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Enhanced Flight Vision Systems; Final Rule

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Parts 1, 91, 121, 125, and 135

[Docket No. FAA–2003–14449; Amendment Nos. 1–52; 91–281; 121–303; 125–45; 135–93]

RIN 2120–AH78

Enhanced Flight Vision Systems

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final rule.

SUMMARY: The FAA is revising its regulations for landing under instrument flight rules to allow aircraft to operate below certain specified altitudes during instrument approach procedures, even when the airport environment is not visible using natural vision, if the pilot uses certain FAA-certified enhanced flight vision systems. This action informs the public and the aviation industry of the approval of the use of new technology for certain operational benefits.

DATE: Effective February 9, 2004.

FOR FURTHER INFORMATION CONTACT: Les Smith, Flight Technologies and Procedures Division, Flight Standards Service, AFS–400, Federal Aviation Administration, 800 Independence Ave. SW., Washington, DC 20591; telephone: (202) 385–4586.

SUPPLEMENTARY INFORMATION:

Availability of Rulemaking Documents

You can get an electronic copy of this document using the Internet by:

(1) Searching the Department of Transportation's electronic Docket Management System (DMS) Web page (*http://dms.dot.gov*); do a Simple Search for ''14449.''

(2) Visiting the Office of Rulemaking's Web page at *http://www.faa.gov/avr/arm/index.htm* or

(3) Accessing the Government Printing Office's Web page at *http://www.access.gpo.gov/su_docs/aces/aces140.html.*

You can also get a copy by submitting a request to the Federal Aviation Administration, Office of Rulemaking, ARM–1, 800 Independence Avenue, SW., Washington, DC 20591, or by calling (202) 267–9680. Be sure to identify docket number FAA–2003–14449, or the title of this final rule, ''Enhanced Flight Vision Systems.''

Anyone is able to search the electronic form of all comments received into any of our dockets by the name of the individual submitting the comment (or signing the comment, if submitted on behalf of an association, business, labor union, etc.). You may review DOT's complete Privacy Act statement in the **Federal Register** published on April 11, 2000 (Volume 65, Number 70, pages 19477–78) or you may visit *http://dms.dot.gov.*

Small Business Regulatory Enforcement Fairness Act

The Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996 requires the FAA to comply with small entity requests for information or advice about compliance with statutes and regulations within its jurisdiction. Therefore, any small entity that has a question regarding this document may contact its local FAA official, or the Office of Rulemaking at (202) 267–8487. You can find out more about SBREFA on the Internet at *http://www.faa.gov/avr/arm/sbrefa.htm*, or by e-mailing us at *9–AWA–SBREFA@faa.gov.*

List of Abbreviations Used in This Document

AC—Advisory circular
AGL—Above ground level
ASR—Airport surveillance radar
AWO—All-weather operations
DH—Decision height
EFV—Enhanced flight visibility
EFVS—Enhanced flight vision system
EVS—Enhanced vision system
FPV—Flight path vector
FSB—Flight Standardization Board
HAT—Height above touchdown
HUD—Head-up display
IFR—Instrument flight rules
ILS—Instrument landing system
JAA—Joint Aviation Authorities
MDA-Minimum descent altitude
PAR—Precision approach radar
RNAV—Area navigation
SAE—Society of Automotive Engineers
SVS—Synthetic vision system
TAOARC—Terminal Area Operations Aviation Rulemaking Committee
TERPS—U.S. Standard for Terminal Instrument Procedures
TSO—Technical Standard Order
VOR—Very high frequency omnirange station
VDP—Visual descent point

Outline of Preamble

I. Background

Section 91.175 of 14 CFR contains the flight visibility requirements for conducting operations to civil airports using natural vision to identify the approach lights and runway environment. These instrument approach requirements have been modified over the years to provide for operating an aircraft during reduced visibility conditions while maintaining a high level of safety. The current rules on instrument approach procedures do not allow aircraft to operate below the decision height (DH) or minimum descent altitude (MDA) if the airport environment cannot be seen with natural vision. This final rule allows operators conducting other than Category II or Category III straight-in instrument approach procedures to operate below the DH and MDA when new technologies, such as an enhanced flight vision system (EFVS), use imaging-sensor technology that provides a real-time image of the external topography. During some reduced visibility conditions, an EFVS can display imagery that may significantly improve the pilot's capability to detect objects, such as approach lights and visual references of the runway environment that may not be visible. This final rule will allow, but not mandate, the use of this kind of technology.

