.g., B767 at CVG after prior approval at Sea-Tac).

A. Same objective as Case I.

B. Procedure the same as Case I.

C. Observation same as Case I.

D. Data recording not generally required. However, if the results of landings are marginal or unacceptable, the procedures in Case I may need to be followed.

E. Not applicable unless problems occur and Case I procedures are used to resolve discrepancies.

F. Same as Case I.

Case III - Subsequent airline use of previously approved type at special terrain location.

POI may review, and with AFS concurrence, approve subsequent airline operation at special terrain airports based on 25 or more successful "line" landings reported by the airline and no failures. If problems are reported, then Case II or Case I procedures may be needed to resolve potential unique aircraft configuration effects, procedural effects, or maintenance effects.

Case IV. Approval of "first of a type autoland aircraft" at "special terrain" or "normal" airports but not for Cat III minima credit (e.g., for use with better than Cat II weather).

POI's should specify that an airline technical pilot, management pilot, or check airman who is experienced with autoland operations and performance to assess and verify adequate autoland performance prior to permitting line pilots to conduct autoland operations. This evaluation may be done in line operation as long as no previous reported problems have been noted with other aircraft types, and no NOTAMs or other restrictions preclude such operations.

> **NOTE: Unless otherwise restricted by an airline or POI, autoland operations, not for minima credit, may generally be conducted on any ILS runway that does not have notes on the approach plate (e.g., localizer unusable for rollout, glideslope unusable below 400 ft. AGL) and that have adequate TCH (threshold clearance heights) published suitable for the aircraft type). If problems are noted in the airlines' evaluation, the airline should specify to line crews that autolands should**

not be accomplished at that site. This is often done through flight crew bulletins. Conversely, some airlines choose to publish lists of approved autoland runways for line crew use.

The above process is fully responsive to section 121.579(c) requirements and Opspecs may then be signed permitting autoland operation for that type of aircraft. Opspecs, per se, do not need to list each airport/runway unless the POI or carrier have some unique reason why this would be appropriate.

It is desirable, but not necessary, that qualified APM's, ACI's, or POI's, witness "special terrain airport" initial evaluations by the carrier when possible.

POI's should request and review autoland reports from line crews for about the first 25 or so line landings to confirm the initial assessment.

Case V. Approval of subsequent airlines or types to autoland at special terrain or normal airports, not for minima credit.

POI's should request and review data for the first five line landings to confirm adequate performance. If problems occur, processes for cases I through IV may be needed to resolve problems depending on the severity and causes of problems (e.g., maintenance problems, winds, ATC clearance protection, STC using new model of autopilot, new radar altimeter model).

Postscript. Review of "autoland" and "Cat III landing weather minima" approvals is still a rather unique and highly technical area requiring much judgment and variation in special circumstances. It has still not evolved to the point of a cut and dried process like issuance of Part C op specs., etc. When in doubt, seek advice and counsel from a qualified source. Do not assume. In all cases coordinate with AFS-400 prior to making commitments to a carrier.

INSPECTION AND SURVEILLANCE RECORD Page 1 of 3

1. WORK ACTIVITY	2. UNITS	3. HOURS
DC-9-80 Autoland Evaluation, SEA-TAC Airport	1	4.0

4. NAME AND ADDRESS OF CARRIER, OPERATOR, AIRPORT AGENCY, OR AIRMAN	5. CERTIFICATE NO. OR AIRCRAFT REGISTRATION MARK (No.)	6. RESULTS		FURTHER ACTION REQ.	
Pacific Southwest Airlines, Inc. 3225 North Harbor Drive San Diego, CA 92101	N941PS		SATISFACTORY		NO
		X	UNSATISFACTORY (Explain in Item 8)	X	YES (Explain in Item 8)

8. FINDING/RECOMMENDATION

Seattle Tacoma International Airport is served by PSA DC9-80 equipment and the carrier has proposed to conduct Category IIIa operations on runway 16R. The carrier was briefed on the relevancy of Air Carrier Operations Bulletin No. 7-82-3, Possible Autoland Anomalies at Airports Which Have Irregular Underlying Terrain in the Approach Area Near The Runway Threshold. They were familiar with FAA Order 8400.8 and Advisory Circular 120-28C, which addresses this subject. The PSA POI had requested that PSA demonstrate the capability of the DC9-80 autoland system on runway 16R at SEA-TAC, to determine if the irregular underlying terrain associated with this runway would adversely affect autoland performance and the degree of performance degradation found. PSA agreed that the evaluation was necessary and scheduled the event for 12-15-84.

This Inspector participated in the demonstration/evaluation of the DC-9 autoland/HUD system at SEA-TAC, on 12-15-84. Flight technical pilots conducted four autoland approaches were HUD monitored by the Captain. Furthermore, a HUD manual approach to touch down was flown to demonstrate the Sundstrand guidance system. The weather conditions were considered optimum for the evaluation (Measured Ceiling 1200 Ft. Broken, 1700 Ft. Overcast, Visibility 15 miles, Temperature 38 degrees, Due Point 34 degrees, Wind averaging 190/8K. The following performance parameters were monitored closely during each approach:

Parameter/Event	**A/P Performance Degradation**
Localizer & Glide Slope Tracking to 500 Ft. GL	None
Localizer Tracking 500 Ft. AGL to Runway Surface	None
Glide Slope Tracking 500 Ft. AGL to 100 Ft. AGL	Minimal perturbations; A/C within Category II performance window at 100 Ft.
Glide Slope Tracking 100 Ft. AGL to 50 Ft. AGL.	Approach attitude stabilized. However, some pitch oscillation was noted prior to flare engage.
Flare Maneuver from 50 Ft. AGL to Runway Surface	Flare engage was late on two approaches, causing firm touch downs within the Category III dispersion box

		DATE	REGION AND DISTRICT OFFICE	INSPECTOR'S SIGNATURE
X	OPERATIONS	12-15-84	AWP-FSDO-09	
	MAINTENANCE			
	AVIONICS			

FAA Form 3112 (8-70)

DC9-80 Autoland Evaluation, SEA-TAC Airport.

Parameter/Event	A/P Performance Degradation
Flare Maneuver from 50 ft. AGL to Runway Surface.	An overflare with extended float and flare stagnation requiring pilot takeover and go-around was observed on two approaches. Throttle retard did not appear to be uniform throughout the flare maneuvers.
Radio Altimeter Display Indications on Approach.	Both altimeters were observed to be normal from the outer marker to approximately 500 ft. AGL. From 500 ft. to 120 ft., the altimeters were displaying excessive oscillations (spiking). No flags were observed. However, on two approaches the altimeters appeared out of synchronization during the most active display oscillations below 300 ft. AGL.
Primary and Secondary Sensors.	No flags were observed.
Autopilot Integrity During Approach.	No disconnects were observed, except for pilot takeover during two unacceptable flare maneuvers. Autopilot Align Mode function at 150 ft. was normal.

HUD Performance During Manual and Autoland Approaches. PSA Flight Technical Pilots reported satisfactory performance of the Sundstrand Head-Up Display installed on the DC9-80. A full manual HUD approach was made to Category II decision height, followed by a manual HUD landing. There was a slight overflare and early throttle retard, however, the touch down sink rate and dispersion was considered acceptable. The HUD monitored autoland approaches reflected compatibility between guidance computations except during the flare maneuvers. The HUD guidance cue (Command Dot) was overly active, indicating a significant disparity between the autoland flare and HUD flare computations. The HUD flare logic appears to be more predictable than the autoland flare computations on this particular ILS runway.

Evaluation Analysis. The DC9-80 autoland system performance, during the flare maneuver on runway 16R, was unpredictable during this evaluation. Two of the approaches resulted in touch down sink rates, which were considered unacceptable for passenger operations (very firm touch down). Two approaches resulted in an overflare condition and extended float, requiring pilot take over and go-around. Furthermore, the autothrottle performance during the flare maneuver, was inconsistent (not synchronized) with the autopilot flare profile.

The irregular underlying terrain and approach lighting structures in the approach area near the runway threshold created undesirable radio altimeter excitatory characteristics. This input to the autopilot is apparently destabilizing the flare profile and may be degrading autothrottle performance during this critical phase of flight.

Recommendations. This inspector and the PSA technical pilots concluded that DC9-80 autoland approaches to runway 16R at SEA-TAC Airport not be permitted by PSA until further investigation of the aforementioned problems has been completed

That the Director, PSA Flight Operations, issue an Alert Bulletin imposing appropriate restrictions on autoland approaches to runway 16R at SEA-TAC Airport.

That operators of DC9-80 aircraft equipped with autoland capability be notified of the result of this mini evaluation.

That PSA conduct a second mini evaluation with a DC9-80 equipped with a DFGS 906 computer. This updated computer may respond more favorably on runway 16R at SEA-TAC.
Also, conduct additional manual HUD approaches to runway 16R.

Remarks: ACO's, AEG's and NRS's were provided a copy of this report.

APPENDIX 9. GROUND SYSTEM AND OBSTRUCTION CLEARANCE CRITERIA FOR CATEGORY II AND CATEGORY III APPROACH AND LANDING OPERATIONS

1. PURPOSE. This Appendix outlines ground system and obstruction clearance criteria for Category II and Category III approach and landing operations supported by ILS, MLS, or DGPS sensors, or operations based on RNP.

Other applicable Federal Aviation Administration (FAA) Orders, Notices, and Advisory Circulars (AC) define sensor system performance and equipment characteristics and are available at any Airport District Office, FSDO or by writing to the address specified on page ___ of this AC.

2. GENERAL. Category II and Category III procedures are based on both navigation and visual guidance systems. The navigation system must be capable of guiding an aircraft to the runway reference datum (e.g., the ILS, MLS or RNP glide path reference datum) with a high degree of accuracy. The visual guidance system must provide the correct visual cues to the pilot from the decision altitude (height), if applicable, down to and including the touchdown, and along the runway for rollout, under the appropriate visibility conditions.

In order for a runway to qualify for CAT II or CAT III operations, the runway must be capable of supporting the lowest CAT I minimums.

Runways which do not meet the criteria established in this Appendix, but where an operational or other evaluation identifies that an equivalent level of safety exists, may be authorized appropriate Category II or Category III minimums. Such an evaluation shall be conducted by Flight Standards Service on a case-by case basis as required.

This AC and the criteria in the Air Transportation Operations Inspectors Handbook, FAA Order 8400.10, and Operations-Specifications, as amended, establish the lowest approach and landing minimums which can be authorized for Category II and Category III operations for air carriers operating under Title 14 of the Code of Federal Regulations (14 CFR) part 121 or part 135. Use the implementation guidelines in Order 8260.36A for all new ILSs and all MLSs. TERPS is to be used only for the old established ILSs.

Foreign airports served by United States air carriers or commercial operators under part 121 or 135 may be approved in accordance with the provisions of ICAO Annex 3 on a basis of a comparable level of safety.

3. CATEGORY II AND CATEGORY III SUPPORTING NAVIGATION AIDS OR SENSORS.

a. Navaid System. A system which meets appropriate Category II and Category III integrity, continuity and reliability performance standards and provides continuous electronic guidance at least to the ILS reference datum or RNP reference datum must be provided consistent with the elements described below:

(1) Localizer or Localizer Equivalent. The localizer or approach azimuth station, DGPS, or RNP equivalent azimuth guidance must be provided from the specified coverage limit down to the specified reference datum, or equivalent, as indicated in the U.S. Flight Inspection Manual, FAA Handbook, 8200.1, as amended.

(2) Glide Slope or Glide slope Equivalent. The glide slope or elevation antenna, or DGPS or RNP equivalent must provide guidance in the vertical plane from the specified coverage limit down to the ILS reference datum, or equivalent, as indicated in the U.S. Flight Inspection Manual.

(3) VHF Marker Beacons. In addition to the outer and middle marker beacons, a 75 MHz inner marker beacon must be provided at each runway intended for a Public Use Published 14 CFR part 97 Category II or Category III Procedure.

b. Visual Guidance System. The lighting system must provide continuous visual guidance from the point where an approaching aircraft at the lowest published DA(H), if applicable, can begin to transition from instrument reference to visual reference. The visual system provides visual reference for the approach, flare, landing, and rollout. The system will consist of the following components:

(1) Approach Lighting System. Lighting standards outlined in FAA Selection Order 1010.39, except that no negative gradient will be permitted in the inner 1500 ft. Where required, and when fixtures are available, approved flush approach lighting system may be installed, i.e., displaced landing threshold.

(2) Touchdown Zone Lighting System. A centerline lighting system will be provided defining the runway touchdown zone and conforming to AC 150/5340-4C as amended.

(3) Centerline Lighting System. A centerline lighting system defining the runway centerline and conforming to AC 150/5340-4C, as amended, using. L-843 and L-850 runway centerline lighting systems should be provided.

(4) High Intensity Runway Edge Lighting. A high intensity runway edge lighting system will be provided defining the lateral and longitudinal limits of the runway and conforming to AC 150-5340-24, as amended.

(5) Taxiway Turnoff Lighting Systems. Taxiway turnoff lighting systems, stop bar, runway guard lighting, and critical area taxiway lighting designations should be provided in accordance with AC 120-57 as amended and the AC 150/5340 series as amended.

(6) All-Weather Runway Markings. Runways will be marked with all-weather runway markings as specified in AC 150/5340-1G, as amended.

c. Other Requirements. The following additional systems are required as part of the Category II and Category III procedures.

(1) Runway Visual Range (RVR). An RVR system is an automated computer controlled measurement and monitoring system reporting minimum visibility limits existing on airport runways to the air traffic controller. Until 1995 the minimum RVR reading obtainable from most FAA RVR equipment was RVR-600. New RVR equipment being deployed measures RVR from 50-ft. to 6500-ft.

(a) RVR equipment is required to provide visibility information at the approach and rollout ends of any runway intended for Category II or Category III Public use Published procedures. For runways over 8000 length, or where otherwise designated by FAA Mid Field RVR equipment or equivalent is also required.

(b) RVR equipment serving other runways may be used to provide the RVR information in the rollout area. Where transmissometers from other runways are used for this purpose, it must be located within a radius of 2000 ft. of the rollout threshold of the runway and provide a minimum of 2000 ft. coverage of the rollout area as measured from the rollout threshold.

(c) FAA Standard 008 prescribes installation criteria for RVR equipment and AC 97-1, as amended, describes RVR measuring equipment and it use.

(2) Radar (Radio) Altimeter Setting Height. Radar (radio) altimeter setting heights will be provided on the FAA Form 8260.3, indicating the vertical distance at the 100/150 foot DA(H) or alert height assuming a 19 wheel to navigation reference point height (e.g., glide slope antenna height) and the terrain beneath these points, on the runway centerline extended.

(3) Remote Monitoring. Remote monitoring shall be provided for the following elements of the navaid or visual aid systems, reference FAA Order 6750.24, as amended.

(a) Navaids.

(b) Approach lighting system.

(c) Power systems

(d) Runway edge, centerline and touchdown zone lights

(e) Critical taxiway lighting, runway guard lights, and stopbars

(4) Manual Inspection. The following systems may not be remotely monitored and may require inspection by airport management or FAA personnel or pilot reports to determine if they are operating in accordance with the criteria, reference AC 120-57, as amended. Remote monitoring systems must be capable of detecting when more than 10 percent of the lights are inoperative. The lighting system/configuration shall be considered inoperative when more than 10 percent of the lights are not functioning. Taxiway lights and individual airport/runway lights do not have to be remotely monitored; however, when visual Aid lights which support CAT II or CAT III are manually monitored they must be inspected at an interval which should ensure that it would be very unlikely that no more than 10 percent of the lights and two adjacent lights would be inoperative, taking into consideration lamp light, environmental conditions, etc. The procedure to visually verify operation of runway edge, centerline, and touchdown zone lights must ensure a visual inspection is conducted prior to commencement of CAT II or CAT III operations and repeated through physical inspections and/or pilot reports at least every two hours thereafter if still in CAT II or CAT II conditions.

(a) Touchdown zone and centerline lights.

(b) Runway edge lights.

(c) Runway markings.

(d) Runway guard lights.

(e) Taxiway centerline lights.

(f) Taxiway clearance bar lights.

(g) Taxiway signs.

(h) Taxiway markings.

d. Critical Areas. Obstacle critical areas will be marked and lighted to insure that ground traffic does not violate these areas during specified operations. These areas may differ depending on the type of Navaids used.

(1) Glide Path Critical Area. The glide path critical area for ILS installations is specified in FAA Order 6750.16B, as amended. The glide path critical area of the elevation antenna for MLS installations is specified in FAA Order 6830.5, as amended.

(2) Localizer Critical Area. The localizer critical area for ILS installations is specified in FAA Order 6750.16B, as amended. The Azimuth Antenna critical area for MLS installations is specified in FAA Order 6830.5, as amended.

4. OBSTACLE CLEARANCE CRITERIA. This section prescribes the obstacle clearance criteria for the final and missed approach areas for use in the formulation of Category II and Category III instrument approach procedures. Obstacles which are fixed by their functional purpose, vehicles, and taxiing and parked aircraft are addressed by application of the Obstacle Free Zone criteria contained in FAA AC 150/5300-13 Airport Design, as amended, and controlled by application of paragraph 3-1-5, Vehicles / Equipment / Personnel On Runways and paragraph 3-7-5, Precision Approach Critical Area in FAA Handbook 7110.65, Air Traffic Control, as amended. The definition of obstacles which are fixed by their functional purpose is found in FAA Order 8400.10, as amended.

a. Final Approach. The criteria found in Handbook 8260.3B and FAA Order 8260.36 will be used to establish CAT II or CAT III minimums for all new ILSs and MLSs. Use TERPS criteria for previously established ILSs. Appendix -5 of this advisory contains guidance for GPS and RNP final approach areas.

5. SPECIAL OBSTRUCTION CLEARANCE AREAS. Because of the lower flight altitudes which occur in the immediate vicinity of the runway during Category II and III approach and missed approach operations, it is necessary to specify certain areas in which obstructions must be eliminated or controlled. These special areas are the Approach Light Area, the Touchdown Area, the Touchdown Area Transitional Surfaces, the Missed Approach Area, and Missed Approach Secondary Areas.

6. APPROACH LIGHT AREA. (See Figure 2.)

a. Definition. An area longitudinally centered on the extended centerline of the precision Category II or Category III runway, and extending outward from the approach end of the Touchdown Area (See Paragraph 7) to a point 200 ft. beyond the last approach light fixture, and having a total width of 400 ft. Refer to FAA Order 6850.2, as amended.

b. Obstruction Clearance. No obstruction shall penetrate the approach light area light plane. Further, no obstruction, including the approach light structure or fixtures, shall penetrate a 50:1 surface (which originates at the same point as the inner final approach area (See Paragraph 4.b.) at the elevation of the runway threshold. The 50:1 surface over the Approach Light Area remains a constant requirement even when other portions of the final approach surface are adjusted for glide slope or glide path angles greater than 2-1/2 degrees. However, where glide slope angles of less than 2-1/2 are established, no obstruction in the Approach Light Area shall penetrate the associated approach surface. Refer to FAA Order 6850.2, as amended.

FIGURE 2

insert FIGURE 9: Approach Light Area and 50:1 Inner OFZ Surface
(from FAA Order 8260.36A)

7. TOUCHDOWN AREA. (See Figure 3.)

a. Definition. An area longitudinally centered on the runway centerline, extending from a point 200 ft. outward from the runway threshold (normal or displaced) for a distance of 3200 ft. in the direction of landing, and having a total width of 1000 ft.

b. Obstruction Clearance. The only fixed obstructions permitted in the Touchdown Area are those objects which are fixed by their functional purpose or which are required for precision approaches to that Category II or Category III runway. The definition of objects fixed by their functional purpose is found in FAA Order 8400.10, as amended. All objects except visual aids and frangible functional objects shall be appropriately marked and lighted unless shielded by a properly lighted and marked functional object. The identity and height limits of acceptable objects are as follows:

(1) Visual Aids. Unless flush-mounted, all visual aids shall be installed on frangible mounts. Maximum height is 14 inches above the surface where the fixture is located. Except that taxiway guidance signs may be installed in accordance with AC 150/5340-18, as amended.

(2) Siting For Vertical Path Navigation Systems. ILS, MLS or other IFR vertical path equipment fixed by its function for that runway or an adjacent runway must comply with the following siting standards:

a. Category I Runways

i. No part of the navigation equipment or appurtenances may be constructed within a runway safety area (RSA) or so as to penetrate the obstruction free zone (OFZ) for the primary or adjacent runway(s) as determined by FAA criteria contained in Advisory Circular AC 150/5300-13. FAA Airport Standards must be consulted to ensure that the minimum offset distance and height are appropriate for the most critical aircraft planned for that runway. Effects of airport elevation on the standards must be accounted for.

ii. Where special utilization of a Category I system may be intended to provide lower landing minimums (e.g.. CAT II on a Type I system), the siting criteria for Category II/III systems applies.

b. Category II and III Runways

i. The nominal minimum offset distance for vertical path navigation equipment is 400 feet from the CAT II/III runway centerline.

ii. Where 400 feet has been documented to be technically not feasible or impractical due to associated costs to either the airport sponsor or the agency, the vertical path equipment may be sited closer to the runway centerline than 400 feet as long as the requirements for RSA and OFZ are accounted for as in 1 (c) above. Note that there are expanded requirements for the dimensions of the OFZ which must be applied for CAT II/III runways or runways with Type 1 ILS but where an operational approval for CAT II minimums is proposed.

