

State and local officials. (See 7 CFR part 3015, subpart V.)

Executive Order 12988

This rule has been reviewed under Executive Order 12988, Civil Justice Reform. This rule: (1) Preempts all State and local laws and regulations that are inconsistent with this rule; (2) has no retroactive effect; and (3) does not require administrative proceedings before parties may file suit in court challenging this rule.

Paperwork Reduction Act

In accordance with the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 *et seq.*), the information collection or recordkeeping requirements included in this rule have been approved by the Office of Management and Budget (OMB) under OMB control number 0579-0168.

List of Subjects in 7 CFR Part 301

Agricultural commodities, Plant diseases and pests, Quarantine, Reporting and recordkeeping requirements, Transportation.

Accordingly, we are amending 7 CFR part 301 as follows:

PART 301—DOMESTIC QUARANTINE NOTICES

1. The authority citation for part 301 is revised to read as follows:

Authority: 7 U.S.C. 166, 7711, 7712, 7714, 7731, 7735, 7751, 7752, 7753, and 7754; 7 CFR 2.22, 2.80, and 371.3.

Section 301.75-15 also issued under Sec. 204, Title II, Pub. L. 106-113, 113 Stat. 1501A-293; sections 301.75-15 and 301.75-16 also issued under Sec. 203, Title II, Pub. L. 106-224, 114 Stat. 400 (7 U.S.C. 1421 note).

2. Section 301.75-1 is amended by adding a definition of *ACC coverage* to read as follows:

§ 301.75-1 Definitions.

ACC coverage. The crop insurance coverage against Asiatic citrus canker (ACC) provided under the Florida Fruit Tree Pilot Crop Insurance Program authorized by the Federal Crop Insurance Corporation.

* * * * *

3. In Subpart—Citrus Canker, a new § 301.75-16 is added to read as follows:

§ 301.75-16 Payments for the recovery of lost production income.

Subject to the availability of appropriated funds, the owner of a commercial citrus grove may be eligible to receive payments in accordance with the provisions of this section to recover income from production that was lost as

the result of the removal of commercial citrus trees to control citrus canker.

(a) **Eligibility.** The owner of a commercial citrus grove may be eligible to receive payments to recover income from production that was lost as the result of the removal of commercial citrus trees to control citrus canker if the trees were removed pursuant to a public order between 1986 and 1990 or on or after September 28, 1995.

(b) **Calculation of payments.** (1) The owner of a commercial citrus grove who is eligible under paragraph (a) of this section to receive payments to recover lost production income will, upon approval of an application submitted in accordance with paragraph (c) of this section, receive a payment calculated using the following rates:

Citrus variety	Payment (per acre)
Grapefruit	\$3,342
Orange, Valencia, and tangarine	6,446
Orange, navel (includes early and midseason oranges)	6,384
Tangelo	1,989
Lime	6,503
Other or mixed citrus	3,342

(2) **Payment adjustments.** (i) In cases where the owner of a commercial citrus grove had obtained ACC coverage for trees in his or her grove and received crop insurance payments following the destruction of the insured trees, the payment provided for under paragraph (b)(1) of this section will be reduced by the total amount of the crop insurance payments received by the commercial citrus grove's owner for the insured trees.

(ii) In cases where ACC coverage was available for trees in a commercial citrus grove but the owner of the grove had not obtained ACC coverage for his or her insurable trees, the per-acre payment provided for under paragraph (b)(1) of this section will be reduced by 5 percent.

(c) **How to apply for lost production payments.** The form necessary to apply for lost production payments may be obtained from any local citrus canker eradication program office in Florida, or from the USDA Citrus Canker Project, 6901 West Sunrise Boulevard, Plantation, FL 33313. The completed application should be accompanied by a copy of the public order directing the destruction of the trees and its accompanying inventory that describes the acreage, number, and the variety of trees removed. Your completed application must be sent to the USDA Citrus Canker Eradication Project, Attn: Lost Production Payments Program, c/o

Division of Plant Industry, 3027 Lake Alfred Road, Winter Haven, FL 33881. Claims for losses attributable to the destruction of trees on or before the effective date of this rule must be received on or before August 17, 2001. Claims for losses attributable to the destruction of trees after the effective date of this rule must be received within 60 days after the destruction of the trees. The Administrator may, on a case-by-case basis, approve the consideration of late claims when the circumstances appear, in the opinion of the Administrator, to warrant such consideration. However, any request for consideration of a late claim must be submitted to the Administrator on or before July 18, 2002 for trees destroyed on or before July 18, 2001, and within 1 year after the destruction of the trees for trees destroyed after July 18, 2001.

Done in Washington, DC, this 12th day of June 2001.

Bill Hawks,

Under Secretary for Marketing and Regulatory Programs.

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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No. NM185; Special Conditions No. 25-180-SC]

Special Conditions: Enhanced Vision System (EVS) for Gulfstream Model G-V Airplanes

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final special conditions.

SUMMARY: These special conditions are issued for Gulfstream Model G-V airplanes. These airplanes, as modified by Gulfstream Aerospace Corporation, will have novel or unusual design features associated with a head-up display (HUD) system modified to display forward-looking infrared (FLIR) imagery. The regulations applicable to pilot compartment view do not contain adequate or appropriate safety standards for this design feature. These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that provided by the existing airworthiness standards.

EFFECTIVE DATE: June 18, 2001.

FOR FURTHER INFORMATION CONTACT: Dale Dunford, FAA, Transport Standards

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SUPPLEMENTARY INFORMATION

Background

On February 13, 1998, Gulfstream Aerospace Corporation, 4150 Donald Douglas Drive, Long Beach, California 90808, applied for a supplemental type certificate (STC) to modify Gulfstream Model G-V airplanes. The Model G-V is a transport category to modify Gulfstream Model G-V airplanes. The Model G-V is a transport category airplane with a maximum takeoff weight of 90,500 pounds and powered by two BMW-Rolls Royce Mark BR700-710A1-10 engines. This airplane operates with a two-pilot crew and can hold up to 19 passengers.

The modification incorporates the installation of an Enhanced Vision System (EVS), consisting of a Honeywell 2020 head-up display (HUD) system modified to display forward-looking infrared (FLIR) imagery provided from a Kollsman FLIR assembly. The FAA has previously approved the Honeywell 2020 HUD.

The FAA only considered natural pilot vision for the pilot compartment view when issuing § 25.773. The electronic infrared image displayed between the pilot and the forward windshield represents a novel or unusual design feature in the context of § 25.773. The projection of electronic imagery has the potential to enhance the pilot's situational awareness. The FAA needs to evaluate EVS to determine that the imagery does not adversely affect the pilot's outside compartment view.

Although the FAA determined that the existing regulations are not adequate for certification of EVS, it believes that EVS could be certified through application of appropriate safety criteria. Therefore, the FAA has determined that special conditions should be issued for certification of EVS to establish an equivalent level of safety and effectiveness of the pilot compartment view as intended by the regulation.

Gulfstream and the FAA conducted an extensive proof of concept flight demonstration program and concluded that the EVS could be certified to provide an image that would aid the pilot during an instrument approach for detecting and identifying the visual references listed in Title 14, Code of Federal Regulations (14 CFR

91.175(c)(3)) for descent below decision height to 100 feet above touchdown. Conditions permitting, EVS may yield safety and operational benefits by providing the pilot with enhanced situational awareness.

Type Certification Basis

Under the provisions of § 21.101 ("Designation of applicable regulations"), Gulfstream Aerospace Corporation must show that the Gulfstream Model G-V airplanes, as changed, comply with the regulations in the U.S. type certification basis established for the Model G-V airplane. The U.S. type certificate basis established for the Model G-V airplane is established in accordance with § 21.21 ("Issue of type certificate * * *") and § 21.17 ("Designation of applicable regulations"), and the type certification application date. The U.S. type certification basis for this model airplane is listed in Type Certificate Data Sheet No. A12EA.

If the Administrator finds that the applicable airworthiness regulations (*i.e.*, part 25, as amended) do not contain adequate or appropriate safety standards for the Gulfstream Model G-V airplanes modified by Gulfstream Aerospace Corporation because of a novel or unusual design feature, special conditions are prescribed under the provisions of § 21.16 ("Special conditions").