II. Discussion of the Proposed Rule

By notice of proposed rulemaking (NPRM) Notice No. 03–03, February 10, 2003 (68 FR 6801), the FAA proposed to amend its rules to allow for the operational use of an EFVS, which can display imagery that may significantly improve the pilot's capability to detect objects that may not otherwise be visible. The FAA proposed that the provisions of this NPRM would apply to operations conducted under parts 91, 121, 125, 129, and 135. The comment period on the proposal closed March 27, 2003.

In the NPRM, the FAA also proposed that the pilot of an aircraft could use this system to determine ''enhanced flight visibility'' while flying a straight-in standard instrument approach procedure. An EFVS would enable the pilot to determine ''enhanced flight visibility'' at the decision height (DH) or MDA, in lieu of ''flight visibility'' (as currently defined), by using a head-up display (HUD) to display sensor imagery of the approach lights or other visual references for the runway environment at a distance no less than the visibility prescribed in the instrument approach procedure being used.

The FAA proposed to define ''enhanced flight visibility'' as the average forward horizontal distance, from the cockpit of an aircraft in flight, at which prominent topographical objects may be clearly distinguished and identified by day or night by a pilot using an EFVS. This definition would be substantially equivalent to the definition of flight visibility in part 1. The pilot would use this enhanced flight visibility and go through a similar decisionmaking process as required by existing § 91.175 (c) to continue the approach from the DH or MDA down to 100 feet above the touchdown zone elevation of the runway of intended landing. At that point and below, certain things would have to be visible to the pilot without using the EFVS in order for the aircraft to proceed to a landing on the intended runway. This rule will permit but will not require the use of this technology.

The proposed rule, therefore, could allow for operational benefits, reduced costs, and increased safety for aircraft equipped with an EFVS. Use of an EFVS with a HUD may improve the level of safety by improving position awareness, providing visual cues to maintain a stabilized approach, and minimizing missed approach situations. In addition to using an EFVS to satisfy new § 91.175 (l) requirements, an EFVS may allow the pilot to observe an obstruction on the runway, such as an aircraft or vehicle, earlier in the approach, and observe potential runway incursions during ground operations in reduced visibility conditions. Even in situations where the pilot experiences the required flight visibility at the DH or MDA, he or she could still use an EFVS to have better situational awareness than may be possible without it especially in marginal visibility conditions.

However, it should be noted that the NPRM did not propose to allow the use of a ''synthetic vision'' system as a means of determining the required enhanced flight visibility or to identify one of the visual references for the intended runway. Synthetic vision is a computer-generated image of the external scene topography from the perspective of the flight deck that is derived from aircraft attitude, a high-precision navigation solution, and a database of terrain, obstacles, and relevant cultural features. A synthetic vision system is an electronic means used to display a synthetic vision image of the external scene topography to the flight crew.

III. Related Rulemaking Actions

In a separate rulemaking project, the FAA conducted a thorough review of its rules to ensure consistency between the operating rules of 14 CFR and future proposed area navigation (RNAV) operations for the National Airspace System (NAS). On December 17, 2002, the FAA published a proposed rule entitled, ''Area Navigation (RNAV) and Miscellaneous Amendments'' (67 FR 77326; Dec. 17, 2002). In that NPRM, the FAA proposed to enable the use of space-based navigation aid sensors for aircraft RNAV systems through all phases of flight (departure, en route, arrival, and approach) to enhance the safety and efficiency of the national airspace system.