(3) Structures. Those structures which are elements of the Glide Slope, PAR, or RVR systems (except GS antenna or monitor masts) should not exceed 15 ft. in height above the elevation of the runway centerline nearest them, and in addition may be no closer to the runway centerline than 400 ft. When such structures are more than 15 ft. high, they may be permitted if the minimum distance from the runway centerline is increased 10 ft. for each foot the structure exceeds 15 ft. Frangible PAR reflectors are not considered to be obstructions. MLS antennas are permitted within the touchdown area subject to the criteria in Order 6830.5, as amended.

(4) Objects permitted by AC 150/5300-13. Objects, such as taxiing aircraft or moving vehicles, are allowed within the touchdown area as long as they remain clear of the Obstacle Free Zone. Objects allowed by application of Handbook 7110.65 can be within the touchdown area under certain conditions. However, during Category II and III landing operations, all vehicles, equipment, and aircraft must be held clear of the Obstacle Free Zone. (See FIGURE X).

8. TOUCHDOWN AREA TRANSITIONAL SURFACES.

a. Definition. Transitional Surfaces sloped at 7:1 extend outward and upward from the edges of the Touchdown Area and Section 1 of the Missed Approach Area (See Paragraph 9) to a height of 150 ft. above the elevation of the runway centerline at the end of the touchdown area.

FIGURE 3. OBSTRUCTION CLEARANCE AREAS CATEGORY II AND CATEGORY III

b. Obstruction Clearance. A structure, such as a building or tower, which penetrates the Touchdown Area Transitional Surfaces is an obstruction to Category II and Category III landing operations even when the same object does not penetrate the Obstacle Free Zone. Parked aircraft which penetrate the Touchdown Area Transitional Surfaces are an obstruction to Category II and Category III landing operations. Aircraft taxiing via a parallel taxiway and clear of the Obstacle Free Zone, may penetrate the Touchdown Area Transitional Surfaces. When a fixed object penetrates the 7:1 transitional surfaces and when deemed necessary, adjustment in the RVR minimums will be made commensurate with the degree of interference presented by the obstruction. Such adjustment will be approved by the Flight Standards Service. A caution note will be added to the approach procedure to identify obstacles which penetrate the 7:1 surfaces.

<u>FIGURE X AC-150/5300-13 OBSTACLE FREE ZONE</u>

INSERT Figure 3-4 Obstacle free zone (OFZ) for runways serving large airplanes with lower than 3/4 statute mile (1200m) approach visibility minimums.
from AC 150/5300-13 CHG. 4 dated 11/10/94

9. MISSED APPROACH AREA. A missed approach will be specified to commence at the DH if the required visual reference during Category II operations has not been established. However, it is possible that aircraft will continue to descend through the decision height while initiating the Category II missed approach, or that a decision to land may be altered by circumstances and the approach aborted at a lower altitude. In either case, the missed approach obstruction clearance criteria must consider aircraft which have progressed into the touchdown area to heights below the decision height, perhaps even to a momentary touchdown. Category III missed approach operations must be protected for a momentary touchdown during the missed approach maneuver. Therefore, two Sections to the Missed Approach Area, and a special treatment for the turning missed approach are necessary.

a. Missed Approach Section 1. This portion of the area begins at the end of the Touchdown Area at the height of the runway, and is longitudinally centered on the runway centerline. It has the same width as the touchdown area at the point of beginning (1,000 ft.) and the width increases uniformly to 3,100 ft. at 6,000 ft. from the point of beginning. (See Figure 3).

b. Missed Approach Section 2. This portion of the area starts at the end of Missed Approach Section 1 and is centered on a continuation of the Section 1 course. The width increases uniformly from 3100 ft. at the beginning to 8 miles at a point 15 miles from the runway threshold. When positive course guidance is NOT provided for the missed approach procedure, secondary areas which are zero miles wide at the point of beginning and increase uniformly to 2 miles wide at the end of Missed Approach Section 2, must be added to the edges of Section 2. See Figure 4). Certain airborne equipment may qualify to utilize the FMS missed approach criteria in Order 8260.40 or the RNP criteria at appendix 5 of this AC.

c. Turning Missed Approach Area. (Applies to turns of over 15 degrees). The design of the turning missed approach area assumes that aircraft missing an approach will climb straight ahead until reaching a height of at least 300 ft. above the elevation of the runway centerline at the end of the Touchdown Area. The procedure will identify the obstruction if a turn toward a significant obstruction has to be made. The turning flight track radius shall be 1.75 miles, and it shall be plotted to begin at the end of Missed Approach Section 1. The outer boundary of Missed Approach Section 2 shall be drawn with a 3.5 mile radius. The inner boundary line shall commence at the outer edge of the transitional surface opposite the end of the Touchdown area. The outer and inner boundary line shall terminate at points 4 miles each side of the assumed flight track 15 miles from the runway threshold. (See Figures 5 and 6). Where secondary areas are required, they shall commence after completion of the turn. Turns in the missed approach area are normally specified to commence after reaching a height of 300 ft. Where an operational requirement exists to continue the climb of the aircraft to a height of more than 300 ft. prior to commencing a turn, Missed Approach Section 1 will continue to increase uniformly in width, and will be extended longitudinally 4000 ft. for each 100 ft. of height over 300 ft. In addition, the 12:1 Transitional Surface (Paragraph 8.a) is also extended laterally on the inside of the turn to a height equal to the elevation attained by the extension of Missed Approach Section 1.

> **NOTE: Where a positive course guidance is provided in Section 2 consideration may be given to reducing the width of this Section.**

d. Obstruction Clearance. (See FIGURE XX).

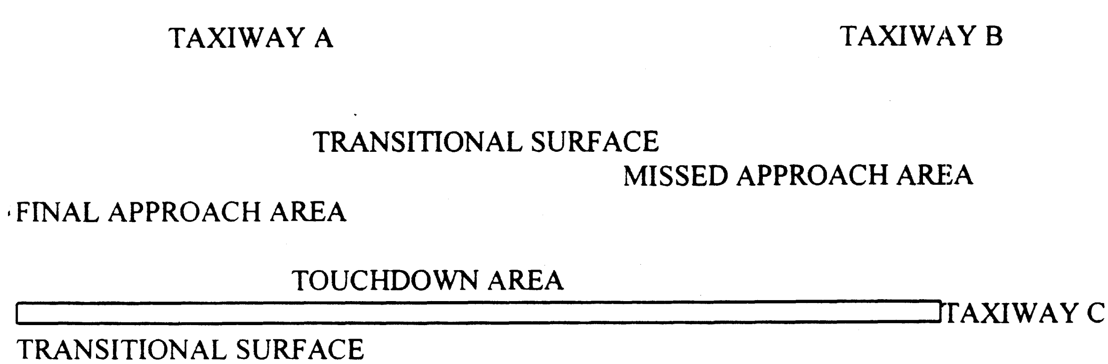


FIGURE XX. TAXIING AIRCRAFT AS OBSTACLES.

In referring to FIGURE XX, taxiing aircraft on Taxiway A are not allowed to penetrate the Final Approach Surface or the Final Approach Area Transitional Surface. Taxiing aircraft on Taxiway B are not allowed to penetrate the Missed Approach Area Section 1 Surface. Taxiing aircraft on parallel Taxiway C are permitted to penetrate the Touchdown Area, the Touchdown Area Transitional Surface and the Missed Approach Area Section 1 Surface, as long as they remain clear of the Obstacle Free Zone. And taxiing aircraft on parallel Taxiway C are not allowed to penetrate the Final Approach Surface or the Final Approach Area Transitional Surface.

Where it is necessary to hold taxiing aircraft on taxiways located in the approach or missed approach areas so that taxiing aircraft do not interfere with Category II or Category III operations, taxiway pavement markings and airfield signs are required. AC 150/5340-18C, Standards For Airport Sign Systems, as amended, specifies use of a Holding Position Sign for Approach Areas and AC 150/5340-1G, Standards For Airport Markings, as amended, specifies use of Runway Holding Position Markings on taxiways. For Category III operations less than 600 ft. RVR, AC 120-57, Surface Movement Guidance and Control System, as amended, specifies Geographic Position Markings and in-pavement Taxiway Clearance Bar lights are required to be installed in addition to the Runway Holding Position Markings at the runway approach holding locations.

(1) Straight Missed Approach. No fixed obstruction in Sections 1 or 2 may penetrate a 40:1 surface. This surface originates at the beginning of Section 1 at the elevation of the runway centerline at the end of the touchdown area, and overlies the entire Missed Approach Area. An object, such as a parked aircraft or a tower, which penetrates the Missed Approach Area is an obstruction to Category II and Category III operations even when the same object does not penetrate the Obstacle Free Zone. Aircraft taxiing via a parallel taxiway adjacent to the Category II or Category III runway and clear of the Obstacle Free Zone, may penetrate the missed approach area. Taxiing aircraft which are not on a parallel taxiway adjacent to the Category II or Category III runway may not penetrate the Section 1 or 2 missed approach 40:1 surface.

(2) Turning Missed Approach. Section 1 obstruction clearance is the same as that for straight missed approach. To determine the obstruction clearance requirements in Section 2, the lines A-B and B-C are identified in Figures 5 and 6. The height of the missed approach surface over any obstruction in Section 2 is determined by measuring the distance from the obstruction to the nearest point on the line A-B or B-C and computing the height according to the 40:1 ratio starting at the elevation of line A-B or B-C. Note that lines A-B and B-C are always at the same elevation as the end of Section 1. (See Figure 6).

(3) Secondary Areas. Where secondary areas are considered, no obstruction may penetrate a 12:1 surface which slopes outward and upward from the missed approach surface.

***10. GLIDE SLOPE ANGLE.** The standard and maximum angle is 3.0 degrees. An angle less than 2.5 degrees will be established only to satisfy a unique operational requirement, and must be justified by special study for consideration of approval by Flight Standards Service, Washington, D.C.

11. GLIDE SLOPE THRESHOLD CROSSING HEIGHT. The optimum glide slope threshold crossing height is 50 ft. The maximum is 60 ft. A height as low as 47 ft. may be used at locations where special consideration of the glide path angle and antenna location are required. Heights are measured at the landing threshold. See FAA Order 8260.34, as amended. The approach reference datum height for the MLS glide path is also governed by FAA Order 8269.34, as amended. Guidance specifying GPS and RNP threshold crossing height is not available at this time.

*** NOTE: Use of glide slope crossing heights as low as 47 ft. are predicated on the vertical distance between the aircraft glide slope antenna and the lowest part of the main landing gear wheels not exceeding 19 ft. with the aircraft in its normal landing approach attitude.**

12. ADJUSTMENT TO CATEGORY II ILS MINIMUMS. The decision height is measured from the highest elevation of the runway in the touchdown area. The lowest minimums permitted by the Category II system are a decision height of 100 ft. and RVR 1200. Application of Category II obstruction clearance criteria may identify objects which exceed the allowable height in the touchdown area or penetrate the approach light surface. In such cases, adjustment to the decision height shall be made as follows:

Final Approach Surface. Requires a special study of local features and conditions before Category II operation can be authorized by the Flight Standards Service, FAA, Washington, DC.

Approach and Touchdown Area Light Surface. Adjust the DH upward one foot for each one foot an object exceeds the allowable height. The RVR value will then be adjusted as indicated in the table:

Adjusted Decision Height	RVR
101-140 ft. (1'-40' adjustment)	1200
141-180 ft. (41'-80' adjustment)	1600
181-199 ft. (81'-99' adjustment)	1800

FIGURE 6. TURNING MISSED APPROACH AREA CONSTRUCTION DETAIL PRECISION CATEGORY II AND III

13. OBSTRUCTION IN THE MISSED APPROACH AREA. The 40:1 missed approach surface is established to identify objects which may be a hazard in the missed approach area. Objects which do not penetrate the 40:1 surface are not considered a hazard. When an object penetrates this 40:1 surface, a special study is required to ensure the appropriate level of safety before Category II operations can be authorized by the Flight Standards Service, FAA, Washington D.C.

APPENDIX 10. TAKEOFF SYSTEM PERFORMANCE AFTER LIFTOFF

The entire takeoff operation requires continuity and a smooth transition from the runway portion of the takeoff through 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 Hazardously Misleading Information is Improbable when the flight crew 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 not within the pilot's primary eye-scan area. Annunciations displayed in head forward locations near the HUD field of view, such as the glare shield, might be found suitable, if they are clear, conspicuous and unambiguous to the pilot while focused on the HUD.

b) The display of Hazardously Misleading takeoff guidance 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:

V2, for engine failure at or below V2 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 or (e.g., as a result of engine failure) shall not result in the guidance to either pilot being removed.

f) The flight crew 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.

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

5. Crews 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 aircraft dispatcher may consider "engine inoperative Category III" capability in planning flights for a takeoff alternate, en route (ETOPS) alternate, re-dispatch alternate, destination, or destination alternate only if each of the following conditions are met:

1. The 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. The same 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 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 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. Other requirements applicable to "all engine" Category III, such as training, crew qualification, procedures, and other items must also be addressed for the engine inoperative landing 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 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 provisions are applied to identification of any 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, crews 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, crews 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 aircraft dispatcher and pilot 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 aircraft dispatcher and pilot have determined that the approach can be conducted within the wind, weather, configuration, or other relevant constraints demonstrated for the configuration.

4. The aircraft dispatcher and pilot 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 aircraft dispatcher and pilot 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 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 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 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/1200 RVR then 50 ft. DH/600 RVR
Fail - Operational Landing System	100 ft. DH/1200 RVR then 600 RVR, then 300 RVR
Starting from Category II	
Fail - Passive Landing System	50 ft. DH/600 RVR
Fail - Operational Landing System	600 RVR then 300 RVR

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 IIIa or Category IIIb 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 Operations Specifications 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 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 crews 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, NAVAIDs and runways used, and procedures to be used, etc. (e.g., Newly acquired B757s being added to Category III Operations Specifications, 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 CHDOs, 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 Operations Specifications of the acquired or merged operator. If CHDO doubt exists regarding applicability or status of Category III Operations Specification 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 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 the Technical Programs Division, AFS-400, FAA Headquarters, Washington, D.C.

Figure 10.13-1 provides a checklist for carriers use to facilitate approval of CAT 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-US airports. Completion of this checklist must reflect achieved or completed status -- not planned actions. 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-US 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: METARs _______ TAFs __________
TRANSMISSOMETERS:
(Locations/Lowest RVR reported/readout step increment)
Touch down ______________ 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:

- 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).
- 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).
- Crews 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).
- The Operations Specifications must authorize off-route charter Category III procedures, and
- 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, Operations Specifications 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 NAVAIDs. 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 Operations Specifications 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 Operations Specifications 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 (SIAPS), 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.

10.18 Proof-of-Concept Requirements 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 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; NRSs; the applicant, and supporting personnel as necessary (e.g., Air Traffic and representative flight crews, 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, flight crew, 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 real-time simulator environment and validated in a realistic airplane environment.

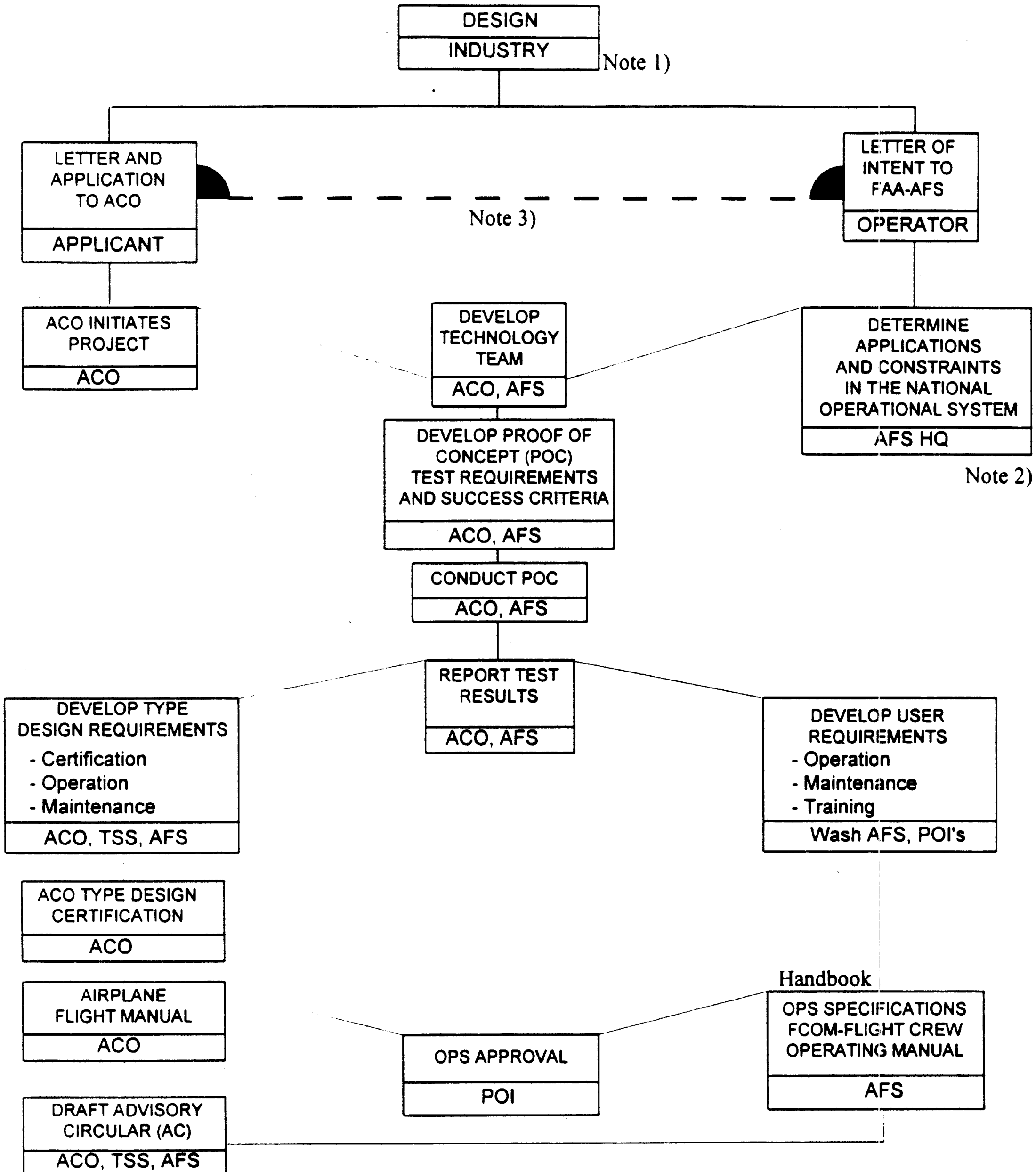
7. FAA is responsible for assessing the PoC data which is typically provided to FAA as agreed by FAA and the applicant. FAA reports relevant findings to the applicant and if applicable, interested industry representatives.

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, AFMs, 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 US 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 Cat III at US 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., Cat 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 US 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 six 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 Operations Specifications, which ever is the more restrictive. However, operators approved in accordance with this provision may nonetheless be subject to additional FAA demonstration requirements for special situations, such as at airports with irregular underlying terrain (see 11.3), or for aircraft types not having flown to US 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 requirements of 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 Operations Specifications (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), and

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 Operations Specifications 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 requirements, 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.

Additionally, 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, ADs, navaid status or performance problems, applicable NOTAMs, 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.

APPENDIX 1 DEFINITIONS AND ACRONYMS

This Appendix contains the definition of terms and acronyms used within this Advisory Circular.