In addition to the applicable airworthiness regulations and special conditions, these Gulfstream Model G-V airplanes must comply with the fuel vent and exhaust emission requirements of part 34 and the noise certification requirements of part 36.

Special conditions, as appropriate, are issued in accordance with § 11.19 ("What is a final rule?"), after public notice, as required by § 11.38 ("What public comment procedures does FAA follow for Special Conditions?"), and become part of the type certification basis in accordance with § 21.101(b)(2).

Special conditions are initially applicable to the model for which they are issued. Should Gulfstream Aerospace Corporation apply at a later date for a supplemental type certificate to modify any other model included on the same type certificate to incorporate the same novel or unusual design feature, these special conditions would also apply to the other model under the provisions of § 21.101(a)(1).

Novel or Unusual Design Features

The Gulfstream EVS project is the first civil certification of infrared imagery displayed on a HUD. This EVS is novel or unusual technology because it places

a raster* infrared image in the center of the pilot's regulated "pilot compartment view," which must be free of interference, distortion, and glare that would adversely affect the performance of the pilot's normal duties. (*A "raster" image is comprised of a set of horizontal lines that continuously sweep across the display and form a picture on the display by modulating their intensity (luminance).) The EVS/HUD system projects a raster image derived from a forward-looking infrared (FLIR) camera onto the display of the Honeywell HUD 2020 system. The EVS image is displayed with HUD symbology and overlays the forward outside view.

Operationally, during an instrument approach, the EVS image is intended to enhance the pilot's ability to detect and identify "visual references for the intended runway" (see § 91.175(c)(3)), to continue the approach below decision height. Depending on atmospheric conditions and the strength of infrared energy emitted and/or reflected from the scene, the pilot can see these visual references in the image better than the pilot can see them through the window without EVS.

Scene contrast detected by infrared sensors can be much different than that detected by natural pilot vision. On a dark night, thermal differences of objects, which are not detectable by the naked eye, will be easily detected by many imaging infrared systems. On the other hand, contrasting colors in visual wavelengths may be distinguished by the naked eye, but not by an imaging infrared system. Where thermal contrast in the scene is sufficiently detectable, shapes and patterns of certain visual references can be recognized in the infrared image by the pilot, but, depending on conditions, they can also appear significantly different to a pilot in the infrared image than they would with normal vision.

There is the potential for the image to improve the pilot's ability to detect and identify items of interest. EVS needs to be evaluated to determine that the imagery does not adversely affect the pilot's ability to see outside the window through the image. Section 25.773(a)(2) states:

Each pilot compartment must be free of glare and reflection that could interfere with the normal duties of the minimum flight crew.

A raster image can be more difficult for the pilot to see through than stroke-written symbols also displayed on the HUD. Stroke symbology illuminates a small fraction of the total display area of the HUD, leaving much of that area free of reflected light that could interfere

with the pilot's view out the window through the display. However, unlike stroke symbology, the raster image illuminates, to some degree, most of the total display area of the HUD (approximately 30 degrees horizontally and 20 degrees vertically) with much greater potential interference with the pilot compartment view. The pilot cannot see around the raster image, but must see the outside scene through it.

Unlike the pilot's external view, the EVS image is a monochrome, two-dimensional display. Some, but not all, of the depth cues found in the natural view are also found in the imagery. The quality of the EVS image and the level of EVS infrared sensor performance could depend significantly on the atmospheric and external light source conditions. Gain settings of the sensor, and brightness or contrast settings of the HUD, can significantly affect image quality. Certain system characteristics could create distracting and confusing display artifacts. Finally, because this is a sensor-based system that is intended to provide a conformal perspective corresponding with the outside scene, the potential for misalignment must be considered.

Hence, safety standards for each of the following factors are needed:

- An acceptable degree of interference of the window or "window and HUD" view;
- Potential image misalignment;
- Distortion; and
- The potential for pilot confusion or misleading information.

The FAA did not anticipate the novel and unusual design features of the EVS when § 25.773 was issued, and does not consider the current regulation to be adequate to address the specific issues related to an enhanced vision system. Therefore, the FAA has determined that, in addition to the requirements of 14 CFR part 25, special conditions are needed to address requirements particular to the installation of an EVS.

Discussion

Gulfstream Aerospace Corporation intends for the EVS to function by presenting an enhanced view that would aid the pilot, during the approach:

- To see and recognize external visual references that are required by § 91.175(c), and
- To visually monitor the integrity of the approach, as described in FAA Order 6750.24D ("Instrument Landing System and Ancillary electronic Component Configuration and Performance Requirements," dated March 1, 2000).

Based on this functionality, users would seek to obtain operational approval to conduct approaches when the Runway Visual Range (RVR) is as low as 1,200 feet, including approaches to Type I runways. Gulfstream does not intend, and the FAA does not intend by these special conditions for the EVS imagery to be used either as a means of flight guidance, or as the substitution for the outside view while maneuvering the airplane during approach, landing, rollout, or takeoff.

The criteria of these special conditions were developed to determine that this EVS is of the kind and design appropriate to the following functions:

- Presenting an enhanced view that would aid the pilot during the approach.
- Displaying an image that the pilot can use to detect and identify the "visual references for the intended runway" required by § 91.175(c)(3) to continue the approach with vertical guidance to 100 feet height above touchdown (HAT).

Depending on the atmospheric conditions and the particular visual references that happen to be distinctly visible and detectable in the EVS image, these two functions would support its use by the pilot to visually monitor the integrity of the approach path.

Compliance with these special conditions does not affect the applicability of any of the requirements in the operating regulations (e.g., parts 91, 121, and 135). The EVS does not change the approach minima prescribed in the standard instrument approach procedure being used; published minima still apply.

The FAA certification of this EVS is limited as follows:

- The infrared-based EVS image will not be certified as a means to satisfy the requirements for descent below 100 feet HAT.
- The infrared-based EVS image will not be certified as a means to establish that flight visibility is consistent with the visibility condition prescribed in the standard instrument approach being used (see § 91.175(c)(2)).
- The EVS imagery, alone, will not be certified either as flight guidance, or as a substitution for the outside view for maneuvering the airplane during approach, landing, rollout, or takeoff.
- The EVS may be used as a supplemental device to enhance the pilot's situational awareness during any phase of flight or operation in which its safe use has been established.

An EVS image may provide an enhanced image of the scene that may compensate for any reduction in the clear outside view of the visual field

framed by the HUD combiner. The pilot must be able to use this combination of information seen in the image, and the natural view of the outside scene seen through the image, as safely and effectively as the pilot would use a § 25.773-compliant pilot compartment view without an EVS image. This is the fundamental objective of the special conditions.

The FAA also intends to apply certification criteria, not as special conditions, for compliance with other Federal Aviation Regulations, including § 25.1301 ("Equipment: Function and installation") and § 25.1309 ("Equipment, systems, and installations"). These criteria address certain image characteristics, installation, demonstration, and system safety.

Image characteristics criteria include:

- resolution,
- luminance,
- luminance uniformity,
- low level luminance,
- contrast variation,
- display quality,
- display dynamics (for example, jitter, flicker, update rate, and lag), and
- brightness controls.

Installation criteria address:

- visibility and access to EVS controls, and
- integration of EVS in the cockpit.

The EVS demonstration criteria address the flight and environmental conditions that need to be covered.

The FAA also intends to apply certification criteria relevant to high intensity radiated fields (HIRF) and lightning protection.

Discussion of Comments

Notice of proposed special conditions No. 25-01-02-SC for Gulfstream Model G-V airplanes was published in the **Federal Register** on March 16, 2001 (66 FR 15203). Eighteen commenters, including the applicant, responded. A discussion of the comments follows, along with the FAA's disposition of those comments.

Special Conditions Paragraph 4. (Intended Function)

Several commenters recommend withdrawal or revision of paragraph 4. and provide the following comments in support of this recommendation.

Two commenters state that it is not clear why operational restrictions are specified within the special conditions, and recommend that all references and attempts at rulemaking and rule interpretations of parts 91 and 97 be withdrawn and removed.