Because at the time the EFVS NPRM was issued, the comment period for the RNAV NPRM was still open, the FAA incorporated certain proposed terminology, such as ''approach procedure with vertical guidance (APV)'' and ''decision altitude (DA),'' from the RNAV NPRM into the EFVS NPRM. This is discussed in detail in the preamble to the EFVS NPRM (under ''Related NPRM'' at 68 FR 6803). The comment period on the RNAV proposed rule closed on July 7, 2003. The FAA received numerous comments on the terminology proposed in the RNAV NPRM, and must consider those comments before issuing a final rule. Since those comments are still under review, and the RNAV rulemaking action is not yet a final rule, the FAA is not adopting the RNAV-related language in the EFVS final rule.

In addition, on April 8, 2003, the FAA adopted certain terms from the December 2002 RNAV NPRM by publishing a final rule, ''Designation of Class A, B, C, D, and E Airspace Areas; Air Traffic Service Routes; and Reporting Points' (68 FR 16943). The FAA also reorganized the structure of its regulations concerning the Designation of Class A, B, C, D, and E airspace areas, and it incorporated by reference two FAA Orders—8260.3, U.S. Standard for Terminal Instrument Procedures

(TERPS) and 8260.19, Flight Procedures and Airspace. These portions of the December 2002 RNAV NPRM were issued as a final rule to facilitate the development of RNAV routes that are not restricted to ground-based navigation systems.

IV. Discussion of Comments

IV.1. General

The FAA received more than 40 comments in response to the NPRM. Commenters supporting the proposed rule commended the FAA for developing a regulation to enable the use of enhanced visibility technology that will increase levels of safety, provide operational benefits, and increase aircraft operational efficiency. Some commenters also believed that through the use of EFVS, aircrews will experience increased situational awareness, improve approach completion rates, reduce operational costs and significantly increase IFR safety margins.

Commenters opposed to the changes in the proposal requested that the FAA withdraw the NPRM because they asserted that the NPRM is inconsistent with current FAA advisory materials and the NPRM should be coordinated through one of the FAA's rulemaking committees, that have aviation industry participants. Some believed that the use of EFVS as proposed in the NPRM would be so restrictive that it would limit investment in vision system technologies and would limit the safety benefits of such systems.

FAA's response: The FAA believes that the use of EFVS-equipped aircraft will provide operational benefits and increase aircraft operational efficiency in reduced visibility conditions. The FAA believes that the NPRM is consistent with advisory materials and that the best course for approval is to use the rulemaking process. The FAA does not believe that this rule limits investment in vision-sensor technologies. Responses to these and other issues are provided in greater detail in the following subject-by-subject discussions.

IV.2. Flight Visibility and Visual References

Comment: There were several comments recommending the deletion of § 91.175(c)(2) on flight visibility because the visibility determination is readily established in § 91.175(c)(3) via identifiable airport lighting systems and/or environment. Commenters pointed out that the additional requirement of a pilot quantifying flight visibility (as defined in 14 CFR part 1) with no other means than a subjective determination adds an undue burden to the flight crew and no means of substantiation. A commenter asserted that this flight visibility requisite is especially an undue burden when the requirement of § 91.175(c)(3) has been accomplished. Conversely, commenters suggested, continuation with an approach below the MDA or DH should be predicated on the ability to see the runway environment, not a numerical determination of the current flight visibility.

FAA's response: The FAA disagrees with the recommendation to delete the ''flight visibility'' requirement of § 91.175(c)(2) because the requirement still applies to instrument approach procedures not involving the use of EFVS. Not all operators will install an EFVS. However, in accordance with the requirements in § 91.175(l)(2), this rule will allow the use of an EFVS to meet the requirement for determining enhanced flight visibility, which is substantially equivalent to the requirements in § 91.175(c)(2). The intent of this rulemaking is to allow the use of enhanced flight vision systems to operate an aircraft below DH or MDA even when ''flight visibility'' requirements are not met. The FAA did not propose to change requirements that apply to non-EFVS operations. The origin of the term ''flight visibility'' and ''visual references'' can be found in Amendment No. 91–173, (46 FR 2280, January 8, 1981). In that amendment of former § 91.116 (recodified as § 91.175 in 1989), the term ''visibility'' was clarified with the introduction of the term ''flight visibility.'' Guidance was also provided for the specific ''visual references'' that the pilot must identify at the MDA or DH to continue the approach.