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]
Approach Intercept Waypoint (APIWP)	Variable waypoint used only when intercepting the Final Approach Segment (FAS)
Automatic Dependent Surveillance	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".
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 II Navigation	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 of ICAO standard airway navigation facilities (VOR, VOR/DME, NDB).
Combiner	The element of the 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 (feet) of the Flight Path Control Point above the Runway Datum Point.
Decision Altitude	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)	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 touch down 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 US facilities. (Adapted from ICAO - IS&RP Annex 6)
Decision Height	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 flight crew and air traffic control can expect the aircraft to fly.
Enhanced Vision System	An electronic means to provide the flight crew with a synthetic image of the external scene.
Estimate of Position Uncertainty [EPU]	A measure based on a scale which conveys the current position estimation performance.
Extended Final Approach Segment	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 less than or equal to 1×10^{-9} per hour of flight, or per event (e.g., takeoff, landing)
Extremely Remote	A probability of occurrence greater than 1×10^{-9} but less than or equal to 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]	
Final Approach Fix (FAF)	
Final Approach Point (FAP)	
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 flight crew 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 Flight Path Alignment Point (FPAP) is used in conjunction with the Runway Datum Point (RDP) and the geometric center of the WGS-84 ellipsoid to define the geodesic plane of a precision final approach, landing and flight path. The FPAP 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	The accuracy with which the aircraft is controlled as measured by the indicated aircraft position with respect to the indicated command or desired position. It does not include blunder errors.
Glide Path Angle [GPA]	The glide path angle is an angle, defined at the Flight Path Control Point, that establishes the intended descent gradient for the final approach flight path of a precision approach procedure. It is measured from a horizontal plane that is parallel to the WGS-84 ellipsoid at the Flight Path Control Point.
Glide Path Intercept Waypoint (GPIWP)	The point at which the Final Approach Segment (FAS) projects to intercept the runway surface
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.
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 24 satellites in six orbital planes . The control segment consists of five monitor stations, three 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 flight crew 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 dis-similar 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.
Landing	For the purpose of this Advisory Circular, landing will begin at 100 feet, the DH or the AH to the first contact of the wheels with the runway.
Landing rollout	For the purpose of this Advisory Circular, 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	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	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 feet (2 m) 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

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	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)
Probable	A probability of occurrence greater than on the order of 1×10^{-5}
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.
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 Type (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 per cent 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. 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 Runway Datum Point (RDP) is used in conjunction with the Flight Path Alignment Point (FPAP) and the geometric center of the WGS-84 ellipsoid to define the geodesic plane of a precision final approach flight path to touch down and rollout. It is a point at the designated center of the landing runway defined by latitude, longitude, ellipsoidal height, and orthometric height. The RDP is a surveyed reference point used to connect the approach flight path with the runway. The RDP may not be coincident with the designated runway threshold.
Runway Segment	That segment of an approach from the Glidepath Intercept Waypoint (GPIWP) 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
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 99.99% 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	The first 3000 feet of usable runway for landing - unless otherwise specified the FAA.
Visual Guidance	Visual information the pilot derives from the observation of real world cues, outside the cockpit and used as the primary reference for aircraft control or flight path assessment

Acronyms

ACRONYM	EXPANSION
ADS	Automatic Dependent Surveillance
AFDS	Autopilot Flight Director System
AH	Alert Height
ANP	Actual Navigation Performance
APIWP	Approach Intercept Waypoint
ATC	Air Traffic Control
ATS	Air Traffic Services
CHDO	Certificate Holder District Office
CNS	Communication, Navigation and Surveillance
DA	Decision Altitude
DCH	Datum Crossing Height
DEP	Design Eye Position
DGNSS	Differential Global Satellite Navigation System
DA(H)	Decision Altitude(Height)
DH	Decision Height
DME	Distance Measuring Equipment
ECEF	Earth Centered Earth Fixed
EFAS	Extended Final Approach Segment
EPU	Estimated Position Uncertainty
FAF	Final Approach Fix
FAS	Final Approach Segment
FPAP	Flight Path Alignment Point
FPCP	Flight Path Control Point
FTE	Flight Technical Error
GLS	Global Positioning System Landing System
GNSS	Global Navigation Satellite System
GPA	Glide Path Angle
GPIWP	Glide Path Intercept Waypoint
GPS	Global Positioning System
HAA	Height Above Airpad
HAT	Height above Touch down
HUD	Head Up Display
IAW	In Accordance With
ILM	Independent Landing Monitor
ILS	Instrument Landing System
IM	Inner Marker
IMAS	Initial Missed Approach Segment
IMAWP	Initial Missed Approach Waypoint
LNAV	Lateral Navigation
LAD	Local Area Differential
MDA	Minimum Descent Altitude
MDA(H)	Minimum Descent Altitude(Height)
MDH	Minimum Descent Height - NOTE: MDH is not used for US Operations
MEL	Minimum Equipment List
MLS	Microwave Landing System
NOTAM	Notice to Airman
PF	Pilot Flying
PNF	Pilot Not Flying
POI	Principal Operations Inspector
RDP	Runway Datum Point
RNAV	Area Navigation
RNP	Required Navigation Performance
RWS	Runway Segment
SIAP	Standard Instrument Approach Procedure
STC	Supplemental Type Certificate
TC	Type Certificate
TDZ	Touch Down Zone
VNAV	Vertical Navigation
VOR	VHF Omni Range
WAD	Wide Area Differential
WAT	Weight, Altitude and Temperature

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

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.

References to JAA All Weather Operations Regulations are provided to facilitate the All Weather Operations Harmonization process. A reference to a JAR provision does not necessarily mean that the FAA and JAA requirements are <u>equivalent</u> but they are <u>related with similar intent</u>. The FAA typically may identify which JAR provisions are acceptable to FAA at the time a type certification basis is established.

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 §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 10.

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 flight crew 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 [PoC], or
- by a vision enhancement system. [PoC]

In addition to indications of the airplane position, the takeoff system should also compute and display command 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 guidance, 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 operations specification to visibility values not requiring command guidance, or

2) Based on authorizations requiring command guidance.

The airworthiness criteria for takeoff systems are based 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 with any failure or combination of failures not shown to be Extremely Improbable.

5. TYPES OF TAKEOFF SERVICES.

There are a number of navigation aids which may support aircraft systems in providing guidance to the flight crew 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 advisory circular. 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 8.1 of this advisory circular. These standards should be considered when demonstrating aircraft system operation.

5.3 GNSS [PoC].

This appendix section is not intended to provide an acceptable means of compliance for airworthiness approval of GNSS based systems. Currently approved systems are ILS or MLS based. The application of new technologies and systems will require an overall assessment of the integration of the airplane components with other elements (e.g., new ground based aids, satellite systems, advanced radar mapping systems, enhanced vision sensor systems etc.) to ensure that the overall safety of the use of these systems low visibility conditions is acceptable. This GNSS section is included to show the inherent differences between conventional ILS/MLS based systems and 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 GNSS Flight Path Definition [PoC].

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.

The required lateral path is not inherent in the design of the GNSS based Takeoff System, therefore the airplane navigation and flight guidance system will require specification of earth referenced waypoints to define the required path, which is coincident with the runway centerline.

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 advisory circular, *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 an Takeoff System should be addressed as part of the certification process. The flight crew should not be able to modify information in the data base which relates to the definition of the required flight path.

5.3.2 GNSS Airplane Position Determination [PoC].

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) [PoC]

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 [PoC]

Differential augmentation uses a GNSS receiver at a known (surveyed) point on the ground to provide corrections to the individual satellite pseudo-range data.

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 [PoC]

Local Area Differential (LAD) augmentation consists of a ground based GNSS receiver located in the area of the airport which provides differential coverage runways at that airport.

5.4 Other.

5.4.1 Datalink [PoC].
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 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 system is established.

6. BASIC AIRWORTHINESS REQUIREMENTS.

6.1 General Takeoff System Requirements.

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 flight crew 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 etc.). 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 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 overshoots or oscillations around the centerline are considered acceptable.

The performance envelope and conditions for evaluating takeoff systems for the following scenarios are described in Section 5.1.3 of this advisory circular (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 Vmcg - 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 7 meters 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 25-7. The takeoff system should provide required tracking performance with Satisfactory workload and pilot compensation, under all foreseeable normal conditions. It is 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 system shall provide guidance information, 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 as guidance for the application of 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.

To the maximum extent possible, failures that would result in unsafe conditions should be detected by the takeoff system and promptly annunciated to the pilot. Unsafe conditions include the airplane violating the lateral confines of the runway while on the ground, and rotation at an unsafe speed, pitch rate or pitch angle.

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 takeoff guidance 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 probability of the flight guidance system generating misleading information that could lead to an unsafe condition shall be Improbable when the flight crew 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 flight guidance system generating misleading information that would be hazardous 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.

The loss of an electrical source or (e.g., as a result of engine failure) shall not result in the guidance to either pilot being removed.

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 Requirements. 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 flight crew. 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 Requirements.

System design or use should not degrade the flight crews 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, Vspeed 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 Requirements. 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 Requirements.

The takeoff system must alert the flight crew 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 crew member, and compatible with the alerting philosophy of the airplane. The alerts should not result in conflicts with the alert inhibit philosophy developed to reduce high speed aborts.

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

d) Engine failure

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.

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).

6.4.3.5 Engine Failures.

Engine alerts, to include the propeller system, if applicable, should be consistent with the overall flight deck design philosophy. Engine failures shall be annunciated in a manner that provides appropriate aircrew recognition and ensures the crew has adequate awareness to take appropriate. Annunciations should be consistent with overall cockpit design philosophy, clearly indicate which engine has failed, should not cause any confusion, and should not lead to an inadvertent abort. Aircrew awareness of the engine failure should be appropriately provided for subsequent portions of the operation where the failure may be a factor.

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 on how the performance, integrity and availability "requirements" of the non-airplane elements will be ensured. Ensurance can be addressed by compliance with ICAO SARPs (or equivalent State Standard) or by reference to an acceptable standard for the performance of any navigation service.

The plan for certification shall describe 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.

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-airplane elements of the system and how these assumptions and considerations relate to the airplane system certification plan.

7.1 Performance Evaluation.

The performance of the airplane and its systems must 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 with a satisfactory level of workload and pilot compensation, as defined by the FAA Handling Quality Rating System (HQRS) found in AC 25-7.

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 flight crew 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):

- 20 normal, all-engine takeoffs.
- 10 completed takeoffs, with simulated engine failure at or after the appropriate Vef for the minimum V1 for the airplane. All critical cases must be considered.
- 10 rejected takeoffs, some with simulated engine failure just prior to V1, some with simulated engine failure at V1 and at least one run with simulated engine failure at a critical speed less than Vmcg

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 150% of the winds 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 flight crew to react in an inappropriate manner.

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, Vspeed 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 using manual control with takeoff (or command) and guidance, the set of subject pilots provided by the applicant must have relevant variability of experience (e.g., experience with HUD, Capt/FO, experience in type). These subject pilots must not have special experience that invalidates the test (e.g., not special recent training to cope with the failures, beyond what a line pilot would be expected to have). The set of pilots provided by the certifying authorities will not be limited by the aforementioned variables. Failure cases must be spontaneous and unexpected on the subject'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 25.1329-1A to meet the requirements of section 25.1309.

In showing compliance with airplane systems 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 the 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 advisory circular).

Documented conclusions of the safety analysis shall include:

A Functional Hazard Assessment (FHA), conducted in accordance with section 25.1309, will determine potential hazards that are either induced or aggravated by system malfunctions. The FHA determines the necessity for Fault Tree Analysis of particular functions, and defines the upper level events in the fault trees.

A fault tree analysis, demonstrated compliance, and probability requirements for significant functional hazards.

A list of all alleviating flight crew actions, that were considered in the safety analysis, and must be validated during testing for incorporation in the airplane flight manual procedures section or for inclusion in type-specific training.

A list of all maintenance procedures required to ensure safety, such as certification maintenance requirements (CMR), periodic checks, and so on.

8. AIRBORNE SYSTEM REQUIREMENTS.

8.1 General Requirements.

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 Title 14 of the Code of Federal Regulations (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 §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 situational 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 Captains 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 requires an overall assessment of the integration of the airplane components with other elements (e.g., ground based aids, satellite systems, advanced radar mapping systems, enhanced vision sensor systems, as applicable) 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 advisory circular.

8.4.2 On Board Database.

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 flight crew 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.

A data link may be used to provide data to the airplane to provide the accuracy necessary to define the takeoff flight path. 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:

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.

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.

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 flight crew with an enhanced view of the scene outside the airplane (e.g., radar) may be considered for airworthiness approval. However, this Appendix does not comprehensively address a means of compliance for airworthiness approval of such Enhanced Vision Systems. Performance must be demonstrated to be acceptable to the FAA through proof of concept testing **[PoC]**, during which specific airworthiness and operation 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 for a takeoff system are provided in Appendix 6.

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

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 Advisory Circular. 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 120-29A, 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.

References to JAA All Weather Operations Regulations are provided to facilitate the All Weather Operations Harmonization process. A reference to a JAR provision does not necessarily mean that the FAA and JAA requirements are equivalent but they are related with similar intent. The FAA typically may identify which JAR provisions are acceptable to FAA at the time a type certification basis is established.

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 advisory circular 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, Global Navigation Satellite System (GNSS), Inertial information, Local Area Differential GNSS, or 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),

- on-board navigation system computations with corresponding displays of position and reference path [PoC], or

- by a vision enhancement system. [PoC]

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

NOTE: The following engine inoperative capabilities may be demonstrated, for each 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.

The following definitions can be used for the operations described above.

Landing - for the purpose of this Appendix, landing begins at 100 ft. and continues 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.

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.

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 GNSS [PoC]. This appendix section is not intended to provide a comprehensive means of compliance for airworthiness approval of GNSS based systems. Currently approved systems are ILS or MLS based. The application of new technologies and systems will require an overall assessment of the integration of the airplane components with other elements (e.g., new ground based aids, satellite systems, advanced radar mapping systems, enhanced vision sensor systems) to ensure that the overall safety of the use of these systems for Category III. This GNSS section is included to identify important differences between conventional ILS/MLS based systems and GNSS based systems that 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 GNSS Flight Path Definition [PoC]. 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.

The required flight path is not inherent in the design of the GNSS based Landing and Rollout System, therefore the airplane navigation and flight guidance system must specify a sequence of earth referenced waypoints to define the required flight path.

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 advisory circular 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 an 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 GNSS Airplane Position Determination [PoC]

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) [PoC]

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 [PoC]

Differential augmentation uses a GNSS receiver at a known (surveyed) point on the ground to provide corrections to the individual satellite pseudo-range data.

If a ground based GNSS receiver 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 will have to be established.

The role of the differential station in the landing 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 .[PoC]

Local Area Differential (LAD) augmentation consists of a ground based GNSS receiver located in the area of the airport which provides differential coverage runways at that airport.

Wide Area Differential Augmentation [PoC]

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 [PoC]. 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 US, or international standards for data link ground systems are established.

6. BASIC AIRWORTHINESS REQUIREMENTS. 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 6.1.1 below) are the same for landing systems with automatic flight control, and systems with manual control and command 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 Requirements.

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 120-29A, 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 landing and rollout using command guidance, may not be less than that achieved in an equivalent 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 under automatic or command guidance control.

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 guidance provided during the landing and rollout should be consistent with manual flight control 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 (e.g., Go-around), 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 control or command guidance actions of the system and the resulting airplane flight path shall not contain unusual features liable 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 Requirements. The applicant shall establish acceptable approach performance to the criteria contained in AC 120-29A, 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 should be conducted to the point where a smooth transition is made to the landing.

Prior to touch down, the system may enter an align mode to correct for crosswind effects. This mode, if provided, must be annunciated to the flightcrew and should operate in a manner consistent with a pilots manual technique for crosswind landings using the wing low side slip procedure.

The landing flare to touch down should reduce the airplane sink rate to a value and in a manner, that is compatible with normal flight operations.

The automatic flight control system should provide de-rotation, consistent with manual operation. Manual rollout systems are not required to provide de-rotation. Systems which provide de-rotation (automatic or guidance) 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 manual pilot operation and not require excessive skill or crew workload to accomplish the operation.

6.3.1 Landing System Performance. All types of low visibility landing systems, whether they use automatic flight control, manual control with command guidance, or hybrid, under the conditions for which their use is to be approved, shall be demonstrated to achieve the performance accuracy with the prescribed probabilities as described below. The values may be varied where characteristics of a particular airplane justify such variation.

(a) Longitudinal touch down earlier than a point on the runway 200 ft. (60m) from the threshold to a probability of 1 x 10-6;

(b) Longitudinal touch down beyond the end of the touch down zone lighting, 2700 ft.(823 m) from threshold to a probability of 1 x 10-6;

(c) Lateral touch down with the outboard landing gear more than 70 ft. (21.3 m) from runway centerline to a probability of 1 x 10-6.

(These values assume a 150 ft. (45.7 m) runway. The lateral touch down performance limit may be appropriately increased if operation is limited to wider runways;

(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 Title 14 of the Code of Federal Regulations (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 of FAR/JAR 25.485 and the worst combination of loads which are likely to arise during a lateral drift landing. In the absence of a more rational analysis of this condition, the following must be investigated:

(A) A vertical load equal to 75% of the maximum ground reaction of FAR/JAR 25.473 must be considered in combination with a drag and side load of 40% and 25%, respectively, of that vertical load.

(B) The shock absorber and tire deflections must be assumed to be 75% of the deflection corresponding to the maximum ground reaction of FAR/JAR 25.473 (a)(1)(ii). This load case need not be combined with flat tires.

(e) Bank angle resulting in hazard to the airplane to a probability of 1 x 10-7. A hazard to the airplane is interpreted to mean a bank angle resulting in any part of the wing 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. This requirement applies to both manual and autothrottle operations.

NOTE: This criteria is not specific to low visibility systems, but must be met by low visibility systems.

6.3.3 Rollout System Performance.

(a) The rollout system, if included, should control the airplane, in the case of an automatic flight control system, or provide 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. The following performance must be investigated to ensure the rollout system will:

(1) Cause the airplane to capture the runway/localizer centerline in a smooth and predictable manner. Minor oscillations around the localizer centerline are acceptable. Undamped or divergent oscillations are not acceptable

(2) Promptly correct any lateral movement away from the runway centerline in a positive manner.

(3) Cause the airplane to 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. This point of intercept should be sufficiently before the end of the runway to permit the system to capture the centerline.

(b) The rollout system performance is referenced to the center line 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 converge on the intended path in a mild and predictable manner. Minor overshoots are considered acceptable, but sustained or divergent oscillations are unsatisfactory.

(c) The normal rollout system performance should not cause the outboard tires to deviate from the runway centerline by 70 ft. (21.3 m) from the point of touch down to a safe taxi speed, more often than once in one million (10^6) landings.

(d) 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. (45.7 m) runway width. The rollout performance limit may be appropriately increased if operation is limited to wider runways.

NOTE: 70 ft.(21.3 m) deviation from centerline is equivalent to outboard tires at 5 ft. (1.5 m) within the edge of a 150 ft. (45.7 m) 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, DGPS, GNSS - ground, airplane and space elements etc.)

f. Approach airspeed and variations in approach airspeed.

g. Airport conditions (density altitude, 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 60 m prior to the threshold; or

c. Sea-wall - 6 m (20 ft.) step up to threshold elevation at a point 60 m 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 advisory circular).

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 positions;

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:

1. Information on height loss as a function of go-around initiation altitude, and

2. Performance information allowing the operator to determine that safe obstacle clearance can be maintained during a go around with an engine failure, or

3. A method to assess and extend applicability of engine inoperative takeoff performance obstacle clearance determinations for a balked landing or go-around event, or

4. For aircraft certificated by the JAA, information on the standard climb gradient achievable with an engine inoperative in the applicable configuration and with applicable configuration changes. (NOTE: for use of this method, the operator must in turn show that the standard gradient shown during airworthiness demonstration assures engine inoperative obstacle clearance for a balked landing at the end of the touch down zone for each runway served.)

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 as guidance for the application of section 25.1309 to Landing Systems:

For Fail Passive landing systems after beginning the final approach, any malfunction or any combination of malfunctions that could prevent a safe landing or go around must be considered at least Hazardous, and must be detected and annunciated as a warning to the flightcrew, unless shown to be Extremely Improbable, to ensure immediate corrective action. Flightcrew corrective actions shall be consistent with the requirements of section 25.1309.

Prior to 200 ft. HAT, the Fail Operational landing system shall detect and annunciate any failure condition not shown to be Extremely Improbable that could prevent a safe landing or go around. Below 200 ft. HAT, any single failure, and any combination of malfunctions not shown to be Extremely Improbable, must not prevent the Fail Operational landing system from performing a safe landing on the runway.

Below 200 ft. HAT, malfunctions of the Fail Operational landing system that would require flightcrew intervention to ensure safe landing or go around must be considered at least Hazardous, and must be detected and annunciated as a warning to the flightcrew to ensure immediate corrective action. Flightcrew corrective actions must be shown to be consistent with the requirements of section 25.1309.

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. (1000 m) 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. (21 m) from runway centerline.

(These values assume a 150 ft. (45 m) 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 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 of FAR/JAR 25.485 and the worst combination of loads which are likely to arise during a lateral drift landing. In the absence of a more rational analysis of this condition, the following must be investigated:

(A) A vertical load equal to 75% of the maximum ground reaction of FAR/JAR 25.473 must be considered in combination with a drag and side load of 40% and 25%, respectively, of that vertical load.

(B) The shock absorber and tire deflections must be assumed to be 75% of the deflection corresponding to the maximum ground reaction of FAR/JAR 25.473 (a)(1)(ii). This load case need not be combined with flat tires.