Another commenter states that paragraph 4. may not be accurate as a

categorical statement for the future. There could be other images developed in the future that may have greater capabilities than FLIR; hence, this statement could be mistakenly interpreted to rule out any chance of progress in this area.

One commenter states that the proposed language is a precedent-setting prohibition against the reduction of ceiling and visibility minimums through EVS usage.

The same commenter also states that the extensive investments by NASA and industry to develop commercially viable and certifiable enhanced and synthetic vision products to increase the overall safety are viewed as jeopardized by the operational restrictions contained within the proposed special conditions.

Two commenters contend that the use of EVS to lower landing minimums is not an issue that is historically addressed by FAA Aircraft Certification, but by FAA Flight Standards. Following some period of operational use, Flight Standards may or may not see fit to allow the use of an enhanced vision image to replace visual contact below the normal decision height.

Several commenters state that paragraph 4. is beyond the scope of the rulemaking and outside the authority established by § 21.16 in that it establishes interpretations of operating rules.

One commenter objects to the use of the special conditions by the Aircraft Certification Service to prescribe operational limits. Approach limits are codified rather than allowing for growth of the system into one with reduced limits.

Another commenter states that the proposed special conditions set the overall policy direction for all future HUD and EVS installations. The commenter goes on to say that even though the rule is written as a part 91 only concern, the philosophy will carry forward and affect part 121 operators as well.

Three commenters recommend the following revisions to paragraph 4.:

- Delete the first sentence,
- Replace the reference to “100 ft. HAT” with “to an appropriate height above touchdown,”
- Add a paragraph 4.c. that states, “presenting an image that would act as an independent integrity monitor during the approach,” and
- Revise paragraph 4. to read, “The use of EVS will not reduce the ceiling and visibility minima of the instrument approach procedure being used, unless an equivalent level of task performance and safety required for that reduced visibility minima can be achieved.”

The FAA agrees that special conditions should not establish interpretations of the operating rules. The special conditions are not intended to create, change, restrict, or reinterpret provisions of the operational rules, including those related to ceiling and visibility minima. Special conditions paragraph 4. is meant to define the intended function for which this EVS would be certified, since installed equipment must be of a type and design appropriate to its intended function. If future applicants propose to expand the intended functions of this or similar equipment, different special conditions may be necessary to identify the appropriate certification criteria for those intended functions.

The FAA does not agree that references to operational regulations should be deleted. Section 91.175(c)(3) is only mentioned to clarify a function of the EVS that the pilot may use to detect and identify “visual references.”

The first sentence of special conditions paragraph 4. is not an operational restriction. Instead, the intent of that sentence was to clarify that the airworthiness approval of EVS does not reduce or override the established ceiling and visibility minima that are legally prescribed in the standard instrument approach procedure. In fact, airworthiness approval of any equipment, whether it uses a raster image or not, cannot take precedence over the established minima. The special condition does not impose this limitation; it acknowledges it. When the notice was issued, there were no published instrument procedures that prescribed different minima for operators of EVS-equipped airplanes.

The FAA agrees that FAA Flight Standards is responsible for determining operational requirements. However, it is also true that the requirements of the existing operational regulations are mandatory. Flight Standards may choose to approve different minima for operators of EVS-equipped airplanes either by revising the operational rules or instrument approach procedures to specify minima for EVS-equipped airplanes. As needed, Flight Standards would also determine in the future whether different minima would be applied to operators of airplanes equipped with this or other EVS configurations. Therefore, the FAA does not agree that the first sentence of special conditions paragraph 4. should be revised to add the phrase “unless an equivalent level of task performance and safety required for that reduced visibility minima can be achieved.”

The FAA also does not agree that the first sentence of paragraph 4. should be deleted. However, to clarify the intent of the first sentence, it is changed to read: “Compliance with these special conditions does not affect the applicability of any of the requirements in the operating regulations (e.g., parts 91, 121, 135).”

The FAA does not agree that the reference to “100 feet HAT” should be replaced with “an appropriate height above touchdown.” Section 91.175(c)(3) (as well as respective provisions in parts 121 and 135) distinguishes between visual references required for descent below decision height and those required for descent below 100 feet HAT. The Gulfstream Proof of Concept (PoC) Flight Test Report recommended that descent below 100 feet HAT must not be predicated on EVS imagery alone. To make such a change as requested would require separate rulemaking to change the relevant regulations.

The FAA does not agree that a new paragraph 4.c. needs to be added to address the use of the EVS as an independent monitor. The pilot may use the EVS image to identify certain visual references that serve as airplane position cues. The EVS sensor performance (i.e., what can be seen and at what distance) in the actual atmospheric conditions will affect the usefulness of the image for the purpose of verifying airplane position. Special conditions paragraph 4., with its subparagraphs, does not explicitly list the function of “integrity monitor” for the guidance, but this function is covered within the dual intended function of “presenting an image that would aid the pilot during the approach” and “that the pilot can use to detect and identify the visual references” [§ 91.175(c)(3)]. The EVS cannot be an independent monitor in the same sense as the term is normally used. Normal use of this term is automatic detection and annunciation of system performance deviations and failure conditions.

Clarification of Notice Preamble (Discussion) and Special Conditions Paragraph 4

One commenter submitted the following questions to the FAA docket for these special conditions. Each question is followed by an FAA response which is based on the plain reading of the regulatory requirements; specifically, the applicability of the operational regulations (e.g., parts 91, 121, 135) is the same whether EVS is installed or not.

Question: Paragraph 4. of the proposed special conditions states: “The

use of EVS will not reduce the ceiling and visibility minima of the instrument approach procedure being used." What is the purpose of this statement? Is this a reference to § 91.175(c)(2), and would this preclude operation below DH or HAT if the requirements of § 91.175(c)(3) were met with EVS alone but the flight visibility was less than the visibility prescribed in the approach being used?

FAA Response: The first sentence of special conditions paragraph 4. is meant to clarify that the airworthiness approval of EVS under part 25 does not reduce or override the established ceiling and visibility minima that are legally prescribed in the standard instrument approach procedure.

To clarify the intent of the first sentence, it is changed to read: "Compliance with these special conditions does not affect the applicability of any of the requirements in the operating regulations (e.g., Parts 91, 121, 135)."

Question: With respect to item 4(b); would the pilot be allowed to continue the approach below a 200 foot HAT to 100 feet, if the EVS detected the required "visual references for the intended runway" but the flight visibility was less than the visibility prescribed for the approach being used?

FAA Response: As stated previously, the applicability of the operational regulations (e.g., parts 91, 121, 135) is the same whether EVS is installed or not. Descent and operation below decision height is not permitted by § 91.175 and similar provisions of other operational parts, as applicable, when flight visibility is less than prescribed in the standard instrument approach procedure being used.

Question: In paragraph eight of the "Discussion" the FAA states: "However, the FAA finds that it would not be appropriate to reduce the ceiling and visibility minima of the instrument approach procedure being used based on the use of EVS." Is this a reference to § 91.175(c)(2) and would this preclude a descent below a 200 foot HAT minimum to 100 feet if the requirements of § 91.175(c)(3) were met with the EVS?

FAA Response: This sentence was not clearly stated. The intent was to say that compliance with the criteria of these special conditions does not affect the applicability of any of the requirements in the operating regulations (e.g., Parts 91, 121, 135). A descent would be permitted only if all requirements of § 91.175 are met. The first sentence of special conditions paragraph 4. is revised accordingly.

Question: Reference paragraph ten of the "Discussion" section: "The infrared-based EVS image will not be certified as a means to satisfy the requirements for descent below 100 feet HAT." Does this statement mean that, if the pilot meets the requirements of § 91.175(c)(3) with EVS alone at a 200 foot HAT, then he may descend to a 100 foot HAT?

FAA Response: No, this statement means that, in order for the pilot to descend below 100 feet HAT, the requirements of §§ 91.175(c) and (d) must be met without the aid of EVS. The pilot may use EVS below 100 feet HAT, but the visual references must be distinctly visible and identifiable with the naked eye.