Amendment No. 91–173 clarified the term ''visibility'' in § 91.116(c)(2) to specify that ''no pilot may operate an aircraft below MDA or DH unless the flight visibility is not less than the visibility prescribed in the standard instrument approach procedure being used.'' This revised requirement was necessary to make it clear that the visibility referred to is the visibility from the aircraft and not ground visibility. To simply state that, if the pilot has the runway in sight, the flight visibility requirement is satisfied, is not always valid. This concept may be valid for a Category I ILS approach but would not be valid for other straight-in approaches such as a very high frequency omnirange station (VOR) approach where the missed approach point (the VOR navaid) is located on the airport. For example, if the visibility for the VOR approach is 1 statute mile and the MDA is 600 feet (assuming no approach light system), and the pilot of an airplane does not see the runway environment until passing over the runway threshold at 600 feet, the pilot would have met the criteria for identifying the runway, but with only 600 feet of visibility assured would typically not be in a position to safely maneuver the aircraft for a landing. In this hypothetical situation, the flight visibility is less than 1 statute mile. However, if the flight visibility had been 1 statute mile, the pilot would have been able to identify the runway threshold or runway lights at a distance sufficient to make a normal rate of descent, using normal maneuvers from a visual descent point (depicted on the approach chart or determined by the pilot) and maneuver the aircraft for a landing. Simply saying that by identifying one of the visual references of § 91.175(c)(3) satisfies the requirement for flight visibility, as stated on the instrument approach procedure, is not enough for a safe operation.

It should be noted that the amendment to former § 91.116 also made it clear that the pilot must have the prescribed flight visibility from descent below MDA or DH until touchdown by using as reference items such as approach lights, threshold, threshold markings, *etc.*, instead of towers, smoke stacks, buildings, and other landmarks that may be located far from the end of the runway.

The objective of this rulemaking is to allow the use of any FAA-certified EFVS that can display a real-time image of the external scene topography and meet the requirements of § 91.175(l) and (m). A proposed EFVS could meet the requirements of § 91.175(l) and (m) and yet not be capable of distinguishing colors, and may not even be capable of detecting the approach light system or runway lights, but will provide an image of the runway surface and the metal structures that encompass the approach lights or runway lights.

IV.3. Visual Cues (Visual References)

Comment: Several commenters also stated that the visual cues should not be restricted to the two listed in the EFVS NPRM for the final descent, but broadened to include any of those listed in § 91.175(c)(3).

FAA's response: The FAA disagrees with these commenters. In the NPRM, the FAA proposed that in order for the pilot to descend below the DH or MDA when using the EFVS, one of two requirements had to be met: (1) The approach light system (if installed) had

to be seen; or (2) both the threshold and the touchdown zone had to be seen. If the approach light system was not seen (*e.g.*, because it was not installed or because it was not operating), the proposed rule would have required that the pilot see both the threshold and the touchdown zone in order to proceed below the DH or MDA. The FAA proposed a compound requirement (*i.e.*, the threshold and the touchdown zone) to have a more stringent standard than what is allowed under existing § 91.175(c)(3) when using natural vision. The FAA proposed and adopts in this final rule a more stringent standard because these EFVS devices might not display the color of the lights or the runway markings.