(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 control, or guidance information for the pilot, 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 as guidance for the application of section 25.1309 to Landing Systems:

The Fail Operational rollout system must meet the safe rollout performance requirements of appendix section 6.3.3 (i.e. no lateral deviation greater than 70 ft. (21.3 m) from centerline) after any single malfunction, or after any combination of malfunctions not shown to be Extremely Remote. The wheel deviation occurrence rate requirement which applies to a normal system (once in one million (10^6) landings) does not apply to a system with the single failures described above. Malfunction cases may be considered under nominal environmental conditions.

Below 200 ft. HAT, unannunciated malfunctions that would prevent a safe rollout must be shown to be Extremely Improbable.

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.

After touch down, loss of the Fail Passive automatic rollout function shall cause the automatic flight control system to disconnect. Whenever the Fail Passive guidance function for manual rollout does not provide valid guidance, it shall be annunciated to both pilots, and the guidance removed. The removal of guidance, alone, is not adequate annunciation. The loss of a Fail Passive rollout system after touch down shall be Improbable.

With malfunctions that only affect low speed directional control (speeds below which rudder is ineffective for steering), the rollout system performance should not cause the airplane wheels to exceed the lateral confines of the runway from the point of touch down, to a safe taxi speed, more often than once in ten million (10^7) landings. A Safe Taxi Speed is a speed at which the pilot can resume manual control to 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.

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.

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% (i.e. the combination of failures in the airplane approach and landing system and the incidence of unsatisfactory performance shall not result in a go-around rate greater than 5%) for approaches conducted in the airplane. Compliance with this requirement 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. AGL on approach due to an airplane failure condition should be Infrequent (i.e. 1 per 1000 approaches).

For a Fail Operational system, the probability of total loss of the landing system with appropriate annunciation below 200 ft. HAT on approach must be Extremely Remote (and without annunciation shall be Extremely Improbable, refer to section 6.4.1 of this appendix).

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. 1 per 1000 approaches), and the probability of total loss of rollout capability should be Extremely Remote, considering loss or failure of the rollout system.

6.6 Go-Around Requirements.

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 go-around from a low altitude may result in inadvertent runway contact, the safety of the procedure should be established giving consideration to at least the following:

a. The guidance information and control provided by the go-around mode, if provided, should be retained and be shown to have safe and acceptable characteristics throughout the maneuver,

b. 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.

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.

Height loss from a range of altitudes during the approach and flare should be determined when under automatic control and when using the landing guidance system as appropriate.

a. Height losses may be determined by flight testing (typieally 10 go-arounds) supported by simulation.

b. 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.

c. Normal procedures for a go-around with all engines operating should be followed.

6.7 Automatic Braking System Requirements.

If automatic braking is used for credit under seetion 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 Requirements. 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 Requirements. This section identifies requirements for basic situational and guidance 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 approach identifier/frequency, and selected navigation source)

2) Indication of the position of the aircraft with respect to the intended path (e.g., situational information localizer and glide path, or equivalent).

6.8.2 Annunciation Requirements.

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 them to take appropriate corrective action. A warning indication must be provided if immediate corrective action is required. An analysis must 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 the worst case ambient noise conditions, but not so loud and intrusive as to interfere with the crew taking the required corrective action. Visual warnings, such as lights or alphanumeric messages, must be distinct and conspicuously located in the primary field of view for both pilots.

The loss of a Fail Passive or Fail Operational system, after beginning the final approach, shall be annunciated. Whenever a Fail Passive guidance function (for manual control) does not provide valid guidance, it shall be annunciated to both pilots, and the guidance removed. The removal of guidance, alone, is not adequate annunciation.

Below the Alert Height, a reversion (or degradation) of the Fail Operational system to Fail Passive capability shall not be annunciated.

6.8.3.2 Cautions

A caution is required whenever immediate crew awareness is required and timely subsequent crew action will 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.

During final approach, but above the Decision Height, a Fail Passive landing system, or landing and rollout system, shall alert the flightcrew to any malfunction or condition that would affect the ability of the system to support the operation.

After initiation of the final approach, a Fail Passive command guidance systems (HUD guidance for example), shall provide a clear, distinct and unmistakable indication to both pilots for any malfunction or condition that would affect the ability of the system to support the operation.

During final approach, but above 200 ft. HAT, a Fail Operational landing and rollout system (Fail Operational or Fail Passive rollout) shall alert the flightcrew to any malfunction or condition that would affect the ability of the system to support the operation, and any malfunction that degrades the landing system from a Fail Operational to a Fail Passive landing system.

Below 200 ft. HAT and throughout the rollout phase, Fail Operational landing systems shall suppress alerts for malfunctions that reduce the landing system to a Fail Passive landing system.

Deviation alerting - The FAA does not require automatic alerting of excessive deviation, but will approve systems which meet appropriate criteria. 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 is provided, its use must not cause excessive nuisance alerts.

For systems demonstrated to meet criteria for Category II, compliance with the following criteria, from JAA/AWO 236, is an acceptable means of compliance, but is not a required means of compliance:

a) For systems meeting the AWO 236 criteria, excess-deviation alerts should operate when the deviation from the ILS or MLS 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 available in these conditions.

b) For systems meeting the AWO 236 criteria, excess-deviation alerts should be set to operate with a delay of nor more than one (1) second from the time that the deviation thresholds are exceeded.

c) For systems meeting the AWO 236 criteria, excess-deviation alerts should be active at least from 300 ft. (90 m) HAT to the decision height, but the glide path alert may be discontinued below 100 ft. (30 m) 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 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 affecting the intended landing operation must be indicated to the flightcrew as an advisory, without flightcrew action.

A means shall be provided to advise the flightcrew of failed airplane system elements that affect the decision to continue to the destination or divert to an alternate.

During the approach, an indication of a failure in each non-selected airplane system element must be provided to the flightcrew as an indication of system status; it should not produce a caution or warning.

System Status indications should be identified by names that are different than operational authorization categories (e.g., use names such as "LAND 3", or "DUAL", - do not use CAT I, II, III)

6.8.3.5 Engine Failure Annunciations with use of Low Visibility Landing Systems. For approach, landing, and rollout, engine failures, including those involving propeller systems, if applicable, shall be annunciated in a manner that provides appropriate aircrew recognition and ensures the crew has adequate awareness to take appropriate action for the current phase and subsequent phases of the operation being conducted. Annunciations should be consistent with overall cockpit design philosophy, clearly indicate which engine has failed, should not cause any confusion, and should not lead to an inadvertent or inappropriate go-around. Aircrew awareness of the engine failure should be appropriately provided for subsequent portions of the operation where the failure may be a factor. The following outlines the operating philosophy relevant to these annunciations.

a. Above decision or alert height, engine failures will be annunciated at all times in a manner which will provide immediate flightcrew awareness and allow the crew to take appropriate action.

b. At touch down and throughout the rollout, engine failures will be annunciated in a manner which will provide immediate flightcrew awareness and allow the crew to take appropriate action. If an engine failure has occurred prior to touch down, but was not annunciated due to inhibits, it must be annunciated at touch down.

c. Below 200 ft. HAT (or the alert height demonstrated in certification, which ever is higher) to touch down for any portion where a go-around is required in the event of an engine loss, engine failures will be annunciated at all times in a manner which will provide immediate flightcrew awareness and allow the crew to take appropriate action.

d. Below 200 ft. HAT (or the alert height demonstrated in certification, which ever is higher), for aircraft that are expected to continue to land with loss of an engine during this phase, engine failure annunciations may be inhibited until touch down. If engine failures are annunciated in these cases, the annunciation must not cause confusion or lead to an inadvertent go-around.

All references to engine failures include failures of the propeller and automatic feathering systems, as applicable.

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, GNSS Landing System (GNSS)).

6.9.1 General Requirements. 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 audio idents) 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 acceptable 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, GNSS 'path identifier') shall be unambiguously indicated in a position readily accessible and visible to each pilot;

A common set of mode ARM and ACTIVE indications (e.g., LOC and GS) is preferred for ILS, MLS and GNSS 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 require alternate airports for takeoff, en route diversion and landing. These alternate airports may have different landing systems. Flight operations may be planned, released and conducted on the basis of using one or more landing systems.

The capability of each element of a multi-mode landing system shall be available to the flightcrew to support dispatch of the airplane.

A failure of each element of a multi-mode landing system must be indicated to the flightcrew as an advisory, without pilot action, during en route operation.

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 during an approach and landing shall be available to the flightcrew as an advisory but should not produce a caution or warning. These advisories may be inhibited at the Alert Height, if appropriate to the operation.

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, 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).

Touch down footprints, sink rates and attitude requirements for systems with manual control and command guidance must be met as for systems with automatic flight control.

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 information 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 information is based upon the presence of adequate outside visual references for the flightcrew to safely continue the operation. The airworthiness demonstration will include the loss of guidance.

For rollout systems with command guidance, it shall be demonstrated that a safe rollout can be achieved with a Satisfactory level of workload and pilot compensation following a failure, using the FAA Handling Quality Rating System (HQRS) found in AC 25-7, with and without external visual references.

For the evaluation of low visibility systems with manual control and guidance, the set of subject pilots provided by the applicant must have relevant variability of experience (e.g., experience with HUD, Capt/FO, experience in type). These subject pilots must not have special experience that invalidates the test (e.g., not special recent training to cope with the failures, beyond what a line pilot would be expected to have). The set of pilots provided by the certifying authorities will not be limited by the aforementioned variables. Failure cases must be spontaneous and unexpected on the subject's part.

For the initial certification of a landing and rollout system comprised of manual control and command guidance (e.g., HUD guidance system) in a new type airplane, at least 1,000 simulated landings and at least 100 actual landings will be 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, pilots of varying background and experience level should be used in the flight and simulation programs. They should have appropriate qualifications and be given training in the use of the landing system similar to that expected for line pilots. After approximately ten consecutive approaches, each pilot should be given an appropriate rest break.

When simulation is used in the establishment of the density altitude demonstration value of the landing and rollout system, it must be accompanied with sufficient flight test demonstrations. Due to the uncertainties in the fidelity of simulations used to represent performance in high density altitude operations, the Figure 7.1.1-1 and accompanying table identify the relationship between the demonstrated density altitude which could be noted in the AFM and the altitude which is actually demonstrated by flight evaluation - when supported by validated simulation.

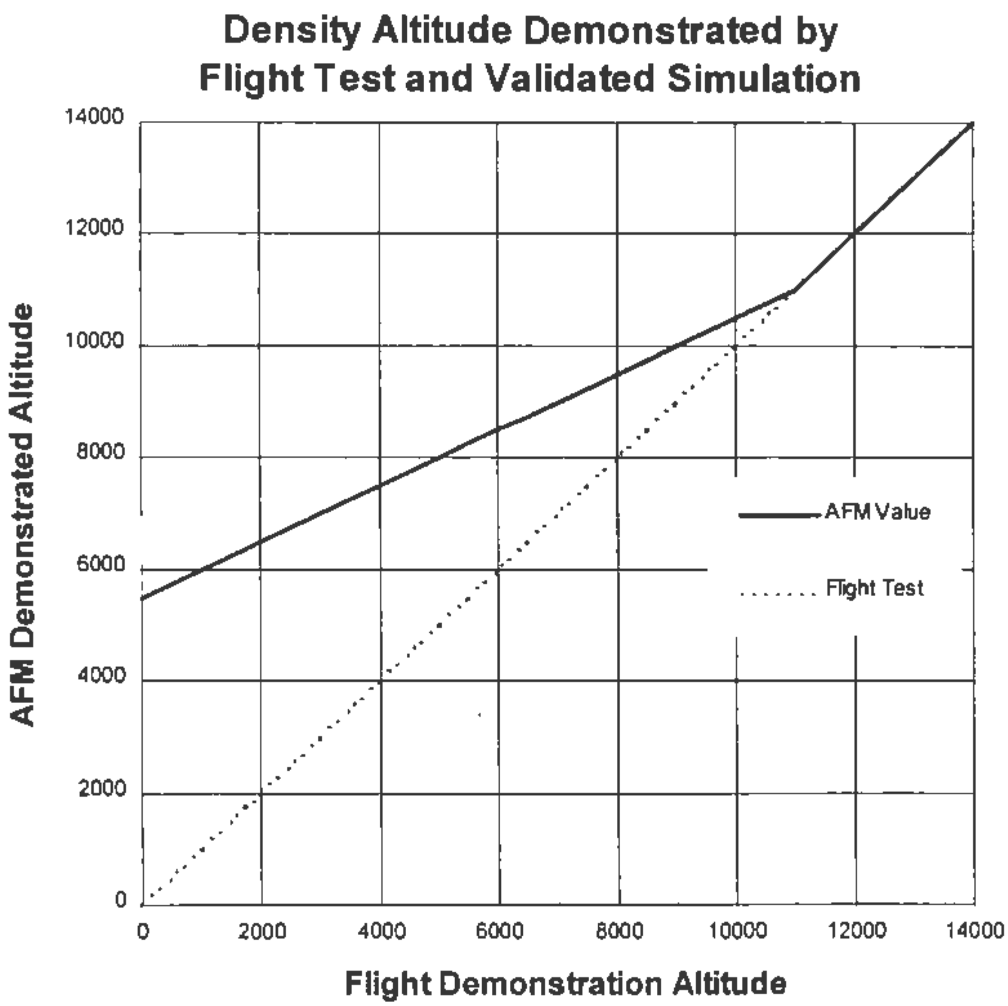


Figure 7.1.1-1

AFM Demonstrated Altitude Shown by Validated Simulation (feet)	Minimum Required Density Altitude of Flight Test Demonstration (feet)
5,500	0
6,000	1,000
6,500	2,000
7,000	3,000
8,000	5,000
9,000	7,000
10,000	9,000
11,000	11,000

Unlike operational demonstrations, this flight test demonstration of a higher density altitude necessitates the use of an instrumented airplane, capable of recording the airplanes trajectory, runway touch down point and rates, atmospheric conditions (temperature, atmospheric pressure, wind velocity and direction) as well as the powerplant and airplane parameters. The recorded flight test data are required to verify the simulated performance of the landing system, including its flare control laws and automatic throttle control laws. If discrepancies in the simulation results are found, the simulation must be corrected and accomplished again to demonstrate performance at the AFM Demonstration Altitude. If approved simulation data cannot be obtained, flight test results alone, based on approximately ten to fifteen landings at the demonstration value, can be used to establish the AFM Demonstration Altitude.

The AFM will state the density altitude values at which the automatic landing system was demonstrated by validated simulation and by flight test.

7.1.1 Validation of the Simulator.

The certification process for systems designed for Category III operations requires the use of a high fidelity simulator. A simulator is capable of varying one parameter at a time, and is the ideal tool to examine the effects of wind and turbulence upon the approach and landing performance.

Advisory Circular AC 120-40B (7/29/91) Airplane Simulator Qualification provides a means to qualify simulators for training of pilots. Meeting these requirements provides a known basis for acceptance of simulation capability. Meeting the requirements of AC 120-40B is optional. In addition, the FAA reviews simulators on a case by case basis considering at least the following:

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) source of aerodynamic performance and handling quality data used,

4) visual system fidelity and layout,

5) environmental models and methods of model input to equations of motion,

6) adverse weather models (e.g., visual reference fog models, runway friction)

7) irregular terrain models,

8) altitude, temperature effects.

A high degree of fidelity is required in all component parts of the simulation including: longitudinal, lateral and directional stability (static and dynamic), ground effect during takeoffs and landings, rollout, propulsion system, (especially if a turbo-propeller is installed), flying qualities, tracking tasks, force characteristics of the flight controls (yoke/wheel, rudder, brakes) and performance of the airplane. The fidelity of the simulator can be demonstrated using matching time histories obtained from flight test. These data will be considered part of the type certificate data.

When simulation is used for demonstration of manual systems with command guidance, suitable simulation fidelity must be addressed (e.g., visual references, system interfaces, motion base, "ground effect" aerodynamics, wind/turbulence model interface with the simulation, landing gear and ground handling dynamics, stability derivative estimates and flight control responses suited to alignment and flare control tasks, fog/visibility restriction models). Typically, training simulators do not have suitable fidelity in each area, and may not acceptable without modification for such use.

7.1.2 Simulations for Automatic System Performance Demonstration.

The certification process for systems designed for Category III operations typically requires the use of a high fidelity fast time simulation for assessment of automatic systems. The FAA reviews simulation capability on a case by case basis considering at least the following:

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) 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 equations of motion,

6) adverse weather models (e.g., turbulence, wind gradients, wind models)

7) irregular terrain models,

8) altitude, temperature effects.

Fidelity of the aerodynamic model are needed, notably for the ground effect, propulsion effects, touch down dynamics, de-rotation, and landing gear models if required for ground rollout characteristics. The fidelity of the simulator can be demonstrated using matching time histories obtained from flight test. These data may be considered as part of the type certificate data.

7.1.3 Flight Test Performance Demonstration. A test airplane equipped with special instrumentation, can be used, to record the necessary low altitude quantitative data, which are used for correlation with the simulator used for the Monte Carlo study and failure demonstrations. The performance parameters of interest include: vertical and lateral flight path tracking, height above terrain, longitudinal and lateral runway touch down point (this requires special instrumentation capable of recording aerodynamic parameters, accelerations, airspeed and surface winds at the time of touch down). Also recorded are heading, altitude, control surface positions, command guidance, sink rate at touch down (for structural limit load) wing tip ground contact, slip angle at touch down (for gear/tire load) and the lateral deviation from runway centerline during rollout.

It should be an objective of the flight test program to demonstrate the performance of the system to 100% of the wind limit values used for statistical performance. The data taken during flight test should be used to validate the simulation. The simulation can be considered validated if four landings are accomplished during flight test at least 80% of the limit value and best effort has been made to achieve the full value and it can be shown that the landing system is robust enough at and close to the desired AFM wind limits.

7.1.4 Demonstration of Approach and Automatic Landing with an Inoperative Engine.

Identification of a critical engine should consider the transient and steady state effects on performance, handling, loss of systems, and landing status. More than one engine may be critical for different reasons.

If the airplane configuration and operation are the same as that used in the performance demonstration of section 6.3.1 for all engine operation, compliance may be demonstrated by, typically, 10 to 15 landings.

If the airplane configuration or operation is changed significantly from the all engine operating case, compliance may be demonstrated by statistical analysis supported by flight test, and the effect on landing distance must be considered.

To aid planning for landing with an inoperative engine, appropriate procedures, performance, and obstacle clearance information will need to be established for a safe go-around at any point in the approach.

For the purposes of this requirement, demonstration of landing and go-around performance in the event of a second engine failure need not be considered.

If compliance is established, a statement shall be included in the Non-normal Procedures, or equivalent section of the Flight Manual, that approach and automatic landing made with an engine inoperative have been satisfactorily demonstrated, together with the conditions under which that demonstration was made.

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 automatic landing and rollout, or landing and rollout using manual systems with command guidance, may not be less than that achieved in manual landing. 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 systems.

In showing compliance with airplane systems performance and failure requirements, the probabilities of performance or failure effects may not be factored by the proportion of approaches which are made in low visibility conditions.

The effect of the failures of the navigation facilities must be considered taking into account ICAO and other pertinent State criteria.

Documented conclusions of the safety analysis shall include:

A summary of results from the fault tree analysis, demonstrated compliance, and probability requirements for significant functional hazards.

A list of all alleviating flightcrew actions, that were considered in the safety analysis, and must be validated during testing for incorporation in the airplane flight manual procedures section or for inclusion in type-specific training.

A list of all maintenance procedures required to ensure safety, such as certification maintenance requirements (CMR), periodic checks, and so on.

Applicable limitations

Equipment required to dispatch the aircraft and start the approach.

Non normal procedures

8. AIRBORNE SYSTEM REQUIREMENTS.

The airborne system should be shown to meet the performance, integrity and availability requirements identified previously for the type(s) of operation for which approval is sought.

Individual Category III airborne systems shall comply with the pertinent sections of this appendix and the specific requirements which follow.

8.1 Automatic Flight Control Systems.

When established on the final approach path below 1000 ft., 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 out-of-trim forces that might lead to an unacceptable flight path disturbance.

It must be possible for the flightcrew to disengage the automatic landing system by applying a force to the control column or control stick. This force should be high enough to preclude inadvertent disengagement, but low enough to be applied with one hand.

Following a failure or inadvertent disconnect of the automatic pilot, or loss of the automatic landing mode, when it is necessary for the 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 crew member, the warning must sound for a period long enough to ensure that it is heard and recognized by other crew members, and continue until silenced by one of the pilots with the automatic pilot quick release control, which is mounted on the control wheel/stick.

Below 200 ft. HAT, for a fail operational landing system, any system failure (Extremely Remote) which could result in an unsafe condition shall be annunciated by disconnecting the automatic flight control system passively.

8.2 Autothrottle Systems.

It must be possible to override the automatic throttle (when provided) without using excessive force.

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 an excessive workload in conditions for which the system is to be demonstrated;

(2) With manual control of throttles, the touch down performance limits are achieved both for normal autopilot operations and during takeover to manual HUD control

A automatic throttle system must provide safe operation taking into account the factors listed in AC Section 7.1 Landing and Rollout Criteria. 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 the 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.

An indication of automatic throttle engagement must be provided.