Question: If the flight visibility is less than the prescribed visibility for the approach being used, but the requirements of § 91.175(c)(3) at 200 feet HAT are met, may the approach be continued to a 100 foot HAT on EVS alone?

FAA Response: As stated previously, the applicability of the operational regulations (e.g., parts 91, 121, 135) is the same whether EVS is installed or not. Descent and operation below decision height is not permitted by § 91.175 and similar provisions of other operational parts, as applicable, when flight visibility is less than prescribed in the standard instrument approach procedure being used.

Descent below the 200 foot decision height cannot be based on EVS alone. To use EVS for the descent below decision height, precision approach guidance must also be provided on the HUD. With valid precision approach guidance provided on the HUD, EVS may be used to meet the requirements of § 91.175(c)(3) from the decision height to 100 feet HAT.

Question: The following example is provided in an attempt to clarify to all parties the suggested operating rules.

Situation:

- Part 91 Operator
- Flight Visibility: 0/0
- Published Minima: 200 feet/½ mile
- EVS: Operational with "Phase I" certification

Note: "Phase I" refers to this certification program.

In this situation, may the pilot commence the approach?

FAA Response: Based on the situation described in the commenter's question above, the Part 91 operator can commence the approach. However, Part 121 and Part 135 operators may not.

Question: At 200 feet the pilot meets the requirements of § 91.175(c)(3) with EVS alone, may he continue to 100 feet?

FAA Response: This response is based on the situation described above by the

commenter. As stated previously, the applicability of the operational regulations (e.g., parts 91, 121, 135) is the same whether EVS is installed or not. Descent and operation below decision height is not permitted by § 91.175 and similar provisions of other operational parts, as applicable, when flight visibility is less than prescribed in the standard instrument approach procedure being used.

Descent below the 200-foot decision height cannot be based on EVS alone. To use EVS for the descent below decision height, precision approach guidance must also be provided on the HUD. With valid precision approach guidance provided on the HUD, EVS may be used to meet the requirements of § 91.175(c)(3) from the decision height to 100 feet HAT.

Question: At 100 feet the pilot meets the requirements of § 91.175(c)(3) without the aid of EVS, may he continue to land?

FAA Response: This response is based on the situation described above by the commenter. As stated previously, the applicability of the operational regulations (e.g., parts 91, 121, 135) is the same whether EVS is installed or not. Operation below decision height is not permitted by § 91.175 and similar provisions of other operational parts, as applicable, when flight visibility is less than prescribed in the standard instrument approach procedure being used.

Need for Special Conditions

Part 21 and FAA Order 8110.4B

Several commenters state that the FAA has failed, in accordance with § 21.16 and FAA Handbook 8110.4B, to justify the need for special conditions. The commenters state that the existing regulations (§§ 25.773, 25.1301, and 25.1309) contain the necessary requirements, and the proposed special conditions serve no additional purpose. Two of these commenters recommend that the special conditions be withdrawn and paragraphs 1., 2., and 3. be developed in a method of compliance issue paper. One of these commenters states that even if the raster display of an FLIR image on the HUD is deemed novel or unusual, regulations are in place to assure safety.

The FAA disagrees. The legal basis for the special conditions was carefully reviewed by the FAA and deemed appropriate. As discussed in the preamble of the notice, and these final special conditions, the FAA issues special conditions when it determines that the existing airworthiness standards do not contain adequate or appropriate

safety standards for a novel or unusual design feature. The regulatory process for issuing special conditions provides for public notification and opportunity for comment on the proposed certification criteria, and promotes standardization of new FAA certification requirements.

The FAA does not agree that § 25.773 is adequate for certification of the EVS. When the FAA issued § 25.773, it did not anticipate the display of an electronic image in the regulated field of view, and did not account for the potential of the EVS imagery to help achieve the safety objectives of the pilot compartment view. As discussed in the notice, the EVS image is different from the natural pilot vision that was assumed when § 25.773 was issued. The differences include:

- Image resolution compared to a pilot's vision,
- Monochrome image compared to color vision,
- Fewer cues for depth perception, and
- The thermal response characteristics of an infrared sensor compared to the color discrimination of pilot vision.

Additionally, the EVS raster image could potentially interfere with the pilot view. The raster image covers most of the combiner at one time, unlike stroke-written HUD symbology, which covers much less combiner area. Because none of the regulations referenced by the commenters contain criteria for evaluating these issues, the FAA has determined that those regulations are inadequate for certification of the EVS. For these reasons, the FAA determined that the EVS is novel and unusual with respect to current airworthiness regulations, and special conditions are needed.

One commenter states that the FAA has failed to provide an adequate explanation for the basis of the "novel and unusual design feature."

The special conditions are not merely a new means of compliance with § 25.773, rather they provide a new requirement and a regulatory path to certify the EVS and achieve an equivalent level of safety. The fundamental requirement contained in the special conditions, not found in § 25.773, is that the combination of what the pilot sees in the EVS image and what the pilot sees through and around the image must be as safe and effective as the view without the image. The FAA considers that the level of safety provided by the special conditions is equivalent to the level of safety intended by § 25.773.

Aerospace Standard AS8055

Two commenters state that Aerospace Standard AS8055 already establishes standards for EVS and therefore the special conditions are unnecessary. One of the commenters states that the FAA requested industry to recommend standards for head up displays, which resulted in the SAE Aerospace Standard AS8055 that recommends standards for HUD's, including raster displays.

The second commenter states that the basis for the special conditions is inadequate, and the rationale is one of opinion. This commenter goes on to say that the special conditions make no mention of certain documents (AC 25.773-1, AC 120-28D, SAE AS8055). The commenter contends that these documents adequately describe HUD and EVS design for certification purposes, without the need for special conditions.

The FAA does not agree. While the FAA did request that SAE develop standards for head up displays, they do not take the place of airworthiness regulations or special conditions. Industry standards, alone, are not mandatory. The FAA request that SAE develop these standards does not contradict the need for special conditions.

Nevertheless, AS8055 contains extremely useful industry developed standards, particularly regarding raster display quality, that have been adapted to the fullest possible extent in a separate means of compliance issue paper for EVS certification. The current AS8055 addresses head up displays and the information presented on them, including raster imagery, but not imaging sensors, such as the infrared camera used in the Gulfstream EVS.

Advisory Circular (AC) 25.773-1 provides criteria for an acceptable means of compliance with § 25.773, but does not address the display of electronic imagery in the regulated pilot compartment view. The FAA therefore found no reason to refer to this document in the notice.

Advisory Circular (AC) 120-28D provides a means of compliance for Category III low visibility operations and certification of equipment designed for that purpose. The Phase I Gulfstream EVS is not intended for Category III operations, and therefore the FAA did not find a reason to refer to this AC in the notice.

HUD vs. Raster Imagery

One commenter contends that the FAA's main argument revolves around § 25.773(a)(2), which states, "Each pilot compartment must be free of glare and

reflection that could interfere with the normal duties of the minimum flight crew." The commenter further states that this could equally apply to stroke-only HUD's which are currently certified.

Another commenter states that the notice is in error, since § 25.773 has been cited and accepted as a means of compliance for many HUD programs.

A third commenter states that although § 25.773 does not directly mention an EVS imagery display, this regulation, in combination with other pertinent regulations, contains the necessary and sufficient requirements for determining an acceptable pilot compartment view. The commenter asserts that these same existing regulations have been successfully applied to HUD's for several years.

The FAA does not agree. Stroke-written HUD symbology and raster imagery have significantly different characteristics. As explained in the notice, stroke-written HUD symbology illuminates a small fraction of the HUD combiner area (approximately 20 by 30 degrees) at any one time. The imagery, on the other hand, can illuminate almost all of the HUD at one time. The pilot can see through the relatively large "unlit spaces" between HUD symbols with very little visual interference, but the EVS design provides no such spaces in the raster imagery. Consequently, depending on the content at any time, the EVS image might interfere with much more of the pilot's view.

Unlike § 25.773, the special conditions account for this potential interference by also considering that the EVS image may also provide useful information which, in combination with what the pilot can see through the image, is as safe and effective as the pilot's view without the image.