As proposed and as adopted in this final rule, the FAA's safety goal was to specify certain visual references that would help the pilot determine whether the aircraft was properly aligned with the runway of intended landing. Thus, if the pilot using the EFVS can see the approach light system, this is adequate to determine whether the aircraft is properly aligned to continue the approach. If, on the other hand, for whatever reason, the approach light system cannot be seen, the FAA proposed, and finds that it is necessary, to have a compound visual cue (visual references) requirement of the threshold and the touchdown zone. The safety reason for this compound visual cue requirement is that EFVS may not be capable of displaying runway markings and the color of lights to identify the touchdown zone area of the runway. Having a threshold identifying cue in sight and a touchdown zone cue in sight should give the pilot an adequate pattern of recognition to determine whether the aircraft is properly aligned with a runway and thus, enable the pilot to determine whether to continue or to execute a missed approach.

In the proposed § 91.175(l)(3)(ii), the FAA used the language, ''the runway threshold and the touchdown zone.'' In the final rule, for clarification purposes, the FAA is specifying those items that it considers as identifiers of the runway threshold and touchdown zone. Thus, in order to identify the runway threshold, the pilot needs to be able to see the beginning of the runway landing surface, the threshold lights, or the runway end identifier lights. In addition, in order to identify the runway touchdown zone, the pilot needs to see the runway touchdown zone landing surface, the touchdown zone lights, the touchdown zone markings, or the runway lights. When the FAA refers to ''runway lights'' in § 91.175(l)(3)(ii)(B)(*4*), this does not mean all of the runway lights. Instead, it means only those runway lights that together with the threshold identifier would help the pilot recognize whether he or she is approaching the runway of intended landing. Therefore, in this final rule, § 91.175(l)(3) is revised to read as follows:

(3) The following visual references for the intended runway are distinctly visible and identifiable to the pilot using the enhanced flight vision system:

(i) The approach light system (if installed); or

(ii) The following visual references in both paragraphs (l)(3)(ii)(A) and (B) of this section:

(A) The runway threshold, identified by at least one of the following:

(*1*) The beginning of the runway landing surface;

(*2*) The threshold lights; or

(*3*) The runway end identifier lights.

(B) The touchdown zone, identified by at least one of the following:

(*1*) The runway touchdown zone landing surface;

(*2*) The touchdown zone lights;

(*3*) The touchdown zone markings; or

(*4*) The runway lights.

IV.4. Restricted Visual References

Comment: One commenter noted that some visual references currently present in § 91.175(c)(3) (for example, the runway end identifier lights, the runway or runway markings, and runway lights) would be lost to EFVS users under proposed § 91.175(l)(4).

FAA's response: The FAA does not agree. Section 91.175(c)(3) of the current regulations relate to a different set of circumstances than proposed § 91.175(l)(4). In the EFVS NPRM and this rule, the pilot at 100 feet above the touchdown zone elevation of the runway of intended landing must see the lights or markings of the threshold or the lights or markings of the touchdown zone using natural vision. Some of the items listed in § 91.175(c)(3) would not be visible at 100 feet above the touchdown zone elevation.

IV.5. Harmonization

Comment: A commenter pointed out that a stated goal of both the Joint Aviation Authorities (JAA) and the FAA is harmonization. This commenter believed that deleting the reference to flight visibility and continuing to use the visual references of § 91.175(c)(3) would harmonize the FAA and JAA regulations.

FAA's response: The topic of ''flight visibility'' could be a subject for future JAA harmonization discussions, but at this time there is no corresponding JAA provision. This comment is not within the scope of this rulemaking because the FAA did not propose to remove the requirement for flight visibility in § 91.175(c)(2).

IV.6. Airport Lighting Systems

Comment: Several commenters stated that the EFVS should be compatible with the airport lighting systems. One commenter noted that recent information indicates that some newly installed airport lighting systems will use current technology light emitting diode (LED) systems that do not have a large infrared signature. According to the commenter, these LED systems potentially are not visible to current enhanced vision systems (EVS).

FAA's response: The FAA acknowledges that some EFVS may perform differently in detecting airport lighting systems. However, the rule provides the pilot with various other identifiers to meet the visual reference requirement of § 91.175(l)(3). If the pilot is unable to identify any of the required visual references in § 91.175(l)(3) with the EFVS at the DH or MDA, a missed approach must be conducted.