An appropriate alert or warning of automatic throttle failure must be provided.

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.

8.3 Head Up Guidance.

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.

The work load associated with use of the HUD must be considered in showing compliance with the minimum flightcrew requirements found in section 25.1523.

The HUD installation and display presentation must not significantly obscure the pilot's view through the cockpit window.

For control of approach, landing and rollout flight path, the HUD must provide sufficient guidance information 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 or to make a go-around without reference to other cockpit displays.

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 there are compensating features for displaying them elsewhere.

If the landing and rollout system is designed as a single HUD configuration, the HUD shall be installed for the Captain's crew station.

For dual HUD configurations, only the Pilot Flying (PF) should use a HUD during the approach, since the Pilot Not Flying (PNF) must monitor the approach, engines and alerts. While the head down instrumentation is primary for the PNF, the PNF HUD may be deployed.

The HUD guidance must not require exceptional piloting skill to achieve the required performance.

If the automatic flight control system is used to control the flight path of the airplane during the initial approach (i.e. to intercept and establish the approach path), the point at which the transition from automatic to manual flight takes place shall be identified and used for the performance demonstration.

Any transition from automatic flight control to manual control with HUD command guidance must not require exceptional piloting skill, alertness, strength or excessive workload.

If the HUD fails at any time during a go-around (G/A), the pilot must be able to revert to the head down instrumentation to complete the maneuver without loss of performance.

Demonstration of landing and go-around (G/A) cases from at least 50 ft. HAT for the HUD system is necessary. Demonstrations are required in conditions without external visual references, and when external visual references and instrument references disagree (e.g., localizer centering errors).

For control of ground roll, if rollout guidance is provided on the HUD, it must enable the pilot to control the airplane along the runway after touch down within the prescribed limits. Generally, rollout 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 situational information, in lieu of command guidance, requires a successful proof of concept evaluation. [PoC]

After touch down, loss of the Fail Passive command guidance rollout system (i.e. with manual control), shall be annunciated with an appropriate visual alert and removal of the command guidance.

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 are provided to the flightcrew to ensure a safe operation.

8) The combined elements of the system are demonstrated to meet the required Fail Operational criteria necessary to support the operation (refer to Section 4 of the advisory circular)

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).

8.4.2 Hybrid System Go Around Capability.

Demonstration of landing and go-around (G/A) cases from at least 50 ft. AGL for each element of hybrid system is necessary. Demonstrations are required both in conditions without external visual references, and with the presence of external visual references that disagree with instrument references (e.g., localizer centering errors).

8.4.3 Hybrid System Transition From Automatic to Manual Flight.

Demonstration of a safe takeover to a go-around, and a safe takeover to a "continuation to land" within the established touch down footprint is necessary. Appropriate time delays for the transition should be demonstrated.

8.4.4 Hybrid System Pilot Not Flying (PNF).

The pilot not flying (PNF) must have suitable information provided to accomplish appropriate duties, be an integral part of the crew, and safely deal with immediate or subtle incapacitation of the Pilot Flying (PF).

8.5 Satellite Based Landing Systems [PoC].

This appendix is intended to provide criteria but not an acceptable means of compliance for airworthiness approval of GNSS based systems. Currently approved systems are ILS or MLS based. The application of new technologies and systems will require an overall assessment of the integration of the airplane components with other elements (e.g., new ground based aids, satellite systems, advanced radar mapping systems, enhanced vision sensor systems) 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 equivalent to the overall performance, integrity and availability provided by ILS to support Category III operations.

The following requirements will apply to Approach and Landing Systems using GNSS:

Prior to departure, the crew must be able to determine the expected status of the GNSS service at the time the airplane arrives at the destination or alternate airport which may experience low visibility conditions.

En route, the crew must be able to determine the current status of the GNSS service at the destination or alternate airport which may experience low visibility conditions.

During the approach, the flightcrew must be informed if the landing system can not support the required performance and integrity - including the GNSS service. This item should include the assessment of satellite vehicle failures and the effect of satellite vehicle geometry on the required performance and integrity.

The GNSS system assessment will include the failure mode detection coverage and adequacy of monitors and associated alarm times. The Landing and Rollout System performance, failure detection and annunciation mechanism shall be designed based upon on ICAO Standards and Recommended Practices, or agreed State criteria.

The effect of airplane maneuvers on the reception of signals must be considered as necessary to maintain the required performance and integrity. 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 advisory circular.

8.5.2 Aircraft Database.

The required flight path could be stored in an aircraft database for recall and incorporation into the flight guidance and/or control system when required to conduct the 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.

The flightcrew shall not be able to modify information in the data base which relates to the definition of the required flight path.

8.5.3 Differential Augmentation.

Differential augmentation uses a satellite receiver at a known (surveyed) point on the ground to provide corrections to the individual satellite pseudo-range data.

If a ground based satellite receiver 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 will have to be established.

The role of the differential station in the landing system will have to be addressed as part of 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 will have to 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 [PoC].

The Enhanced Vision System concept is to use airplane sensors which penetrate visibility restrictions and provide the flightcrew with an enhanced view of the scene outside the airplane (e.g., radar).

This appendix section is not intended to provide an acceptable means of compliance for airworthiness approval of Enhanced Vision Systems. Criteria for approval of the enhanced vision system must match its intended use, whether for assessing integrity (an independent landing monitor), for providing flight guidance, or both. Whatever the intended function of the Enhanced/Synthetic Vision system, its performance must be demonstrated to be acceptable to the FAA through proof of concept testing **[PoC]**, during which specific airworthiness and operation criteria will be developed. The fidelity, alignment and real time response of the enhanced view must be shown to be appropriate for the intended application

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 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).

Applicable atmospheric conditions under which the system was demonstrated (e.g., demonstrated headwind, crosswind, tailwind) as follows:

a) in the Limitations Section. - the wind values used for statistical analysis supported by flight evaluation which apply to landing systems used during low visibility operations

b) in the Normal Operations, or equivalent section, the wind experienced during the flight demonstration as Demonstrated Winds. (Provided for information only)

c) For non-landing systems (i.e. system performance not supported by statistical analysis):

d) FAA - does not apply a limitation unless unacceptable system characteristics dictate a limitation - the demonstrated value for the basic airplane is included in the AFM for information.

5) For a landing or landing and rollout system meeting provisions of Appendix 3, 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."

Examples of general AFM considerations and specific AFM 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 windshear 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 windshear component is that portion which effects the air mass moving along the ground (i.e., ground friction). The magnitude of the shear is defined by the following expression:

$V_{wref} = 0.204 * V_{20} * \ln((h + 0.15)/0.15)$

where V_{wref} is the mean wind speed measured at h ft. and 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:

$$\Phi_W(\Omega) = \frac{\sigma_W{}^2 L_W}{2\pi} \frac{1 + \frac{8}{3}(1.339\ L_W\Omega)^2}{(1+(1.339\,L_W\,\Omega)^2)^{11/6}}$$

where:

$_W$ = spectral density in (ft./sec)^2

$_W$ = root mean square (rms) turbulence magnitude = $0.1061V_{20}$

L_W = scale length = h (for h < 1000 ft.)

= spatial frequency in radians/ft.

Note: = $/V_T$, where

= temporal frequency in radians/sec

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:

$$\Phi_u(\Omega) = \frac{\sigma_u^2 L_u}{\pi} \frac{1}{(1 + (1.339\, L_u \Omega)^2)^{5/6}}$$

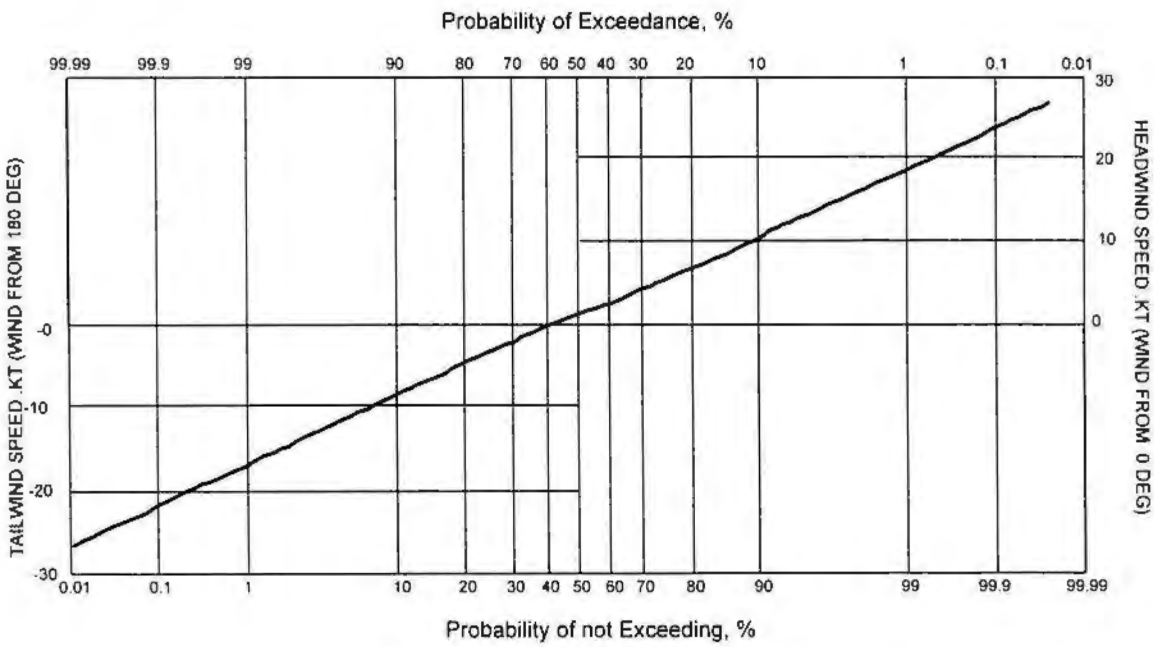
Lateral Component:

$$\Phi_V(\Omega) = \frac{\sigma_V^2 L_V}{2\pi} \frac{1 + \frac{8}{3}(1.339\, L_V \Omega)^2}{(1 + (1.339\, L_V \Omega)^2)^{11/6}}$$

where

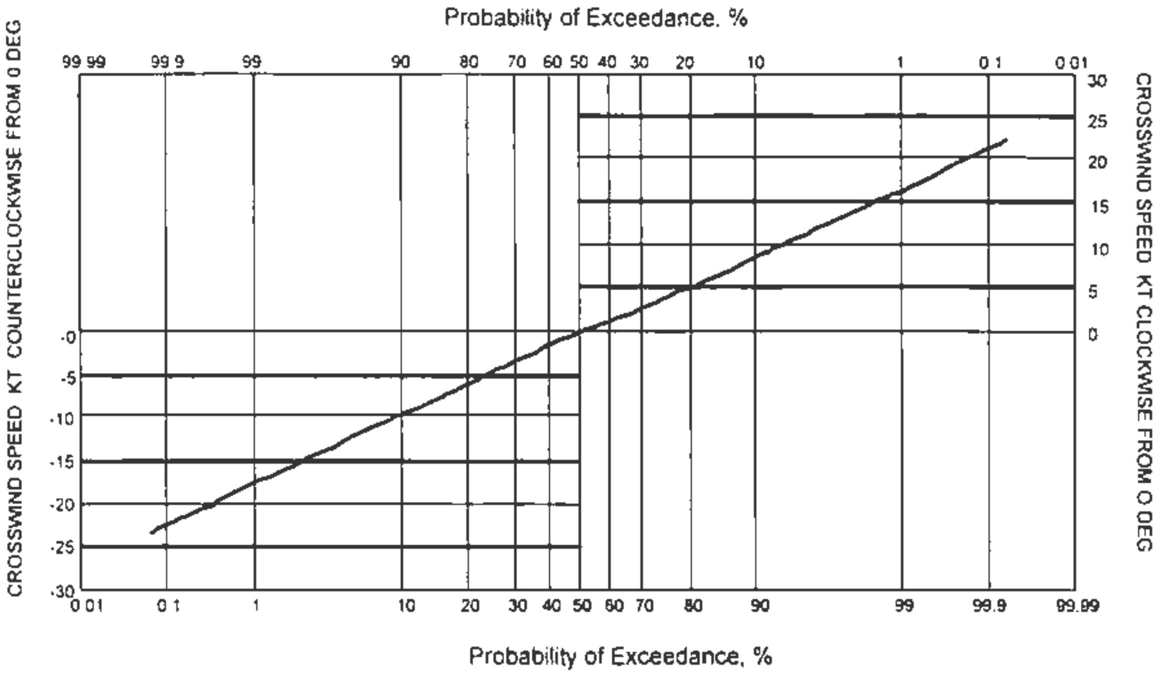
${}_u = {}_v = {}_{w.}f(h)^3$ see Figure A4-6, f(h) is defined in Figure A4-5.

$L_u = L_v = L_{w.}f(h)^3$ see Figure A4-6, f(h) is defined in Figure A4-5.



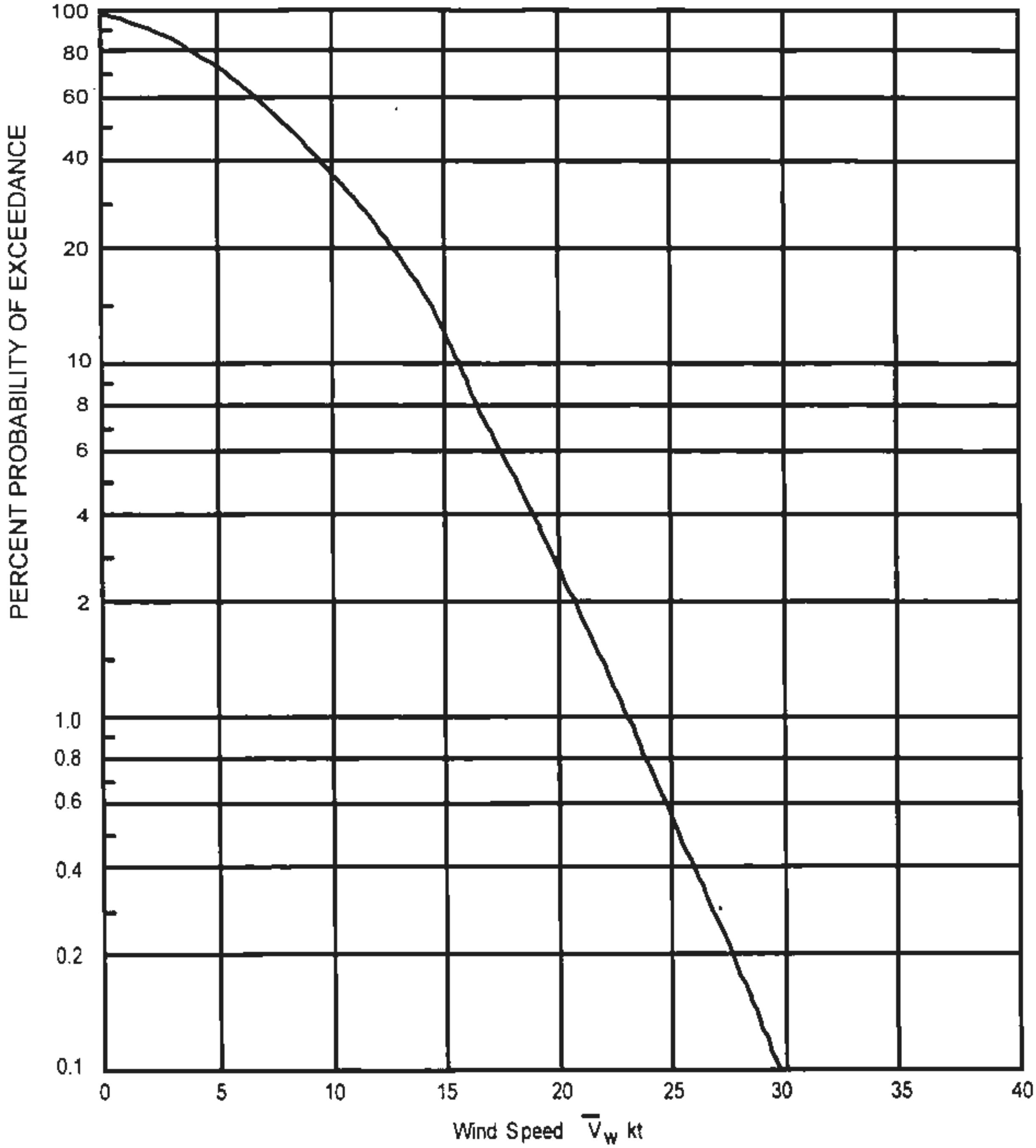
HEADWIND-TAILWIND DESCRIPTION

Figure A4-1



CROSSWIND DESCRIPTION

Figure A4-2



ANNUAL PERCENT PROBABILITY OF MEAN WIND SPEED-EQUALING OR EXCEEDING GIVEN VALUES

Figure A4-3

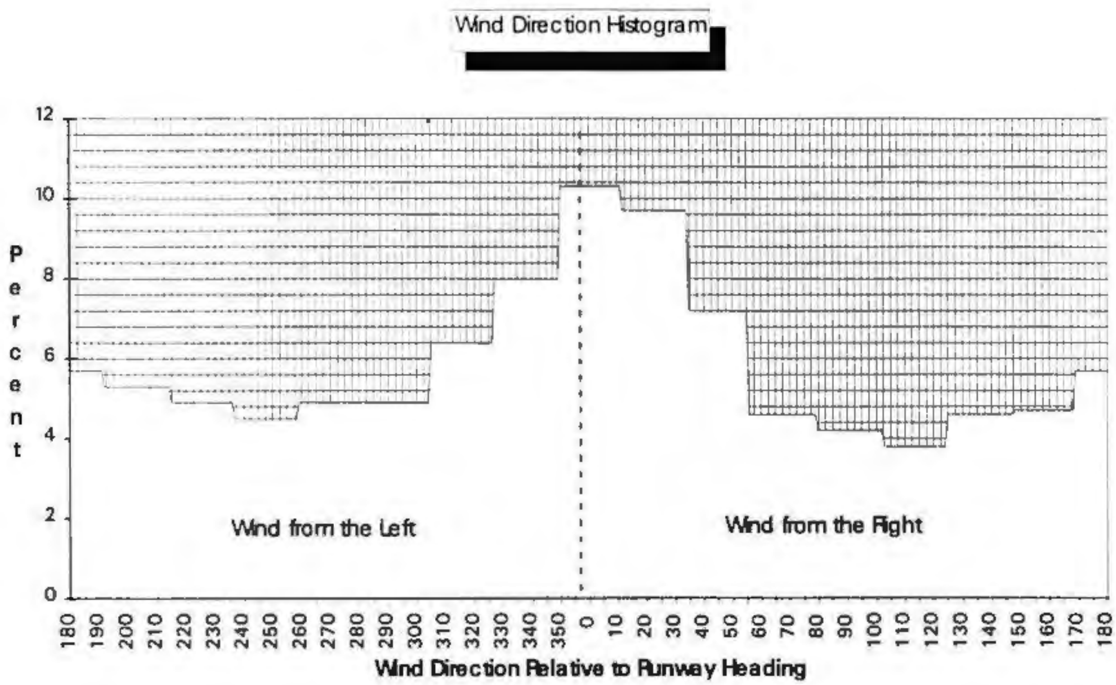
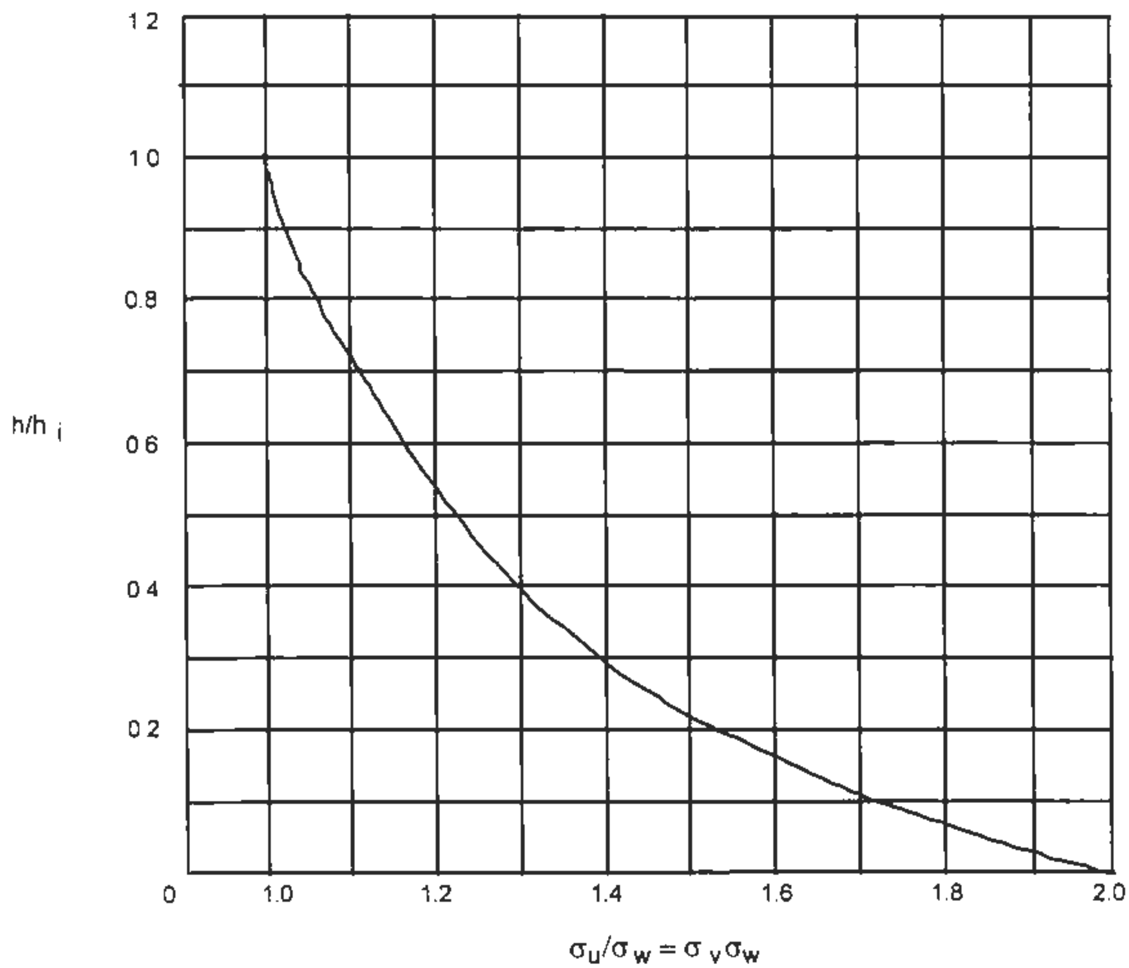