Military Use of EVS

One commenter states that the EVS application may be novel and unusual (that is, for commercial aircraft); however the technology is not. This technology, including raster images on a HUD, has been in use by the military. The commenter states that special conditions are premature and the issue should be studied.

The FAA disagrees. The phrase "novel or unusual" is used in § 21.16 in the context of existing regulations. Under the provisions of § 21.16, the FAA issues special conditions when it determines existing airworthiness regulations do not contain adequate safety standards for a novel or unusual design feature. The special conditions are issued to establish a level of safety

equivalent to that established in the existing regulations.

Granted, elements of the EVS have been in use in the military, even to the extent of displaying infrared imagery on a HUD. However, military use of this technology differs from this civil application, and the level of safety required of military systems used in combat operations differs from what is required for civil transport airplane airworthiness. As previously stated in this document in response to other comments, certain design features of the EVS are considered novel or unusual with respect to the current airworthiness standards, and the FAA has determined that special conditions are needed.

Not Based on Real Data or Analysis

One commenter suggests that the special conditions be deferred and modified as necessary so that they are supported by data and analysis. The commenter suggests that until that time, the FAA could make a determination regarding certification of EVS systems on a case by case basis.

Another commenter considers the special conditions to be premature in that they are based on "findings" that are not supported by real data or analysis, and therefore are actually based on opinions. The commenter states they participated in the Synthetic Vision System (SVS) program and that most of the key elements of the proposed special conditions are not supported by the FAA SVS database.

The FAA does not agree that the special conditions are premature, or that the criteria for applying the special conditions for the EVS is not supported by data and analysis.

The FAA did, in fact, consider the reported findings of the FAA Synthetic Vision System Technology Demonstration program, and the Gulfstream proof of concept (PoC) flight test. The large FAA SVS database is primarily measured sensor performance with measured atmospheric and scene conditions. Many of the issues raised and considered in the FAA SVS program are addressed in these special conditions and in a means of compliance issue paper. As explained in the notice, and earlier in these final special conditions in response to other comments, the electronic EVS image is different from the pilot's natural vision and was not anticipated when § 25.773 was issued, so the FAA determined that special conditions are needed.

While the FAA believes, based on the PoC results, that the Gulfstream EVS can be safely certified, that does not mean safety standards are unnecessary. The

safety standards covered by the special conditions are based on issues investigated during the PoC of the Gulfstream EVS and the earlier FAA SVS program.

These special conditions are specific to the Gulfstream certification project. If appropriate, different special conditions may be adopted for future programs involving similar equipment. The FAA is making these certification determinations on a case-by-case basis.

Proof of Concept (PoC) Test Results

One commenter states that the FAA failed to properly take into account the results of the FAA proof of concept program. The test program required two years and over 200 approaches flown by FAA selected pilots and specialists, and the report states that the HUD and the EVS did not obscure the pilot's forward field of view and did not interfere with the pilot's view of the runway during the landing approach.

Another commenter is of the opinion that the FAA completely ignored the PoC tests. The commenter states that the FAA is not justified in issuing the proposed special conditions since the results of extensive evaluations during FAA-mandated PoC flight tests concluded that the EVS could be certified and safely used in transport category operations under existing airworthiness certification standards.

Another commenter states that the FAA failed to recognize test results that show the good faith effort in addressing the concerns related to safe and effective use of the EVS. The commenter contends that the EVS proof-of-concept tests concluded that the EVS provided situational awareness, did not obscure the pilot's view, and did not interfere with the pilot's view of the runway. As such, it is compliant with the intent of § 25.773.

A fourth commenter states that it is surprising that the notice, which lists the criteria for issues that must be addressed for the EVS, makes no reference to the findings of the PoC flight test results that conclude these issues are not a concern.

The FAA does not agree with the commenters that the PoC test results were not considered in determining the need for special conditions. The purpose of the PoC is to determine what would be operationally acceptable and what standards or criteria are needed for airworthiness approval. It is not the purpose of the PoC to determine whether or not the safety standards must be contained in special conditions.

While the FAA concluded, based on the PoC results, that the Gulfstream EVS could be safely certified, it did not

conclude that safety standards were unnecessary. The safety standards covered by the special conditions are not based on deficiencies of the Gulfstream EVS, but rather on issues that were investigated during the PoC and the earlier FAA SVS program. While the PoC test results show that the EVS image does not obscure the pilot's view, there must be appropriate safety standards for the impact of the EVS image on the pilot's view.

The FAA actions have been consistent with the PoC process as outlined in paragraph 10.18 of Advisory Circular 120-28D. As stated earlier, the special conditions provide a legal avenue to certify this system.

EVS Enhances Safety and Should Not Be Delayed

One commenter states that reduced visibility is a major or contributing factor in many civil aircraft accidents. If the pilot could have had the real-time information provided by EVS, a significant number of these accidents could have been avoided. The commenter asserts that the EVS can save lives now, and recommends that the FAA continue to understand and not delay the benefits of EVS to the air transportation system.

Another commenter states that new technology that provides enhanced aircraft safety should be certified and deployed in a quick and orderly fashion, rather than through a long series of disjointed special conditions. It is the commenter's opinion that this is detrimental both to the FAA and airlines through unnecessary delays, and to the traveling public who deserve improved safety of flight.

A third commenter believes that the EVS will provide operational safety improvement. The commenter states that EVS technology is specifically aimed at eliminating low-visibility conditions as a causal factor in civil aircraft accidents, and that if installed, the EVS will provide operational benefits approaching those found in clear daytime operations, regardless of weather conditions.

The FAA agrees in part with the commenters. Indeed, EVS may be able to improve safety in certain conditions and phases of flight. The FAA acknowledges that the EVS image may improve the pilot's ability to detect and identify items of interest. The application of safety standards through special conditions does not prevent the use of EVS in ways that would enhance safety. The EVS may be used for any operation or phase of flight where it is shown to be safe.

It has not yet been demonstrated that the Gulfstream EVS can actually provide benefits equivalent to conventional clear daytime operations in all low visibility conditions. The infrared sensor is affected by the same visible moisture that is often the cause of low visibility conditions. Nevertheless, the actual operational benefits that the EVS can provide will be shown in due time with the accumulation of service experience.

The FAA has not delayed the certification project, or the safety or operational benefits that the EVS might provide. Publication of these final special conditions has not adversely impacted the overall certification program schedule.

Use of Infrared (IR) Imagery To Establish Visibility

One commenter states that the notice raises concern that the reported visibility (visible spectrum) would not be consistent with the IR visibility "seen" by the EVS, and that this is a valid operational concern, but not a certification issue.

The same commenter also states that the current regulations do not permit any operator to descend below the published approach minimums, unless the visibility is at least that prescribed in the instrument approach procedure being used. The commenter says that the current regulations do not address electronic aiding, and recommends that the following statement be added to the AFM limitations: "Installation of the EVS does not constitute approval to continue an approach below decision height."

The FAA disagrees. The notice addressed "flight visibility," not reported visibility. The two terms are distinctly different. For descent below decision height, § 91.175(c)(2) requires that "flight visibility," which is the forward horizontal distance that unlighted objects can be seen from the cockpit by day, and lighted objects by night, be no less than the visibility prescribed in the standard instrument approach procedure being used.

The FAA agrees that the requirements for approach, including flight visibility, are established by operational regulations, particularly parts 91, 121, and 135, and are therefore operational concerns. However, the requirement that installed equipment must be of a type and design to perform its intended function, defined in special conditions paragraph 4. for certification purposes, is a valid airworthiness certification concern.

The FAA agrees that current regulations do not address electronic images in the pilot compartment view

regulated by § 25.773. As stated earlier, the special conditions are considered necessary because § 25.773 is not adequate for the novel or unusual design features of the EVS. However, the special conditions do not address whether operational regulations adequately address the use of the EVS and do not create, change, restrict, or reinterpret the operational requirements.

The FAA does not agree with the recommended change to the AFM limitations, because it appears more conservative than the FAA concluded is necessary. One conclusion drawn from the PoC testing was that the visual references listed in § 91.175(c)(3) could be detected and identified in the EVS image, and that the ability to do this could be evaluated. The FAA has revised the first sentence of paragraph 4. to clarify that the use of EVS does not affect the applicability of the operational requirements.