IV.7. Electromagnetic Spectrum

Comment: One commenter noted that an EFVS may not be limited to operations outside the visible frequencies of the electromagnetic spectrum. This system restriction is omitted for the proposed definition of EFVS in 14 CFR part 1. This commenter recommends that the FAA disregard the last phrase in the NPRM preamble background discussion for ''Previous type designs'' that states ''* * * which operates outside the visible portion of the electromagnetic spectrum'' and allow the proposed EFVS definition to provide the description.

FAA's response: The FAA agrees with this commenter that an EFVS may be designed to operate within the visible portion of the electromagnetic spectrum. The definition of an EFVS in part 1 does not prohibit these types of EFVS and therefore the rule does not have to be amended.

IV.8. Limitations of Systems

Comment: One commenter proposed that the FAA add a concluding paragraph to the revision of proposed § 91.175 in lieu of the proposed language that stated: ''Notwithstanding provisions of paragraphs above, the Administrator may approve the use of Enhanced Vision Systems (EVS) and procedures meeting requirements other than those specified, if: (1) The systems and procedures proposed are shown to have equivalent or better performance than other approved systems, are operationally safe, effective, and reliable for ground and flight operations

including: Taxi, takeoff, climb, cruise, descent, approach, landing, roll-out, or missed approach as applicable, and, (2) if visual reference requirements apply, the pilot is able to determine that flight visibility is adequate for safe takeoff or landing.'' The commenter stated that realization of EVS benefits and other significant, technology driven, operational and safety enhancements are dependent on structuring language within the NPRM that encourages further technological development and does not specifically limit system design. It is important to avoid rulemaking language that narrowly defines systems or technologies, but instead addresses fundamental requirements. The commenter believed that approval of EVS or other systems should be based on demonstrating equivalent levels of safety and performance to that of currently approved instrument approach and landing systems.

FAA's response: The FAA disagrees with the commenter and believes that the regulatory language proposed by the commenter is too open-ended and non-specific to be applied as a rule. This final rule will allow an aircraft to be operated to lower altitudes (DH or MDA) than presently permitted for straight-in instrument approach procedures other than Category II or Category III if the conditions of the proposed language are met. Thus, this final rule provides an operational benefit (operations to lower altitudes in marginal weather) for those who equip their aircraft with this new technology and who meet the other conditions of the new rule. In addition, many of the commenters' proposed uses of an EFVS are beyond the scope of this rulemaking because the FAA did not propose to allow the use of EFVS to meet any other regulatory requirements. However, the proposed rulemaking does not impose restrictions on other voluntary uses of an FAA certified EFVS where the pilot is not using the EFVS to meet a regulatory requirement, *i.e.*, situational awareness.

The FAA does not intend to discourage technical innovation, and this rule does nothing to hinder innovation. Instead, this rule provides a way for a new technology that has been developed, tested, and certified by the FAA to be used in a way that provides operational and safety benefits. The rule provides an acceptable alternative to the previously existing requirements for flight visibility and allows operations below the DH or MDA without affecting the standard instrument procedures or the prescribed visibility minima. Without the use of EFVS, it would not be possible to offer these significant operational benefits. The operational concepts for using other innovative technology may differ from that underlying this rule.

IV.9. Other Technologies

Comment: Several commenters stated that the NPRM excluded the use of other types of technology that can achieve the same results as EFVS, and that the NPRM would discourage technology and innovation by precluding or seriously discouraging the use of other technologies such as synthetic vision systems (SVS). Another commenter noted several potential advantages of an SVS over an EFVS. EFVS unpredictably has a limited vision capability while SVS capability would be reliably available for much farther distances (such as full scene capability from the final approach fix), allowing for improved approach stability and lower crew workloads.