Wind Direction Histogram
Percent
0
2
4
6
8
10
12
Wind from the Left
Wind from the Right
180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
Wind Direction Relative to Runway Heading

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

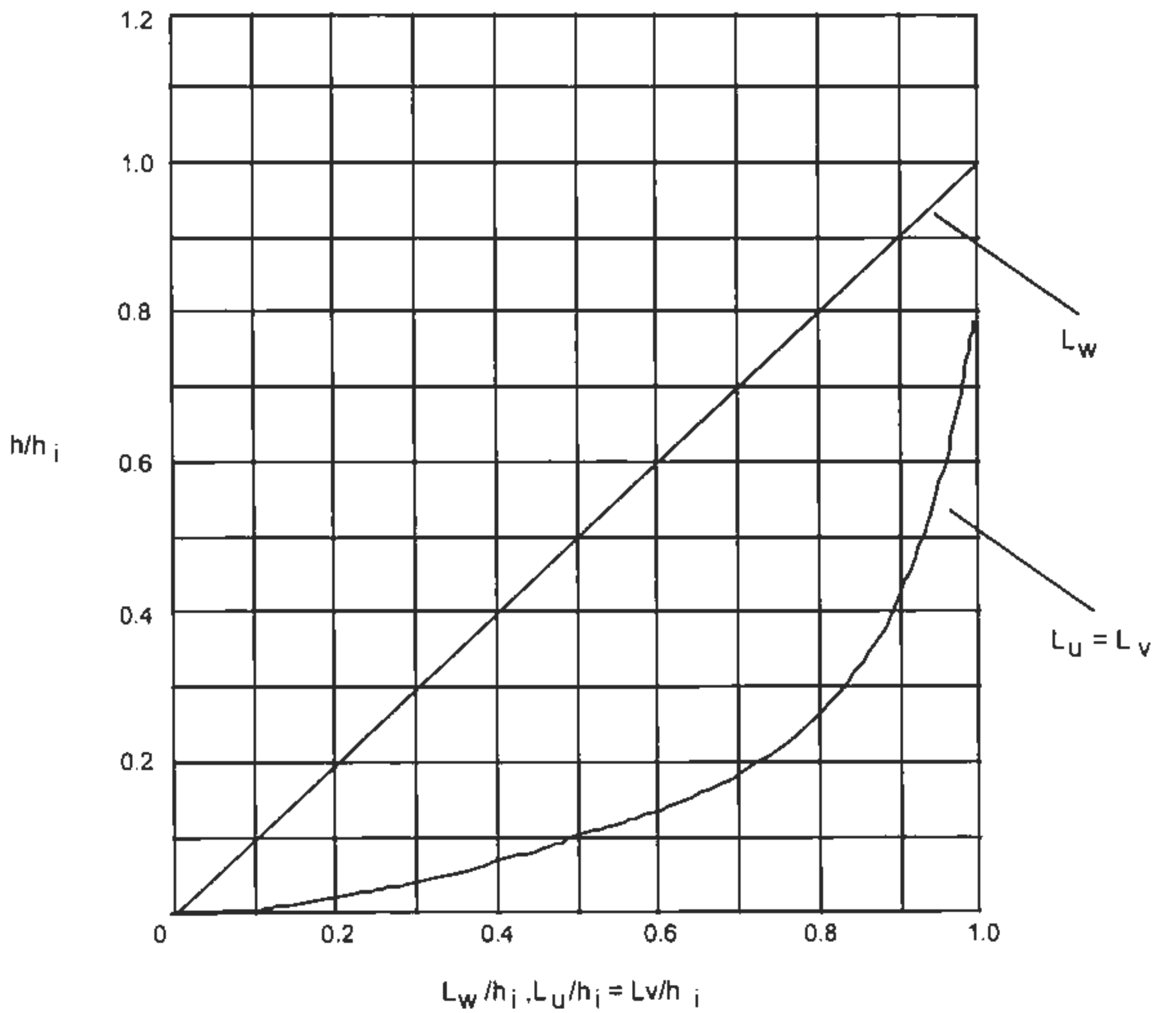
Figure A4-5

$$L_w = \begin{cases} h, h<h_i \\ d, h = h_i \end{cases}$$

$$L_u = \begin{cases} L_w \left(\dfrac{\sigma_u}{\sigma_w}\right)^3 = \dfrac{h}{[0.177 + 0.823\, h/h_i]^{1.2}} & h < h_i \\ d & h \geq h_i \end{cases}$$

$$L_v = L_u$$

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 6 m (20 ft.) and 10 m (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:

$u = 0.43\, U \log_{10}(z) + 0.57\, U$ .....(1)

where u is the mean wind speed at height z meters (z 1m),
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:

$$\Phi(\Omega) = \frac{2\sigma^2}{\pi}\frac{L}{1 + \Omega^2 L^2} \quad .....(2)]$$

where
() = a spectral density in (meters/sec)^2 per (radian/meter).

= root mean square (rms) turbulence intensity = 0.15 U

L = scale length = 183 m (600 ft.)

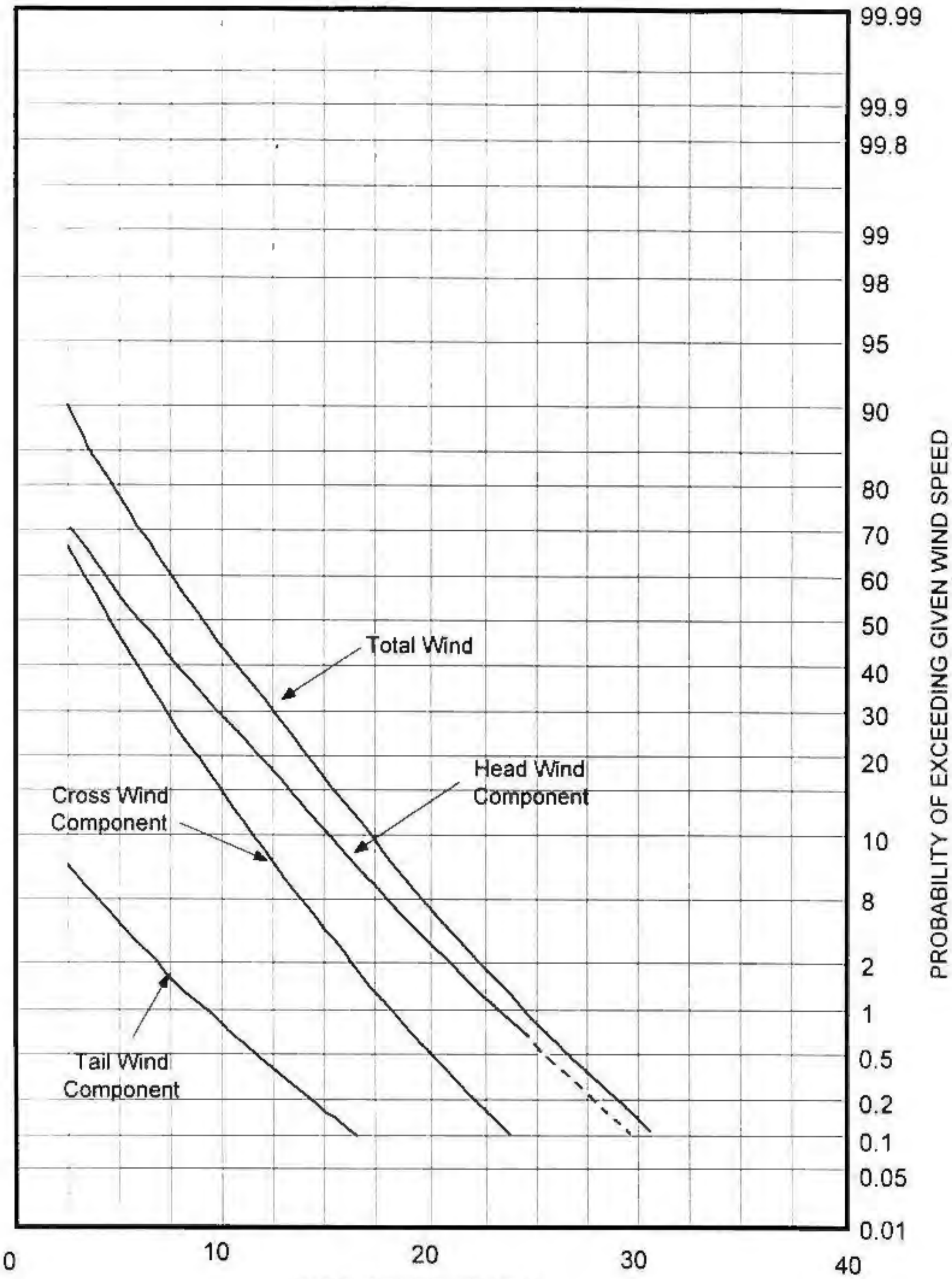
= frequency in radians/meter.

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:

= 1.5 knots with L = 9.2 m (30 ft.)
or alternatively

= 0.09 U with L = 4.6m (15 ft.) when z < 9.2 m (30 ft.)
and

L = 0.5 z when 9.2 < z < 305 m (30 < z < 1000 ft.)



Cumulative probability of reported Mean Wind, and Head Wind, Tail Wind and 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. AIRWORTHINESS DEMONSTRATION OF DECELERATION & BRAKING SYSTEMS OR DISPLAYS.

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RESERVED

APPENDIX 6. AFM PROVISIONS AND SAMPLE AFM WORDING

1.0 GENERAL AFM PROVISION CONSIDERATIONS:

1.1 AFM Should state......... Equipment considered as part of evaluation

1.2 AFM should not state........ Operating minima, limitations for things/conditions not evaluated...

2.0 SPECIFIC EXAMPLES OF AFM PROVISIONS:

2.1 TAKEOFF SYSTEMS

<example>

2.2 LANDING SYSTEMS

2.2.1 FAIL OP AUTOLAND WITH FAIL OP ROLLOUT

<example>

2.2.2 FAIL OP AUTOLAND WITH FAIL PASSIVE ROLLOUT

<example>

2.2.3 FAIL PASSIVE AUTOLAND WITHOUT ROLLOUT

<example>

2.2.4 FAIL PASSIVE AUTOLAND WITH FAIL PASSIVE ROLLOUT

<example>

2.2.5 ENGINE INOPERATIVE AUTOLAND

<example>

2.2.6 HUD (FAIL PASSIVE)

<example>

2.2.7 HYBRID FAIL OP HUD/AUTOLAND

<example>

2.3 NAVAIDs DEMONSTRATED. The type of navigation facilities used as a basis for certification. 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.

2.3.1 For ILS, the Airplane Flight Manual should typically state: "Demonstrated performance was predicated upon the use of an ILS facility with performance and integrity equivalent to, or better than, an ICAO Annex 10 Facility Performance Category II facility, or a United States Type II or Type III ILS, or equivalent."

2.3.2 For MLS, the Airplane Flight Manual typically should state: "Demonstrated performance was predicated upon the use of an MLS facility with performance and integrity equivalent to, or better than, an ICAO Annex 10 Facility Performance Category II facility, or a United States Type II or Type III MLS, or equivalent."

2.4 MISCELLANEOUS PROVISIONS. The Airplane Flight Manual shall contain the following information:

1) Any conditions or constraints on landing performance with regard to Airport conditions (e.g., elevation, ambient temperature, runway slope and ground profile under the approach path).

2) The Airplane Flight Manual should specify the criteria used for the demonstration of the system, acceptable normal and non-normal procedures, the demonstrated configurations, and types of facilities used, and any constraints or limitations necessary for safe operation.

The AFM should not specify either a DH or RVR constraint. The AFM may specify the alert height demonstrated and the criteria used. [If necessary for manually flown systems using visual reference (e.g., HUD), the AFM (in section 3 or equivalent) may include a statement such as "was demonstrated based on a minimum visual segment of 'XXX (ft./m.)' at 'YY' (ft.) above TDZ"].

It is recommended that the AFM state the relevant paragraphs of 120-28D that has been met. The AFM should not include visual segment specifications.

3) Information should be provided to the flight crew regarding atmospheric conditions under which the system was demonstrated (e.g., headwind, crosswind, tailwind). The AFM should contain a statement that "Credit may not be predicated on the use of <type of system> if conditions exceed those for which the system was certificated."

4) The height losses for go-around initiation heights below 100 ft., determined in accordance with section 6.6 of appendix 3.

APPENDIX 7. STANDARD OPSPECS - GENERAL.

This appendix provides samples of standard operations specifications (Opspecs) paragraphs typically issued for operations described in this Advisory Circular. Opspecs are developed by the Flight Standards Service At Washington headquarters. Opspecs specify limitations, conditions, and other provisions which operators must comply with. Opspecs are normally coordinated with industry to ensure a mutual and clear understanding and the effect they will have on operations. After appropriate coordination has been completed, drafts of the new standard paragraphs, or amendments to existing paragraphs are finalized and incorporated into the Opspecs program.

Through the use of standard Opspecs paragraphs, the FAA and industry are ensured that air carriers conducting comparable operations with comparable equipment are held to the same standards. Occasionally, a situation may occur in which it becomes necessary to issue an operator an Opspecs paragraph that is nonstandard because of a unique situation not provided for in the standard paragraphs. Nonstandard Opspecs paragraphs may not be less restrictive than, nor contrary to, the provisions in standard paragraphs. In those cases when a nonstandard paragraph is more restrictive than the standard paragraph, justifiable reasons must exist, since the operator could be placed at a competitive disadvantage.

APPENDIX 7. LIST OF SAMPLE OPERATIONS SPECIFICATIONS

The following Standard OpSpec paragraphs are provided:

Part A - General

A002 Definitions and Abbreviations

Part C - Airplane Terminal instrument Procedures and Airport Authorizations and Limitations

C051 Terminal Instrument Procedures

C055 Alternate Airport IFR Weather Minimums

C056 IFR Takeoff Minimums, Part 121 Operations -- All Airports

C060 Category III Instrument Approach and Landing Operations

Part 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 200 ft. (60m) and with either a visibility not less than 2400 ft. (800m), or a Runway Visual Range not less than 1800 ft. (550m).
Category II	A precision instrument approach and landing with a decision height lower than 200 ft. (60m) but not lower than 100 ft. (30m) and a Runway Visual Range not less than 1200 ft. (350m).
Category IIIa	A precision instrument approach and landing with a decision height lower than 100 ft. (30m), or no decision height and a Runway Visual Range not less than 700 ft. (200m).
Category IIIb	A precision instrument approach and landing with a decision height lower than 50 ft. (15m), or no decision height and a Runway Visual Range less than 700 ft. (200m) but not less than 150 ft. (50m).
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 Redispatch or Re-release En Route. The term "planned redispatch 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 redispatched or re-released inflight in accordance with 14 CFR part 121, section 121.631(c) to a destination airport other than the destination airport specified in the original dispatch or release.

C051. Terminal Instrument Procedures **Control: 1/11/88**
Revision: 010

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 of the Code of Federal Regulations (14 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.

(4) At 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) ICAO Document 8168-OPS, Procedures for Air Navigation Services-Aircraft Operations (PANS-OPS), Volume II, or Joint Aviation Authorities (JAR-OPS1).

b. 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.

c. 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.

d. 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.

RVR	WHEN RVR IS NOT AVAILABLE	METEOROLOGICAL VISIBILITY
FEET	METERS	STATUTE MILES METERS NAUTICAL MILES
300 ft.	75 m.	1/4 sm. 400m 1/4 nm
400 ft.	120 m.	3/8 sm. 600m 3/8 nm
500 ft.	150 m.	1/2 sm. 800 m 1/2 nm
600 ft.	175 m.	5/8 sm. 1000 m 5/8 nm
700 ft.	200 m.	3/4 sm. 1200 m 7/10 nm
1000 ft.	300 m.	7/8 sm. 1400 m 7/8 nm
1200 ft.	350 m.	1 sm. 1600 m 9/10 nm
1600 ft.	500 m.	1 1/8 sm. 1800 m 1 1/8 nm
1800 ft.	550 m.	1 1/4 sm. 2000 m 1 1/10 nm
2000 ft.	600 m.	1 1/2 sm. 2400 m 1 3/10 nm
2100 ft.	650 m.	1 3/4 sm. 2800 m 1 1/2 nm
2400 ft.	750 m.	2 sm. 3200 m 1 3/4 nm
4000 ft.	1200 m.	2 1/4 sm. 3600 m 2 nm
4500 ft.	1400 m.	2 1/2 sm. 4000 m 2 2/10 nm
5000 ft.	1500 m.	2 3/4 sm. 4400 m 2 4/10 nm
6000 ft.	1800 m.	3 sm. 4800 m 2 6/10 nm

e. 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 using the following table.

	DAY	NIGHT
HI 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.

1. **Issued by the Federal Aviation Administration.**
2. **These Operations Specifications are approved by direction of the Administrator.**

____

Principal Inspector

3. **Date Approval is effective:**

Amendment No.:

4. **I hereby accept and receive the Operations Specifications in this paragraph.**

(Name) (Title) Date:

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 flight crew 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 C055)		
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 III procedures, a ceiling of at least 200 ft. HAT , or For Category II procedures, a ceiling of at least 300 ft. HAT.	For Category III procedures, a visibility of at least 1800 RVR, or For Category II procedures, a visibility of at least 4000 RVR.

Print Date:

CERTIFICATE NO.:
XXXXX AIRLINES INC.

U.S. Department of Transportation Federal Aviation Administration | Operations Specifications | Form Approved OMB No. 2120-00028

C056. IFR Takeoff Minimums, Part 121 Airplane Operations - All Airports **Control: 10/05/9** **Revision: 01**

Standard takeoff minimums are defined as 1 statute mile visibility or RVR 5000 for airplanes having

Two 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 Touch down 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 Touch down Zone RVR report, if available, is controlling.

c. 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 RVR 1/4 statute mile or Touch down Zone RVR 1600, provided at least one of the following visual aids is available. The Touch down Zone RVR report, if available, is controlling. The Mid RVR report may be substituted for the Touch down Zone RVR report if the Touch down 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 RVR 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) Touch down Zone RVR 1000 (beginning of takeoff run) and Rollout RVR 1000, provided one of the following visual aids are available.

(a) Operative runway centerline lights (CL).

(b) Runway centerline markings (RCLM).

(c) 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 touch down zone RVR report if a touch down zone report is not available or a Rollout RVR report if a Rollout RVR report is not available.

(3) Touch down 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 Touch down 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.

d. At foreign airports which have runway lighting systems equivalent to U.S. standards, takeoff is authorized with a reported Touch down 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 c(1) or (2), as appropriate, apply.

e. In circumstances when the Touch down 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 Touch down Zone RVR report required by this paragraph, provided that:

(1) The pilot has completed 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.

Optional paragraph C056 f - Takeoff Guidance Systems - All Airports

f. Additional Provisions:

(1) Not withstanding the lower than standard takeoff minimums specified in subparagraph c. above, 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.

(A) Special Provisions And Conditions:

(1) Operative Runway Centerline Lights (CL).

(2) Operative High Intensity Runway Lights (HIRL).

(3) Serviceable Runway Centerline Markings (RCLM).

(4) Front course guidance from the localizer must be available and used (if applicable to guidance systems used).

(5) THE reported crosswind component shall not exceed 10 knots.