Special Conditions Were Identified Late in the Program

Two commenters state that the FAA needs to review processes that were followed to ensure that FAA personnel are fully aware of their responsibilities to raise such concerns early in a program.

The commenters express the opinion that the FAA did not follow the principles of the certification process improvement effort. The principles include surfacing issues early in the program so that they can be resolved before they have an adverse effect on the ability of the applicant to certify the product in accordance with the program schedule.

The FAA disagrees. Although the need for special conditions was not known in the beginning of the program, the need for special conditions was identified early enough in the program to not impact the certification schedule.

The Language in the Notice Is Damaging to the Development and Use of EVS

Two commenters express the opinion that the language and limitations contained in the notice are prejudicial against EVS and HUD developments. One has concerns about the future FAA response to new safety technologies and many other proposed safety systems to meet the goals of the Safer Skies program.

Another commenter states that the proposed special conditions do not accurately represent the Gulfstream EVS program. The commenter asserts that the EVS would enhance the ability of the pilot to see and identify visual

references to continue an approach to a decision point of 100 feet for Phase I and 50 feet for Phase II. It is the commenter's opinion that the special conditions create a negative impression of EVS technology, which further reflects a biased judgment against EVS and is contrary to the conclusions reached under the controlled evaluations.

The FAA disagrees. The special conditions are not intended to be a reference to the product or a commentary on the product's success. Differences between EVS infrared imagery and natural pilot vision were described in the preamble of the notice for the purpose of addressing the uniqueness of the EVS and the need for safety standards to address the differences. That an EVS image has the potential to interfere or obscure the pilot's view does not mean that an EVS is unacceptable, but that the product needs to be evaluated with these potential characteristics in mind to maintain the level of safety established by the current airworthiness standards.

The special conditions are not intended to characterize the Gulfstream EVS project. The requirements in the proposed special conditions, and adopted in these final special conditions, are intended to provide safety standards for this EVS to meet, and to ensure that such a determination is made during certification, not to imply that this EVS is unacceptable. The special conditions address Phase I of the Gulfstream project, and anything beyond Phase I will be addressed outside this rulemaking activity.

The Proposed Special Conditions Are Too Restrictive on the Use of EVS

One commenter states that the notice denies the following uses of the EVS:

- As a substitution for the real-world view,
- As a means to establish that flight visibility is consistent with the visibility condition prescribed in the standard instrument approach being used,
- As a means to reduce the ceiling and visibility minima of the instrument approach procedure being used, and
- As a means to satisfy the requirements for descent below 100 feet HAT.

Another commenter states that there could be other images developed in the future that may have greater capabilities than FLIR. Paragraph 4. of the proposed special conditions could be mistakenly interpreted to rule out any chance of progress in this area.

The FAA disagrees. The special conditions do not deny or restrict the use of EVS. Rather, the language

referred to in the comment (and discussed in the preamble to the notice) defines what intended functions it is being certified for and the limits of that airworthiness certification approval. Unless found unsafe during any operation or phase of flight, this would not limit the use of EVS as a supplemental device, nor would it restrict the role of Flight Standards to authorize the use of EVS.

The first sentence of special conditions paragraph 4. is not an operational restriction; instead, it is meant to clarify that the airworthiness approval of EVS, itself, does not reduce or override the established ceiling and visibility minima prescribed in the standard instrument approach procedure. In fact, airworthiness approval of any equipment, whether it uses a raster image or not, cannot take precedence over the established minima. These special conditions do not impose this limitation; they acknowledge it. When the notice was issued, there were no published instrument procedures that prescribed different minima for operators of EVS-equipped airplanes.

To clarify the intent of the first sentence of special conditions paragraph 4., it is changed to read: "Compliance with these special conditions does not affect the applicability of any of the requirements in the operating regulations (e.g., parts 91, 121, 135)."

FAA Flight Standards has the authority to determine operational requirements. However, it is also true that the requirements of the existing operational regulations are mandatory. Flight Standards may choose to approve different minima for operators of EVS-equipped airplanes. As needed, Flight Standards would also determine in the future whether different minima would be applied to operators of airplanes equipped with this or other EVS configurations.

Clarification Issues

Special Conditions Paragraph 2.a.

One commenter provided the following comments relative to paragraph 2.a.:

- "Burlap overlay" is not defined in the examples provided in paragraph 2.a.
- Use of FLIR, under some circumstances, may not be desirable or an improvement over the pilot's vision, and may not be appropriate.
- The ability to easily dim and/or clear the image on the HUD should be incorporated to permit removal of the image quickly, if conditions are not favorable.

FAA clarification of each issue is as follows:

"Burlap overlay" is one example of a display artifact that has a burlap-like appearance and was observed during the PoC flight testing. It could be distracting to the pilot, make the image difficult to use, and potentially interfere with the pilot's outside view.

The FAA agrees with the commenter that in some circumstances the EVS image may not be desirable, and that is why paragraph 2.c. of the special conditions requires that a readily accessible control be provided for the pilot to immediately deactivate and reactivate display of the image on demand.

The FAA agrees with the commenter that the ability to dim or clear the image on the HUD should be incorporated, and that is why paragraph 2.b. of the special conditions requires effective control of image brightness, and paragraph 2.c. requires that a readily accessible control be provided for the pilot to immediately deactivate and reactivate display of the image on demand.

Special Conditions Paragraph 2.f.

One commenter interprets special conditions paragraph 2.f. to mean that the EVS image must not affect the performance of the pilot in the use of the HUD for previously approved operations. The commenter assumes that the EVS image may be removed during those operations (or phases) which could be impacted, and states that the EVS image may need to be automatically deactivated during certain phases of flight, perhaps at or prior to decision height during a low visibility approach.

The objective of paragraph 2.f. is that the EVS installation would not adversely affect the ability of the HUD to meet any requirement to which it was originally certified. Whether or not the EVS image must be removed for some phases of flight to comply with this paragraph must be determined on a case-by-case basis. If there are cases where removal of the image is required, automatic means to deactivate the image would not be required, unless it is shown that manual procedures to deactivate the image are inadequate.

Special Conditions Paragraph 3.

The commenter interprets paragraph 3. as follows: "The EVS image must not interfere in the pilot's detection of traffic, terrain, obstacles, and other hazards of flight. The assumption is that objects are recognizable within the EVS image, or visual objects are still recognizable through the EVS image."

The commenter's interpretation with respect to the ability of the pilot to "see" discrete visual items is correct. For completeness, though, one must also determine if there are characteristics that adversely affect the pilot's ability to maneuver the airplane to avoid flight hazards. Excessive image latency or lag, for example, might have an adverse effect.

Special Conditions Paragraph 4.a.

One commenter provided the following comments:

- It is not clear if this rules out the use of the EVS for taxi and/or takeoff.
- The words seem to indicate that the evaluation has already been completed and the special conditions authorize use during the approach.
- Other potential uses should be considered (that is, takeoff, taxi, seeing threatening cloud formations at night).

Special conditions paragraph 4. is meant to clarify the intended function of EVS, not to impose operational limitations. A requirement for airworthiness certification is that the system must be of a type and design to perform its intended function.

The FAA and the applicant agree that the intended functions listed in paragraphs 4.a. and 4.b., associated with approach operations, are the primary focus of the certification, and for which the FAA will certify the EVS. However, there is no intent to restrict use of the EVS to approach and landing operations only. The EVS may be used as a supplemental system for any phase of flight, including taxi and take-off, when it is shown to be safe.

A PoC flight test program was conducted to evaluate what the EVS was capable of, how it should be used, and what certification criteria would be needed. Demonstrations for showing compliance with the airworthiness certification requirements will be accomplished after issuance of the final special conditions.

Proof of Concept Test

One commenter states that it is unclear whether a proof of concept demonstration was conducted and if so, no results were revealed.

As stated earlier, a PoC demonstration has already been conducted. The PoC test report, itself, is proprietary to the applicant, so the FAA did not provide it to the public.

Additional Requirements to Proposed Special Conditions

One commenter states that consideration should be given to the following areas in the proposed special conditions:

- Ensure acceptable characteristics when transitioning from EVS ON to OFF and vice versa, particularly the ability to reacquire outside visual references when EVS is selected OFF during an instrument approach.

- Evaluate the perception of actual colors as viewed through the HUD with the EVS ON.

- Address the effects of power transients or temporary interruptions.

- Address pilot fatigue or eye strain while using the EVS.

- Consider EVS dispatch requirements.

- Paragraph 2.d. should be expanded to state that the initial certification should include sufficient testing to cover the normal range of expected flight maneuvers for all of the phases of flight to be certified with the EVS active.

Another commenter states that it may be desirable to provide the option of a head down FLIR display when operations are conducted with a single HUD.

The FAA agrees, in part, with the issues raised by the first commenter. The FAA plans to evaluate these issues during the certification program, but does not see the need to revise the language of the special conditions. FAA responses to the issues are provided in the order presented by the commenter.

- Specific standards for acceptable EVS on/off transitions and color perception need not be stated. These factors can be evaluated in the context of special conditions paragraphs 1. and 2. (including sub-paragraphs).

- The HUD was already certified to have acceptable responses to power transients and interruptions. The FAA does not consider this EVS image, itself, critical. Based on special conditions paragraph 2.f., with the EVS modification, the HUD must continue to meet the requirements of its original approval.

- Per special conditions paragraph 2.f., the HUD with the EVS modification must continue to meet the requirements of its original approval, including the eye strain and fatigue criteria of the HUD issue paper.

- Dispatch requirements are determined by the FAA Aircraft Evaluation Group and will not be specified in the special conditions.

- Software requirements are addressed, separately, in a means of compliance issue paper and will not be addressed in the special conditions.

In response to the second commenter, the FAA considers that the desirability of an option to display the EVS image head down is a matter for the customer to decide, but is not a safety issue that would justify a mandatory standard.

Recognize EVS as an Avionics System With a Broad Base of Experience

The commenter states that the EVS should be recognized as a system with an extremely long and broad base of experience. Many of the issues raised in the notice are old concerns resolved by the military in great detail, and at great cost, including:

- Issues of visual acuity and cognizant processing.

- Perception of the 3rd dimension is accomplished through a combination of relative intensity (brightness), apparent movement, and size growth with decreasing distance to items of interest.

- In spite of technical limitations of older military systems, they were whole-heartedly embraced as beneficial, even a poor image is better than no image. The present technology is better since it has a larger, more sensitive detector array.

The FAA did not discount the military experience when proposing these special conditions. The “old concerns” may have been resolved by the military for the sake of weapon system design and operational use. The notice (preamble and special conditions) raised the issues that distinguish the EVS image from natural pilot vision because there are novel or unusual design features which the existing rule, § 25.773, does not adequately address, and to provide safety standards that can be used to certify the EVS to the level of safety required for civil transport category airplanes.

While acknowledging that there are some differences between the EVS image and natural vision, special conditions provide a way to certify EVS and maintain the level of safety, based on the premise that the combination of what the pilot can see in the image and what can be seen naturally, while the image is displayed, must be as safe and effective as the view without the image (in the same conditions).

The special conditions were proposed because of the need for appropriate safety standards for such systems that perform required functions previously done only by natural pilot vision. The FAA does not suggest, and has no reason to believe, that that the Gulfstream EVS is unsafe and cannot comply with the requirements of the special conditions.

The special conditions acknowledge enhanced situational awareness as an intended function of EVS, where its safety benefits might be best realized. Use of the EVS may also be beneficial during Category I approaches, when the ceiling and visibility are as prescribed

in the standard instrument approach procedure. However, its safety benefit, when used for a Category I approach in less than prescribed flight visibility, has yet to be evaluated.

The FAA accepts that the EVS image can provide some depth cues; however, unlike EVS, the natural view provides actual stereoscopic and accommodation (focus) cues, in addition to depth perception cues which may be found in the EVS image. The airworthiness standard, § 25.773, and the operational rules, including § 91.175, were written with natural vision in mind.

The visual acuity (resolution) of the raster EVS image display also differs from natural pilot vision. This does not mean that EVS is unacceptable, only that it does not match natural vision, and that safety standards are needed for the image resolution to be satisfactory for its intended function, and that it does not unacceptably interfere with the pilot's natural vision.

Notice Implies that Existing Regulations Do Not Permit the Use of a “Sensor Based” System

One commenter states that the notice asserts that the existing regulations do not permit the use of a “sensor based” system for independent verification that the primary guidance is accurate. Another commenter states that there is no reference in the notice to the PoC test results that found the EVS suitable for acting as an independent integrity monitor for ILS approaches.

The FAA did not say in the notice that sensor based systems cannot be used for independent verification of the primary guidance. Paragraph 4. of the special conditions does not explicitly list the function of “integrity monitor” for the guidance, but this function is covered within the dual intended function of “presenting an image that would aid the pilot during the approach” and “that the pilot can use to detect and identify the visual references” (§ 91.175(c)(3)).

The EVS cannot be an independent monitor in the same sense as the term is normally used. Normally, use of this term refers to automatic detection and annunciation of system performance deviations and failure conditions. The pilot may be able to use the EVS image to identify certain visual references that serve as airplane position cues. The EVS sensor performance (i.e., what can be seen and at what distance) in the actual atmospheric conditions will affect the usefulness of the image for the purpose of verifying airplane position.

Lack of Understanding of the Technology and Underlying Physics

One commenter states that the special conditions delve into the technical “nitty-gritty” of infrared and display performance with little understanding of the technology and underlying physics. The commenter further states that:

- Infrared sensors are not limited to the mere sensing of “heat.” The EVS sensor has been tailored to detect electromagnetic radiation from the near-IR out to the long-wavelength. This is technically interesting but not relevant to the issue at hand.

- Most important is what the system provides, not the theoretical basis for infrared operation. With EVS, the pilot sees the same visual cues, in the same way, as presented on the HUD in a form that promotes outside/far-field vision and facilitates a transition from the IR image to the real scene.

The FAA agrees, in part, with the commenter. While the infrared energy detected by these sensors is primarily due to “thermal” contrast in the scene, it is also true that reflected and emitted infrared energy might be detected. Because of their spectral response, the infrared sensors detect contrast in the scene differently from natural pilot vision. A scene that shows significant contrast in the infrared wavelengths may have less contrast in the visual wavelengths, and vice versa.

The FAA agrees that the pilot may see many of the same visual cues with the EVS that might be seen naturally, but they are not seen in exactly the same way. As stated earlier, the cause and degree of scene contrast can vary between the infrared image and the natural view. However, the FAA acknowledges that the size and spatial relationships of certain visual references, particularly lighted objects such as those listed in § 91.175(c)(3), may be similar in the image and in the natural view and therefore may be identifiable to the pilot.

This is not to say that the EVS infrared imagery is unacceptable, only that it is not the same as natural vision, in a variety of ways. Natural vision was originally assumed when §§ 25.773 and 91.175 were issued, which, as discussed earlier, is one basis for the special conditions. So far, the FAA has not certified the use of any electronic imagery displayed in the windshield’s field of view or imagery generated from a different part of the electromagnetic spectrum.

Operational Benefits of EVS

One commenter states that the EVS could be used at many runway ends

closed for critical take-off and landing operations due to limited visibility. The EVS could restore the pilot’s vision and increase airport capacity.

The full potential for operational benefits of the EVS will be demonstrated by the accumulation of service experience, and will depend on the FAA Flight Standards’ determination of what operational uses will be authorized.

That EVS may provide significant operational benefits is not a factor when determining the need for safety standards or special conditions. The special conditions, alone, will not restrict the use of EVS for operationally beneficial purposes.

Requests To Extend Comment Period

One commenter, representing the interests of airlines and manufacturers, requests that the comment period be extended for 30 days. The commenter states that airlines and manufacturers must be able to understand the implications and future impact of the proposed special conditions and need the additional time to provide responsive and constructive comments.

The FAA has decided not to extend the public comment period. Eighteen commenters, including this commenter, were able to provide extensive comments to the proposed special conditions during the allotted time. These special conditions are specific to the Gulfstream Model G–V EVS project, and any extension to the public comment period would adversely delay certification. There will be additional opportunities to comment on other special conditions and rulemaking related to future EVS certification projects as they arise.