(6) OPERATIVE touch down 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 the subparagraph.

(7) The pilot in command and the second in command have completed the certificate holders approved training program for these operations.

(8) 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.

(B) Authorized Airplane. The certificate holder is authorized to use the following takeoff minimums for airplanes listed below:
zzz

AIRPLANE MAKE/MODEL/SERIES	LOWEST AUTHORIZED RVR	REQUIRED TAKEOFF GUIDANCE SYSTEM

1. Issued by the Federal Aviation Administration.
2. These Operations Specifications are approved by direction of the Administrator.

____

Principal Inspector

3. Date Approval is effective:

Amendment No.:

4. I hereby accept and receive the Operations Specifications in this paragraph.

(Name) (Title) Date:

C060 Category III Instrument Approach and Landing Operations **Control: 10/05/90**

Revision: 011

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 straight-in approach and 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 (Make/Model/Series) DH Lowest Authorized RVR

2. Category III Fail-Operational Operations
Airplane (Make/Model/Series) 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 regulations 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 RVR 600.

Airplane Make/Model/Series.	Additional Airborne Equipment

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 RVR 600 (175 meters), the Touch down Zone, Mid, and Rollout RVR reporting systems are required and must be used. Touch down 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 RVR 600 (175 meters) using fail-passive rollout control systems, the Touch down 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 RVR 600 (175 meters) using fail-operational rollout control systems, the Touch down Zone, Mid, and Rollout RV 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 RVR 1800.

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 RVR 600 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	REQUIRED FIELD LENGTH FACTOR	Equipment and special limitations

f. Missed Approach Requirements.

(1) For Category III approaches with a fail-passive flight control system, a missed approach shall be initiated when any of the following conditions exist:

(a) At the DH, if the pilot has not established sufficient visual reference with the touch down zone or touch down zone lights to verify that the aircraft will touch down in the touch down zone.

(b) 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.

(c) When a failure in the fail-passive flight control system occurs prior to touch down.

(d) If the pilot determines that touch down cannot be safely accomplished within the touch down zone.

(e) When any of the required elements of the ground system becomes inoperative before arriving at DH. However, Category III approaches and landings may be continued if sequence flashers or the approach light system are inoperative.

(2) For fail-operational Category III approaches with a rollout control system a missed approach will be initiated when any of the following conditions exist:

(a) Unless a fail-passive rollout control system is used for RVR 600 operations, or a fail-operational rollout control system is used for operations with minimums below RVR 600, a missed approach is required upon reaching the AH/DH if the latest reported controlling RVR is below the applicable minimums.

(b) At the DH, when a DH is used, if the pilot has not established sufficient visual reference with the touch down zone or touch down zone lights to verify that the aircraft will touch down in the touch down zone.

(c) If, after passing the DH when a DH is used, 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) If the pilot determines that touch down cannot be safely accomplished within the touch down zone.

(e) When a failure occurs in one of the required systems in the aircraft before reaching the AH/DH.

(f) Before reaching the AH or DH, as applicable, any of the required elements of the ground system becomes inoperative. However, Category III approaches and landings may be continued if sequence flashers or the approach lights are inoperative.

(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**

1. Issued by the Federal Aviation Administration.
2. These Operations Specifications are approved by direction of the Administrator.

____

Principal Inspector

3. Date Approval is effective:

Amendment No.:

4. I hereby accept and receive the Operations Specifications in this paragraph.

(Name) (Title) Date:

APPENDIX 8 IRREGULAR TERRAIN ASSESSMENT

The following information describes the evaluation process, procedures, and criteria applicable to approval of autoland systems for Category III minima at airports identified in the CAT II/III Status List as having irregular underlying approach terrain.

Background. FAA engineering type design of autoland systems (14 CFR part 25, AC 20-57A, and this Advisory Circular) provides for generic performance evaluation of autoland capability through testing at a few particular locations to verify computer and design analysis. When an aircraft is type certificated (or STC'd) for autoland, it is not the intent, nor is it practical that each model of aircraft, autopilot, radar altimeter etc., be tested at each conceivable location, domestic and foreign, that it could be used in operation. Further, ILS system performance itself may vary somewhat from location to location or time to time due to reflective interference, ATC critical area procedures, etc. The result is that in spite of the manufacturer's thorough design, careful testing and type certification by FAA engineering, and frequent flight inspection by FAA or foreign authorities, specific operational review and approval of particular aircraft type/site autoland performance is necessary when minima are predicated on autoland use. This is especially important at airports with irregular pre-threshold terrain. At "normal" airports/runways (e.g., not restricted in Section 4 of the CAT II/III Status List) this review and approval process can be as simple as verifying the carriers reports of a small number of "line autolands" in better than Cat II weather conditions if the approval is for a follow-on airline starting service at a location previously found suitable for a particular type aircraft. On the other hand, if the request is for the first of an aircraft type to base Cat III minima on having autoland at a "special terrain" airport, then a thorough 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/autopilot/site performance, this summary represents a typical approach that may successfully be used. It is not a definitive treatment, exclusive method, or all encompassing in scope. In certain cases, credit may be applied for relevant testing by the manufacturer, performance at similar locations, etc. (e.g., subsequent special terrain airport approvals). By the same token, certain aircraft/autoland combinations may require more extensive testing, where the aircraft has peculiar characteristics (RA trips due to unlock, inappropriate auto throttle response, inconsistent flare or overflare tendency, etc.) at a particular site. In all cases, before establishing test requirements with a carrier for special terrain airports, the proposed evaluation plan should be coordinated with AFS-400. This must be done prior to agreement by the Principal Operations Inspector, Principal Avionics Inspector with the relevant carrier on testing to be done and data to be collected. Resources available to the PI's and regions in addition to AFS-400 to consult on development of draft plans include the transport directorate AEG's, or the Aircraft Certification's NRS for AFCS.

CAT III EVALUATION PROCESS FOR SPECIAL TERRAIN AIRPORTS

Case I - First of a Model at 1st Special Terrain Airport (e.g., L1011 - first approval of SEA 16R - not previously approved at CVG, MSP, PIT).

A. Test program objective. Assess and verify normal autoland performance from an operational perspective, and identify miscellaneous factors needed for a safe Cat III operation (e.g., alert height identification).

B. Procedure. Perform autoland (at least 4-6) in full operational configuration, using routine line maintenance (not specially tweaked aircraft) in typical atmospheric conditions (e.g., not dead-calm at 5 a.m.) of wind and turbulence. If the system is susceptible to weak performance (e.g., float in tailwind conditions) attempt to pick a time frame that allows the evaluation to take place on a day in which the system is put to fair test of crosswind, tailwind, headwind, wind gradient at altitude etc., or whatever the critical condition is believed to be while still observing AFM limits.

C. Observation. Review Glide Slope displacement, proper flare initiation altitude and mode switching, touch down point (generally within Appendix 3, Paragraph 6.3.1 of this AC), sink rate at touch down and "quality" of flare (continuous, no nose down tendency, no oscillation, proper throttle retard, no abrupt initiation, etc.). A person qualified on autoland and experienced in assessing autoland performance should be used to do these evaluations as the FAA observer (e.g., APM's of Cat III carriers, AFS-400, AEG reps., NRS).

D. 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:

1) Using specially modified DFDR having following parameters at high sample rate (rate > 1 sec):

pitch attitude
glide slope error
radio altitude
baro altitude
elevator command
throttle position
vertical speed
radio altitude rate (h)
airspeed

plus manual observation of touch down point (lateral, longitudinal) wind profile from 1000 ft. to surface from INS that reads winds at approach speeds (e.g., not inhibited below 150 kts).

2) Review of manufacture's data from autoland development flight testing at the particular site, confirmed by observations in the evaluation flight series.

3) Photo recording of pertinent instruments or outside view with video camera allowing post flight replay and review.

E. Data review and post flight analysis. Review flare profile to ensure:

continuous pitch changes - no nose down, abrupt flare, overflare, underflare, float, or other characteristic that a line pilot could interpret as failure of the autoland and be encouraged to disconnect,

appropriate throttle retard - no reversal of retard, early retard, failure to retard, pitch/throttle coupling, etc.,

appropriate speed decay in flare (e.g., no unusually high pitch attitude risking tail strike) no excessive float if above "v" ref at flare initiation, etc.

Review crosswind alignment (if applicable): Assess crosswind (forward slip) alignment, if applicable, to be sure that appropriate RA triggering occurs even though terrain is irregular (e.g., completion of align prior to flare).

Miscellaneous Issues. Determine if inner marker will be adequate or necessary for definition of alert height, if a 50 ft. DH is needed, will the variability of the RA displays in the last stages of the approach permit its stabilization for a long enough period to define the 50 ft. DH point.

Determine if special training or constraints are needed to accommodate peculiar characteristics (e.g., visual ref. required at flare initiation - 50 ft. DH - for the A300 due to a double flare characteristic).

Resolve any anomalies occurring during test (e.g., if autopilot trips occur, firm landings, poor flares occur) more tests may be needed to clearly identify and resolve the problem. Otherwise, approval should not be made or expected when AFS-400 reviews the data.

Case II - First of a Model at Subsequent Special Terrain Airports (e.g., B767 at CVG after prior approval at Sea-Tac).

A. Same objective as Case I.

B. Procedure the same as Case I.

C. Observation same as Case I.

D. Data recording not generally required. However, if the results of landings are marginal or unacceptable, the procedures in Case I may need to be followed.

E. Not applicable unless problems occur and Case I procedures are used to resolve discrepancies.

F. Same as Case I.

Case III - Subsequent airline use of previously approved type at special terrain location.

POI may review, and with AFS concurrence, approve subsequent airline operation at special terrain airports based on 25 or more successful "line" landings reported by the airline and no failures. If problems are reported, then Case II or Case I procedures may be needed to resolve potential unique aircraft configuration effects, procedural effects, or maintenance effects.

Case IV. Approval of "first of a type autoland aircraft" at "special terrain" or "normal" airports but not for Cat III minima credit (e.g., for use with better than Cat II weather).

POI's should specify that an airline technical pilot, management pilot, or check airman who is experienced with autoland operations and performance to assess and verify adequate autoland performance prior to permitting line pilots to conduct autoland operations. This evaluation may be done in line operation as long as no previous reported problems have been noted with other aircraft types, and no NOTAMs or other restrictions preclude such operations.

NOTE: Unless otherwise restricted by an airline or POI, autoland operations, not for minima credit, may generally be conducted on any ILS rnnway that does not have notes on the approach plate (e.g., localizer unusable for rollout, glideslope unusable below 400 ft. AGL) and that have adequate TCH (threshold clearance heights) published suitable for the aircraft type). If problems are noted in the airlines' evaluation, the airline should specify to line crews that autolands should

not be accomplished at that site. This is often done through flight crew bulletins. Conversely, some airlines choose to publish lists of approved autoland runways for line crew use.

The above process is fully responsive to section 121.579(c) requirements and Opspecs may then be signed permitting autoland operation for that type of aircraft. Opspecs, per se, do not need to list each airport/runway unless the POI or carrier have some unique reason why this would be appropriate.

It is desirable, but not necessary, that qualified APM's, ACI's, or POI's, witness "special terrain airport" initial evaluations by the carrier when possible.

POI's should request and review autoland reports from line crews for about the first 25 or so line landings to confirm the initial assessment.

Case V. Approval of subsequent airlines or types to autoland at special terrain or normal airports, not for minima credit.

POI's should request and review data for the first five line landings to confirm adequate performance. If problems occur, processes for cases I through IV may be needed to resolve problems depending on the severity and causes of problems (e.g., maintenance problems, winds, ATC clearance protection, STC using new model of autopilot, new radar altimeter model).

Postscript. Review of "autoland" and "Cat III landing weather minima" approvals is still a rather unique and highly technical area requiring much judgment and variation in special circumstances. It has still not evolved to the point of a cut and dried process like issuance of Part C op specs., etc. When in doubt, seek advice and counsel from a qualified source. Do not assume. In all cases coordinate with AFS-400 prior to making commitments to a carrier.

INSPECTION AND SURVEILLANCE RECORD Page 1 of 3

1. WORK ACTIVITY DC-9-80 Autoland Evaluation, SEA-TAC Airport		2. UNITS 1	3. HOURS 4.0
4. NAME AND ADDRESS OF CARRIER, OPERATOR, AIRPORT AGENCY, OR AIRMAN Pacific Southwest Airlines, Inc. 3225 North Harbor Drive San Diego, CA 92101	5. CERTIFICATE NO. OR AIRCRAFT REGISTRATION MARK (No.) N941PS	6. RESULTS SATISFACTORY X UNSATISFACTORY (Explain in Item 8)	FURTHER ACTION REQ NO X YES (Explain in Item 8)

8. FINDING/RECOMMENDATION

Seattle Tacoma International Airport is served by PSA DC9-80 equipment and the carrier has proposed to conduct Category IIIa operations on runway 16R. The carrier was briefed on the relevancy of Air Carrier Operations Bulletin No. 7-82-3, Possible Autoland Anomalies at Airports Which Have Irregular Underlying Terrain in the Approach Area Near The Runway Threshold. They were familiar with FAA Order 8400.8 and Advisory Circular 120-28C, which addresses this subject. The PSA POI had requested that PSA demonstrate the capability of the DC9-80 autoland system on runway 16R at SEA-TAC, to determine if the irregular underlying terrain associated with this runway would adversely affect autoland performance and the degree of performance degradation found. PSA agreed that the evaluation was necessary and scheduled the event for 12-15-84.

This Inspector participated in the demonstration/evaluation of the DC-9 autoland/HUD system at SEA-TAC, on 12-15-84. Flight technical pilots conducted four autoland approaches were HUD monitored by the Captain. Furthermore, a HUD manual approach to touch down was flown to demonstrate the Sundstrand guidance system. The weather conditions were considered optimum for the evaluation (Measured Ceiling 1200 Ft. Broken, 1700 Ft. Overcast, Visibility 15 miles, Temperature 38 degrees, Due Point 34 degrees, Wind averaging 190/8K. The following performance parameters were monitored closely during each approach:

Parameter/Event	**A/P Performance Degradation**
Localizer & Glide Slope Tracking to 500 Ft. GL	None
Localizer Tracking 500 Ft. AGL to Runway Surface	None
Glide Slope Tracking 500 Ft. AGL to 100 Ft. AGL	Minimal perturbations; A/C within Category II performance window at 100 Ft.
Glide Slope Tracking 100 Ft. AGL to 50 Ft. AGL.	Approach attitude stabilized. However, some pitch oscillation was noted prior to flare engage.
Flare Maneuver from 50 Ft. AGL to Runway Surface	Flare engage was late on two approaches, causing firm touch downs within the Category III dispersion box

X OPERATIONS MAINTENANCE AVIONICS	DATE 12-15-84	REGION AND DISTRICT OFFICE AWP-FSDO-09	INSPECTOR'S SIGNATURE

FAA Form 3112 (8-70)

DC9-80 Autoland Evaluation, SEA-TAC Airport.

Parameter Event	A/P Performance Degradation
Flare Maneuver from 50 ft. AGL to Runway Surface.	An overflare with extended float and flare stagnation requiring pilot takeover and go-around was observed on two approaches. Throttle retard did not appear to be uniform throughout the flare maneuvers.
Radio Altimeter Display Indications on Approach.	Both altimeters were observed to be normal from the outer marker to approximately 500 ft. AGL. From 500 ft. to 120 ft., the altimeters were displaying excessive oscillations (spiking). No flags were observed. However, on two approaches the altimeters appeared out of synchronization during the most active display oscillations below 300 ft. AGL.
Primary and Secondary Sensors.	No flags were observed.
Autopilot Integrity During Approach.	No disconnects were observed, except for pilot takeover during two unacceptable flare maneuvers. Autopilot Align Mode function at 150 ft. was normal.

HUD Performance During Manual and Autoland Approaches. PSA Flight Technical Pilots reported satisfactory performance of the Sundstrand Head-Up Display installed on the DC9-80. A full manual HUD approach was made to Category II decision height, followed by a manual HUD landing. There was a slight overflare and early throttle retard, however, the touch down sink rate and dispersion was considered acceptable. The HUD monitored autoland approaches reflected compatibility between guidance computations except during the flare maneuvers. The HUD guidance cue (Command Dot) was overly active, indicating a significant disparity between the autoland flare and HUD flare computations. The HUD flare logic appears to be more predictable than the autoland flare computations on this particular ILS runway.

Evaluation Analysis. The DC9-80 autoland system performance, during the flare maneuver on runway 16R, was unpredictable during this evaluation. Two of the approaches resulted in touch down sink rates, which were considered unacceptable for passenger operations (very firm touch down). Two approaches resulted in an overflare condition and extended float, requiring pilot take over and go-around. Furthermore, the autothrottle performance during the flare maneuver, was inconsistent (not synchronized) with the autopilot flare profile.

The irregular underlying terrain and approach lighting structures in the approach area near the runway threshold created undesirable radio altimeter excitatory characteristics. This input to the autopilot is apparently destabilizing the flare profile and may be degrading autothrottle performance during this critical phase of flight.

Recommendations. This inspector and the PSA technical pilots concluded that DC9-80 autoland approaches to runway 16R at SEA-TAC Airport not be permitted by PSA until further investigation of the aforementioned problems has been completed

That the Director, PSA Flight Operations, issue an Alert Bulletin imposing appropriate restrictions on autoland approaches to runway 16R at SEA-TAC Airport.

That operators of DC9-80 aircraft equipped with autoland capability be notified of the result of this mini evaluation.

That PSA conduct a second mini evaluation with a DC9-80 equipped with a DFGS 906 computer. This updated computer may respond more favorably on runway 16R at SEA-TAC.
Also, conduct additional manual HUD approaches to runway 16R.

Remarks: ACO's, AEG's and NRS's were provided a copy of this report.

APPENDIX 9. GROUND SYSTEM AND OBSTRUCTION CLEARANCE CRITERIA FOR CATEGORY II AND CATEGORY III APPROACH AND LANDING OPERATIONS

1. PURPOSE. This Appendix outlines ground system and obstruction clearance criteria for Category II and Category III approach and landing operations supported by ILS, MLS, or DGPS sensors, or operations based on RNP.

Other applicable Federal Aviation Administration (FAA) Orders, Notices, and Advisory Circulars (AC) define sensor system performance and equipment characteristics and are available at any Airport District Office, FSDO or by writing to the address specified on page ___ of this AC.

2. GENERAL. Category II and Category III procedures are based on both navigation and visual guidance systems. The navigation system must be capable of guiding an aircraft to the runway reference datum (e.g., the ILS, MLS or RNP glide path reference datum) with a high degree of accuracy. The visual guidance system must provide the correct visual cues to the pilot from the decision altitude (height), if applicable, down to and including the touchdown, and along the runway for rollout, under the appropriate visibility conditions.

In order for a runway to qualify for CAT II or CAT III operations, the runway must be capable of supporting the lowest CAT I minimums.

Runways which do not meet the criteria established in this Appendix, but where an operational or other evaluation identifies that an equivalent level of safety exists, may be authorized appropriate Category II or Category III minimums. Such an evaluation shall be conducted by Flight Standards Service on a case-by case basis as required.

This AC and the criteria in the Air Transportation Operations Inspectors Handbook, FAA Order 8400.10, and Operations-Specifications, as amended, establish the lowest approach and landing minimums which can be authorized for Category II and Category III operations for air carriers operating under Title 14 of the Code of Federal Regulations (14 CFR) part 121 or part 135. Use the implementation guidelines in Order 8260.36A for all new ILSs and all MLSs. TERPS is to be used only for the old established ILSs.

Foreign airports served by United States air carriers or commercial operators under part 121 or 135 may be approved in accordance with the provisions of ICAO Annex 3 on a basis of a comparable level of safety.

3. CATEGORY II AND CATEGORY III SUPPORTING NAVIGATION AIDS OR SENSORS.

a. Navaid System. A system which meets appropriate Category II and Category III integrity, continuity and reliability performance standards and provides continuous electronic guidance at least to the ILS reference datum or RNP reference datum must be provided consistent with the elements described below:

(1) Localizer or Localizer Equivalent. The localizer or approach azimuth station, DGPS, or RNP equivalent azimuth guidance must be provided from the specified coverage limit down to the specified reference datum, or equivalent, as indicated in the U.S. Flight Inspection Manual, FAA Handbook, 8200.1, as amended.

(2) Glide Slope or Glide slope Equivalent. The glide slope or elevation antenna, or DGPS or RNP equivalent must provide guidance in the vertical plane from the specified coverage limit down to the ILS reference datum, or equivalent, as indicated in the U.S. Flight Inspection Manual.

(3) VHF Marker Beacons. In addition to the outer and middle marker beacons, a 75 MHz inner marker beacon must be provided at each runway intended for a Public Use Published 14 CFR part 97 Category II or Category III Procedure.

b. Visual Guidance System. The lighting system must provide continuous visual guidance from the point where an approaching aircraft at the lowest published DA(H), if applicable, can begin to transition from instrument reference to visual reference. The visual system provides visual reference for the approach, flare, landing, and rollout. The system will consist of the following components:

(1) Approach Lighting System. Lighting standards outlined in FAA Selection Order 1010.39, except that no negative gradient will be permitted in the inner 1500 ft. Where required, and when fixtures are available, approved flush approach lighting system may be installed, i.e., displaced landing threshold.