Request for a Public Meeting

One commenter expresses concern about the effect this special condition action will have on the industry-wide joint effort to improve the certification process through the use of strong and trustworthy partnerships, and requests that the FAA conduct a public hearing into the process of handling such further industry developments.

A second commenter requests that the FAA hold a public hearing to discuss the special conditions and the rationale for broader application to products developed as part of the Safer Skies program.

The FAA does not agree. The process of holding a public meeting and dealing with the result of such a meeting would unduly delay completion of this rulemaking and could adversely affect the applicant’s certification schedule.

The FAA does not believe that such a meeting would materially serve the purposes of this rulemaking. A significant amount of substantive public comments have already been submitted that sufficiently characterize objections and concerns with the special conditions.

Applicability

As discussed above, these special conditions are applicable to Gulfstream Model G–V airplanes modified by Gulfstream Aerospace. Should Gulfstream Aerospace apply at a later date for a supplemental type certificate to modify any other model included on the same type certificate to incorporate the same novel or unusual design feature, these special conditions would apply to that model as well under the provisions of § 21.101(a)(1).

Conclusion

This action affects only certain novel or unusual design features on the Gulfstream Model G–V airplanes modified by Gulfstream Aerospace. It is not a rule of general applicability and affects only the applicant who applied to the FAA for approval of these features on the airplane.

List of Subjects in 14 CFR Part 25

Aircraft, Aviation safety, Reporting and recordkeeping requirements.

The authority citation for these special conditions is as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

The Special Conditions

Accordingly, pursuant to the authority delegated to me by the Administrator, the following special conditions are issued as part of the supplemental type certification basis for Gulfstream Model G–V airplanes modified by Gulfstream Aerospace:

1. The EVS imagery on the HUD must not degrade the safety of flight, nor interfere with the effective use of outside visual references for required pilot tasks, during any phase of flight in which it is to be used.

2. To avoid unacceptable interference with the safe and effective use of the pilot compartment view, the EVS device must meet the following requirements:

- 2.a. The EVS design must minimize unacceptable display characteristics or artifacts (for example, noise, “burlap” overlay, running water droplets) that obscure the desired image of the scene, impair the pilot’s ability to detect and identify visual references, mask flight hazards, distract the pilot, or otherwise degrade task performance or safety.

2.b. Control of EVS display brightness must be sufficiently effective, in dynamically changing background (ambient) lighting conditions, to prevent full or partial blooming of the display that would distract the pilot, impair the pilot's ability to detect and identify visual references, mask flight hazards, or otherwise degrade task performance or safety. If automatic control for image brightness is not provided, it must be shown that a single manual setting is satisfactory.

2.c. A readily accessible control must be provided that permits the pilot to immediately deactivate and reactivate display of the EVS image on demand.

2.d. The EVS image on the HUD must not impair the pilot's use of guidance information nor degrade the presentation and pilot awareness of essential flight information displayed on the HUD, such as alerts, airspeed, attitude, altitude and direction, approach guidance, windshear guidance, TCAS resolution advisories, and unusual attitude recovery cues.

2.e. The EVS image must be sufficiently aligned and conformal to both the external scene and conformal HUD symbology so as not to be misleading, cause pilot confusion, or increase workload.

2.f. A HUD system modified to display EVS images must continue to meet all the requirements of the original approval.

3. The safety and performance of the pilot tasks associated with the use of the pilot compartment view must be not be degraded by the display of the EVS image. Pilot tasks that must not be degraded by the EVS image include:

3.a. Detection, accurate identification, and maneuvering, as necessary, to avoid traffic, terrain, obstacles, and other hazards of flight.

3.b. Accurate identification and use of visual references required for every task relevant to the phase of flight.

4. Compliance with these special conditions does not affect the applicability of any of the requirements in the operating regulations (e.g., parts 91, 121, 135). The criteria in special conditions paragraphs 1., 2., and 3. were developed to determine that this EVS is of a kind and design appropriate to the following functions:

4.a. Presenting an image that would aid the pilot during the approach.

4.b. Displaying an image that the pilot can use to detect and identify the "visual references for the intended runway" required by § 91.175(c)(3) to continue the approach with vertical guidance to 100 feet height above touchdown (HAT). Appropriate limitations must be included in the

Operating Limitations section of the Airplane Flight Manual to prohibit the use of the EVS for functions not found to be acceptable.

Issued in Renton, Washington, on June 8, 2001.

Ali Bahrami,

Acting Manager, Transport Airplane Directorate, Aircraft Certification Service.

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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 39

[Docket No. 2000-NM-319-AD; Amendment 39-12268; AD 2001-12-13]

RIN 2120-AA64

Airworthiness Directives; Empresa Brasileira de Aeronautica S.A. (EMBRAER) Model EMB-135 and EMB-145 Series Airplanes

AGENCY: Federal Aviation Administration, DOT.

ACTION: Final rule.

SUMMARY: This amendment adopts a new airworthiness directive (AD), applicable to certain EMBRAER Model EMB-135 and EMB-145 series airplanes, that requires replacement of certain brake control units (BCU) with new units. The actions specified by this AD are intended to prevent uncommanded application of 50 percent braking in one pair of wheels, which could result in the airplane skidding off the runway. This action is intended to address the identified unsafe condition.

DATES: Effective July 23, 2001.

The incorporation by reference of certain publications listed in the regulations is approved by the Director of the Federal Register as of July 23, 2001.

ADDRESSES: The service information referenced in this AD may be obtained from Empresa Brasileira de Aeronautica S.A. (EMBRAER), P.O. Box 343—CEP 12.225, Sao Jose dos Campos—SP, Brazil. This information may be examined at the Federal Aviation Administration (FAA), Transport Airplane Directorate, Rules Docket, 1601 Lind Avenue, SW., Renton, Washington; or at the FAA, Atlanta Aircraft Certification Office, One Crown Center, 1895 Phoenix Boulevard, suite 450, Atlanta, Georgia; or at the Office of the Federal Register, 800 North Capitol Street, NW., suite 700, Washington, DC.

FOR FURTHER INFORMATION CONTACT: Robert Capezzuto, Aerospace Engineer,

Systems and Flight Test Branch, ACE-116A, FAA, Atlanta Aircraft Certification Office, One Crown Center, 1895 Phoenix Boulevard, suite 450, Atlanta, Georgia 30349; telephone (770) 703-6071; fax (770) 703-6097.

SUPPLEMENTARY INFORMATION: A proposal to amend part 39 of the Federal Aviation Regulations (14 CFR part 39) to include an airworthiness directive (AD) that is applicable to certain EMBRAER Model EMB-135 and EMB-145 series airplanes was published in the **Federal Register** on November 13, 2000 (65 FR 67663). That action proposed to require replacement of certain brake control units (BCU) with new units.

Comments

Interested persons have been afforded an opportunity to participate in the making of this amendment. Due consideration has been given to the single comment received.

Add Service Information

The commenter states that EMBRAER Service Bulletin 145-32-0060, dated May 5, 2000, should be included in the final rule as an additional source of service information for previous accomplishment of the specified actions. EMBRAER Service Bulletin 145-32-0060, Change No. 01, dated June 6, 2000, was listed as the source of service information for accomplishment of the actions specified in the proposed rule. The commenter states that the difference between the original issue and Change No. 01 of the service bulletin is administrative in nature.

The FAA agrees with the commenter that the original issue is essentially the same as Change No. 01 of the service bulletin. We have added a new Note 2 to the final rule which clarifies that previous accomplishment of the actions per the original issue of the service bulletin meets the requirements of this final rule.

Conclusion

After careful review of the available data, including the comment noted above, the FAA has determined that air safety and the public interest require the adoption of the rule with the change described previously. The FAA has determined that this change will neither increase the economic burden on any operator nor increase the scope of the AD.

Cost Impact

The FAA estimates that 165 Model EMB-135 and EMB-145 series airplanes of U.S. registry will be affected by this AD. It will take approximately 5 work hours per airplane (2.5 work hours per