(2) Touchdown Zone Lighting System. A centerline lighting system will be provided defining the runway touchdown zone and conforming to AC 150/5340-4C as amended.

(3) Centerline Lighting System. A centerline lighting system defining the runway centerline and conforming to AC 150/5340-4C, as amended, using. L-843 and L-850 runway centerline lighting systems should be provided.

(4) High Intensity Runway Edge Lighting. A high intensity runway edge lighting system will be provided defining the lateral and longitudinal limits of the runway and conforming to AC 150-5340-24, as amended.

(5) Taxiway Turnoff Lighting Systems. Taxiway turnoff lighting systems, stop bar, runway guard lighting, and critical area taxiway lighting designations should be provided in accordance with AC 120-57 as amended and the AC 150/5340 series as amended.

(6) All-Weather Runway Markings. Runways will be marked with all-weather runway markings as specified in AC 150/5340-1G, as amended.

c. Other Requirements. The following additional systems are required as part of the Category II and Category III procedures.

(1) Runway Visual Range (RVR). An RVR system is an automated computer controlled measurement and monitoring system reporting minimum visibility limits existing on airport runways to the air traffic controller. Until 1995 the minimum RVR reading obtainable from most FAA RVR equipment was RVR-600. New RVR equipment being deployed measures RVR from 50-ft. to 6500-ft.

(a) RVR equipment is required to provide visibility information at the approach and rollout ends of any runway intended for Category II or Category III Public use Published procedures. For runways over 8000 length, or where otherwise designated by FAA Mid Field RVR equipment or equivalent is also required.

(b) RVR equipment serving other runways may be used to provide the RVR information in the rollout area. Where transmissometers from other runways are used for this purpose, it must be located within a radius of 2000 ft. of the rollout threshold of the runway and provide a minimum of 2000 ft. coverage of the rollout area as measured from the rollout threshold.

(c) FAA Standard 008 prescribes installation criteria for RVR equipment and AC 97-1, as amended, describes RVR measuring equipment and it use.

(2) Radar (Radio) Altimeter Setting Height. Radar (radio) altimeter setting heights will be provided on the FAA Form 8260.3, indicating the vertical distance at the 100/150 foot DA(H) or alert height assuming a 19 wheel to navigation reference point height (e.g., glide slope antenna height) and the terrain beneath these points, on the runway centerline extended.

(3) Remote Monitoring. Remote monitoring shall be provided for the following elements of the navaid or visual aid systems, reference FAA Order 6750.24, as amended.

(a) Navaids.

(b) Approach lighting system.

(c) Power systems

(d) Runway edge, centerline and touchdown zone lights

(e) Critical taxiway lighting, runway guard lights, and stopbars

(4) Manual Inspection. The following systems may not be remotely monitored and may require inspection by airport management or FAA personnel or pilot reports to determine if they are operating in accordance with the criteria, reference AC 120-57, as amended. Remote monitoring systems must be capable of detecting when more than 10 percent of the lights are inoperative. The lighting system/configuration shall be considered inoperative when more than 10 percent of the lights are not functioning. Taxiway lights and individual airport/runway lights do not have to be remotely monitored; however, when visual Aid lights which support CAT II or CAT III are manually monitored they must be inspected at an interval which should ensure that it would be very unlikely that no more than 10 percent of the lights and two adjacent lights would be inoperative, taking into consideration lamp light, environmental conditions, etc. The procedure to visually verify operation of runway edge, centerline, and touchdown zone lights must ensure a visual inspection is conducted prior to commencement of CAT II or CAT III operations and repeated through physical inspections and/or pilot reports at least every two hours thereafter if still in CAT II or CAT II conditions.

(a) Touchdown zone and centerline lights.

(b) Runway edge lights.

(c) Runway markings.

(d) Runway guard lights.

(e) Taxiway centerline lights.

(f) Taxiway clearance bar lights.

(g) Taxiway signs.

(h) Taxiway markings.

d. Critical Areas. Obstacle critical areas will be marked and lighted to insure that ground traffic does not violate these areas during specified operations. These areas may differ depending on the type of Navaids used.

(1) Glide Path Critical Area. The glide path critical area for ILS installations is specified in FAA Order 6750.16B, as amended. The glide path critical area of the elevation antenna for MLS installations is specified in FAA Order 6830.5, as amended.

(2) Localizer Critical Area. The localizer critical area for ILS installations is specified in FAA Order 6750.16B, as amended. The Azimuth Antenna critical area for MLS installations is specified in FAA Order 6830.5, as amended.

4. OBSTACLE CLEARANCE CRITERIA. This section prescribes the obstacle clearance criteria for the final and missed approach areas for use in the formulation of Category II and Category III instrument approach procedures. Obstacles which are fixed by their functional purpose, vehicles, and taxiing and parked aircraft are addressed by application of the Obstacle Free Zone criteria contained in FAA AC 150/5300-13 Airport Design, as amended, and controlled by application of paragraph 3-1-5, Vehicles / Equipment / Personnel On Runways and paragraph 3-7-5, Precision Approach Critical Area in FAA Handbook 7110.65, Air Traffic Control, as amended. The definition of obstacles which are fixed by their functional purpose is found in FAA Order 8400.10, as amended.

a. Final Approach. The criteria found in Handbook 8260.3B and FAA Order 8260.36 will be used to establish CAT II or CAT III minimums for all new ILSs and MLSs. Use TERPS criteria for previously established ILSs. Appendix -5 of this advisory contains guidance for GPS and RNP final approach areas.

5. SPECIAL OBSTRUCTION CLEARANCE AREAS. Because of the lower flight altitudes which occur in the immediate vicinity of the runway during Category II and III approach and missed approach operations, it is necessary to specify certain areas in which obstructions must be eliminated or controlled. These special areas are the Approach Light Area, the Touchdown Area, the Touchdown Area Transitional Surfaces, the Missed Approach Area, and Missed Approach Secondary Areas.

6. APPROACH LIGHT AREA. (See Figure 2.)

a. Definition. An area longitudinally centered on the extended centerline of the precision Category II or Category III runway, and extending outward from the approach end of the Touchdown Area (See Paragraph 7) to a point 200 ft. beyond the last approach light fixture, and having a total width of 400 ft. Refer to FAA Order 6850.2, as amended.

h. Obstruction Clearance. No obstruction shall penetrate the approach light area light plane. Further, no obstruction, including the approach light structure or fixtures, shall penetrate a 50:1 surface (which originates at the same point as the inner final approach area (See Paragraph 4.b.) at the elevation of the runway threshold. The 50:1 surface over the Approach Light Area remains a constant requirement even when other portions of the final approach surface are adjusted for glide slope or glide path angles greater than 2-1/2 degrees. However, where glide slope angles of less than 2-1/2 are established, no obstruction in the Approach Light Area shall penetrate the associated approach surface. Refer to FAA Order 6850.2, as amended.

FIGURE 2

insert FIGURE 9: Approach Light Area and 50:1 Inner OFZ Surface
(from FAA Order 8260.36A)

7. TOUCHDOWN AREA. (See Figure 3.)

a. Definition. An area longitudinally centered on the runway centerline, extending from a point 200 ft. outward from the runway threshold (normal or displaced) for a distance of 3200 ft. in the direction of landing, and having a total width of 1000 ft.

b. Obstruction Clearance. The only fixed obstructions permitted in the Touchdown Area are those objects which are fixed by their functional purpose or which are required for precision approaches to that Category II or Category III runway. The definition of objects fixed by their functional purpose is found in FAA Order 8400.10, as amended. All objects except visual aids and frangible functional objects shall be appropriately marked and lighted unless shielded by a properly lighted and marked functional object. The identity and height limits of acceptable objects are as follows:

(1) Visual Aids. Unless flush-mounted, all visual aids shall be installed on frangible mounts. Maximum height is 14 inches above the surface where the fixture is located. Except that taxiway guidance signs may be installed in accordance with AC 150/5340-18, as amended.

(2) Siting For Vertical Path Navigation Systems. ILS, MLS or other IFR vertical path equipment fixed by its function for that runway or an adjacent runway must comply with the following siting standards:

a. Category I Runways

i. No part of the navigation equipment or appurtenances may be constructed within a runway safety area (RSA) or so as to penetrate the obstruction free zone (OFZ) for the primary or adjacent runway(s) as determined by FAA criteria contained in Advisory Circular AC 150/5300-13. FAA Airport Standards must be consulted to ensure that the minimum offset distance and height are appropriate for the most critical aircraft planned for that runway. Effects of airport elevation on the standards must be accounted for.

ii. Where special utilization of a Category I system may be intended to provide lower landing minimums (e.g.. CAT II on a Type I system), the siting criteria for Category II/III systems applies.

b. Category II and III Runways

i. The nominal minimum offset distance for vertical path navigation equipment is 400 feet from the CAT II/III runway centerline.

ii. Where 400 feet has been documented to be technically not feasible or impractical due to associated costs to either the airport sponsor or the agency, the vertical path equipment may be sited closer to the runway centerline than 400 feet as long as the requirements for RSA and OFZ are accounted for as in 1 (c) above. Note that there are expanded requirements for the dimensions of the OFZ which must be applied for CAT II/III runways or runways with Type 1 ILS but where an operational approval for CAT II minimums is proposed.

(3) Structures. Those structures which are elements of the Glide Slope, PAR, or RVR systems (except GS antenna or monitor masts) should not exceed 15 ft. in height above the elevation of the runway centerline nearest them, and in addition may be no closer to the runway centerline than 400 ft. When such structures are more than 15 ft. high, they may be permitted if the minimum distance from the runway centerline is increased 10 ft. for each foot the structure exceeds 15 ft. Frangible PAR reflectors are not considered to be obstructions. MLS antennas are permitted within the touchdown area subject to the criteria in Order 6830.5, as amended.

(4) Objects permitted by AC 150/5300-13. Objects, such as taxiing aircraft or moving vehicles, are allowed within the touchdown area as long as they remain clear of the Obstacle Free Zone. Objects allowed by application of Handbook 7110.65 can be within the touchdown area under certain conditions. However, during Category II and III landing operations, all vehicles, equipment, and aircraft must be held clear of the Obstacle Free Zone. (See FIGURE X).

8. TOUCHDOWN AREA TRANSITIONAL SURFACES.

a. Definition. Transitional Surfaces sloped at 7:1 extend outward and upward from the edges of the Touchdown Area and Section 1 of the Missed Approach Area (See Paragraph 9) to a height of 150 ft. above the elevation of the runway centerline at the end of the touchdown area.

FIGURE 3. OBSTRUCTION CLEARANCE AREAS CATEGORY II AND CATEGORY III

b. Obstruction Clearance. A structure, such as a building or tower, which penetrates the Touchdown Area Transitional Surfaces is an obstruction to Category II and Category III landing operations even when the same object does not penetrate the Obstacle Free Zone. Parked aircraft which penetrate the Touchdown Area Transitional Surfaces are an obstruction to Category II and Category III landing operations. Aircraft taxiing via a parallel taxiway and clear of the Obstacle Free Zone, may penetrate the Touchdown Area Transitional Surfaces. When a fixed object penetrates the 7:1 transitional surfaces and when deemed necessary, adjustment in the RVR minimums will be made commensurate with the degree of interference presented by the obstruction. Such adjustment will be approved by the Flight Standards Service. A caution note will be added to the approach procedure to identify obstacles which penetrate the 7:1 surfaces.

FIGURE X AC-150/5300-13 OBSTACLE FREE ZONE

INSERT Figure 3-4 Obstacle free zone (OFZ) for runways serving large airplanes with lower than 3/4 statute mile (1200m) approach visibility minimums.
from AC 150/5300-13 CHG. 4 dated 11/10/94

9. MISSED APPROACH AREA. A missed approach will be specified to commence at the DH if the required visual reference during Category II operations has not been established. However, it is possible that aircraft will continue to descend through the decision height while initiating the Category II missed approach, or that a decision to land may be altered by circumstances and the approach aborted at a lower altitude. In either case, the missed approach obstruction clearance criteria must consider aircraft which have progressed into the touchdown area to heights below the decision height, perhaps even to a momentary touchdown. Category III missed approach operations must be protected for a momentary touchdown during the missed approach maneuver. Therefore, two Sections to the Missed Approach Area, and a special treatment for the turning missed approach are necessary.

a. Missed Approach Section 1. This portion of the area begins at the end of the Touchdown Area at the height of the runway, and is longitudinally centered on the runway centerline. It has the same width as the touchdown area at the point of beginning (1,000 ft.) and the width increases uniformly to 3,100 ft. at 6,000 ft. from the point of beginning. (See Figure 3).

b. Missed Approach Section 2. This portion of the area starts at the end of Missed Approach Section 1 and is centered on a continuation of the Section 1 course. The width increases uniformly from 3100 ft. at the beginning to 8 miles at a point 15 miles from the runway threshold. When positive course guidance is NOT provided for the missed approach procedure, secondary areas which are zero miles wide at the point of beginning and increase uniformly to 2 miles wide at the end of Missed Approach Section 2, must be added to the edges of Section 2. See Figure 4). Certain airborne equipment may qualify to utilize the FMS missed approach criteria in Order 8260.40 or the RNP criteria at appendix 5 of this AC.

c. Turning Missed Approach Area. (Applies to turns of over 15 degrees). The design of the turning missed approach area assumes that aircraft missing an approach will climb straight ahead until reaching a height of at least 300 ft. above the elevation of the runway centerline at the end of the Touchdown Area. The procedure will identify the obstruction if a turn toward a significant obstruction has to be made. The turning flight track radius shall be 1.75 miles, and it shall be plotted to begin at the end of Missed Approach Section 1. The outer boundary of Missed Approach Section 2 shall be drawn with a 3.5 mile radius. The inner boundary line shall commence at the outer edge of the transitional surface opposite the end of the Touchdown area. The outer and inner boundary line shall terminate at points 4 miles each side of the assumed flight track 15 miles from the runway threshold. (See Figures 5 and 6). Where secondary areas are required, they shall commence after completion of the turn. Turns in the missed approach area are normally specified to commence after reaching a height of 300 ft. Where an operational requirement exists to continue the climb of the aircraft to a height of more than 300 ft. prior to commencing a turn, Missed Approach Section 1 will continue to increase uniformly in width, and will be extended longitudinally 4000 ft. for each 100 ft. of height over 300 ft. In addition, the 12:1 Transitional Surface (Paragraph 8.a) is also extended laterally on the inside of the turn to a height equal to the elevation attained by the extension of Missed Approach Section 1.

> **NOTE: Where a positive course guidance is provided in Section 2 consideration may be given to reducing the width of this Section.**

d. Obstruction Clearance. (See FIGURE XX).

TAXIWAY A

TAXIWAY B

TRANSITIONAL SURFACE

MISSED APPROACH AREA

FINAL APPROACH AREA

TOUCHDOWN AREA

TAXIWAY C

TRANSITIONAL SURFACE

FIGURE XX. TAXIING AIRCRAFT AS OBSTACLES.

In referring to FIGURE XX, taxiing aircraft on Taxiway A are not allowed to penetrate the Final Approach Surface or the Final Approach Area Transitional Surface. Taxiing aircraft on Taxiway B are not allowed to penetrate the Missed Approach Area Section 1 Surface. Taxiing aircraft on parallel Taxiway C are permitted to penetrate the Touchdown Area, the Touchdown Area Transitional Surface and the Missed Approach Area Section 1 Surface, as long as they remain clear of the Obstacle Free Zone. And taxiing aircraft on parallel Taxiway C are not allowed to penetrate the Final Approach Surface or the Final Approach Area Transitional Surface.

Where it is necessary to hold taxiing aircraft on taxiways located in the approach or missed approach areas so that taxiing aircraft do not interfere with Category II or Category III operations, taxiway pavement markings and airfield signs are required. AC 150/5340-18C, Standards For Airport Sign Systems, as amended, specifies use of a Holding Position Sign for Approach Areas and AC 150/5340-1G, Standards For Airport Markings, as amended, specifies use of Runway Holding Position Markings on taxiways. For Category III operations less than 600 ft. RVR, AC 120-57, Surface Movement Guidance and Control System, as amended, specifies Geographic Position Markings and in-pavement Taxiway Clearance Bar lights are required to be installed in addition to the Runway Holding Position Markings at the runway approach holding locations.

(1) Straight Missed Approach. No fixed obstruction in Sections 1 or 2 may penetrate a 40:1 surface. This surface originates at the beginning of Section 1 at the elevation of the runway centerline at the end of the touchdown area, and overlies the entire Missed Approach Area. An object, such as a parked aircraft or a tower, which penetrates the Missed Approach Area is an obstruction to Category II and Category III operations even when the same object does not penetrate the Obstacle Free Zone. Aircraft taxiing via a parallel taxiway adjacent to the Category II or Category III runway and clear of the Obstacle Free Zone, may penetrate the missed approach area. Taxiing aircraft which are not on a parallel taxiway adjacent to the Category II or Category III runway may not penetrate the Section 1 or 2 missed approach 40:1 surface.

(2) Turning Missed Approach. Section 1 obstruction clearance is the same as that for straight missed approach. To determine the obstruction clearance requirements in Section 2, the lines A-B and B-C are identified in Figures 5 and 6. The height of the missed approach surface over any obstruction in Section 2 is determined by measuring the distance from the obstruction to the nearest point on the line A-B or B-C and computing the height according to the 40:1 ratio starting at the elevation of line A-B or B-C. Note that lines A-B and B-C are always at the same elevation as the end of Section 1. (See Figure 6).

(3) Secondary Areas. Where secondary areas are considered, no obstruction may penetrate a 12:1 surface which slopes outward and upward from the missed approach surface.

***10. GLIDE SLOPE ANGLE.** The standard and maximum angle is 3.0 degrees. An angle less than 2.5 degrees will be established only to satisfy a unique operational requirement, and must be justified by special study for consideration of approval by Flight Standards Service, Washington, D.C.

11. GLIDE SLOPE THRESHOLD CROSSING HEIGHT. The optimum glide slope threshold crossing height is 50 ft. The maximum is 60 ft. A height as low as 47 ft. may be used at locations where special consideration of the glide path angle and antenna location are required. Heights are measured at the landing threshold. See FAA Order 8260.34, as amended. The approach reference datum height for the MLS glide path is also governed by FAA Order 8269.34, as amended. Guidance specifying GPS and RNP threshold crossing height is not available at this time.

*** NOTE: Use of glide slope crossing heights as low as 47 ft. are predicated on the vertical distance between the aircraft glide slope antenna and the lowest part of the main landing gear wheels not exceeding 19 ft. with the aircraft in its normal landing approach attitude.**

12. ADJUSTMENT TO CATEGORY II ILS MINIMUMS. The decision height is measured from the highest elevation of the runway in the touchdown area. The lowest minimums permitted by the Category II system are a decision height of 100 ft. and RVR 1200. Application of Category II obstruction clearance criteria may identify objects which exceed the allowable height in the touchdown area or penetrate the approach light surface. In such cases, adjustment to the decision height shall be made as follows:

Final Approach Surface. Requires a special study of local features and conditions before Category II operation can be authorized by the Flight Standards Service, FAA, Washington, DC.

Approach and Touchdown Area Light Surface. Adjust the DH upward one foot for each one foot an object exceeds the allowable height. The RVR value will then be adjusted as indicated in the table:

Adjusted Decision Height	RVR
101-140 ft. (1'-40' adjustment)	1200
141-180 ft. (41'-80' adjustment)	1600
181-199 ft. (81'-99' adjustment)	1800

FIGURE 6. TURNING MISSED APPROACH AREA CONSTRUCTION DETAIL PRECISION CATEGORY II AND III

13. OBSTRUCTION IN THE MISSED APPROACH AREA. The 40:1 missed approach surface is established to identify objects which may be a hazard in the missed approach area. Objects which do not penetrate the 40:1 surface are not considered a hazard. When an object penetrates this 40:1 surface, a special study is required to ensure the appropriate level of safety before Category II operations can be authorized by the Flight Standards Service, FAA, Washington D.C.

APPENDIX 10. TAKEOFF SYSTEM PERFORMANCE AFTER LIFTOFF

The entire takeoff operation requires continuity and a smooth transition from the runway portion of the takeoff through 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 Hazardously Misleading Information is Improbable when the flight crew 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 not within the pilot's primary eye-scan area. Annunciations displayed in head forward locations near the HUD field of view, such as the glare shield, might be found suitable, if they are clear, conspicuous and unambiguous to the pilot while focused on the HUD.

b) The display of Hazardously Misleading takeoff guidance 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:

V2, for engine failure at or below V2 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 or (e.g., as a result of engine failure) shall not result in the guidance to either pilot being removed.

f) The flight crew 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.