A commenter noted that an EVS is currently using a raster (television) display technology, while SVS can be implemented in ''Stroke'' (line drawing) technology. Raster inherently obscures the entire view of the outside world through the HUD while Stroke has no obscuration at all except where the actual relevant material, such as runway outlines, are being displayed. The FAA/USAF Synthetic Vision Technology Demonstration Program documented instances where the crew using HUD EVS were unable to see real visual cues due to the EVS raster obscuration of the visual runway view, forcing unnecessary go-arounds.

This commenter also stated that EVS images in minimal weather will be limited to ''improved eyesight'' giving only a few runway lights. An SVS-enhanced solution would give complete approach lead-in, as well as outline of the load bearing boundaries of the runway.

This commenter believed that at most runways in wet, icy, or snowy weather, EVS is unpredictably incapable of providing any indication of where the desired touchdown point is on the runway or the extent of the touchdown zone (typically extending from 500 feet to 3,000 feet down the runway). SVS technology would be able to reliably provide both.

FAA's response: The FAA acknowledges that a synthetic vision system could have certain display advantages in comparison to EFVS with respect to information content and method of presentation and does not intend to prohibit future implementation of standard SVS instrument approach procedures. However, the proposed rule was intended to provide an analogous alternative to § 91.175(c)(2) (flight visibility) for descent and operation below DH or MDA, to conduct straight-in instrument approaches, other than Category II or Category III, with standard minima. The key difference between SVS and EFVS is that an EFVS provides an independent real-time view for the pilot. Whereas, an SVS is comprised, in part, of a database component, a precise navigation component, instrument data interfaces and a processing component that would compute and ''draw'' the forward view based on what the external view should be if the data base and navigation components are valid. The database-derived SVS display is not a real-time source of forward scene information as is the EFVS sensor-based image. Although an SVS may display a synthetic view of the runway, it is incapable of displaying a real-time view of the external scene and the pilot would not be able to determine if the runway were contaminated by water, ice, or snow. Therefore, an SVS display cannot serve as an alternative means of complying with § 91.175(l)(3) for descending below DH or MDA.

IV.10. Regulatory Bar To Use of Systems Such as SVS

Comment: One commenter stated there is no regulatory bar to use of systems such as SVS. In fact, systems having the characteristics of SVS were also developed and implemented for use in the 1960s and 1970s. Specific U.S. civil examples are available. Further, according to the commenter, the NPRM provided no technically sound basis to justifiably and inherently discriminate between the merits of SVS, EVS, and other systems for certain specific low-visibility related tasks or applications.

FAA's response: An SVS cannot provide enhanced flight visibility, especially the capability to show a real-time image of an aircraft or vehicle on the runway of intended landing. Although an SVS has been approved for flying an instrument approach procedure, it has not been approved for operations below the authorized DH or MDA. Therefore, an SVS cannot be used below the DH or MDA unless the flight visibility is not less than the visibility prescribed in the standard instrument approach procedure being used (§ 91.175(c)(2) and unless at least one of the items in § 91.175(c)(3) is distinguishable. Operations below the DH or MDA are only authorized if the requirements of § 91.175 (c)(2) and (c)(3) are met or the requirements of § 91.175(l)(2) and (l)(3) are met. There is a bar to using an SVS to fly a standard

instrument approach procedure and descend below the authorized minima (DH or MDA) without having the required flight visibility or enhanced flight visibility. There is also a bar to using an SVS, even above the DH or MDA, unless the FAA has specifically approved the operation.

IV.11. Differentiation Between Runway and Taxiway

Comment: A commenter stated that the NPRM would not have required that a capability exist to differentiate a taxiway or other runway similar environment (*e.g.*, lighted highway or drag-strip) from a runway environment. EVS systems are usually incapable of distinguishing taxiway lighting or even taxiway environments from runway environments, especially when considering nonprecision runways. Examples of these difficulties include that the sensor cannot determine the visual color of the lighting system, and for imaging radar-based systems, the radiated heat pattern is different than the visual light distribution (taxiway lights do not project light upwards at the same angle as runway lights). To mitigate this problem, the pilot must see the runway visually at 100 feet above the touchdown zone elevation to land the aircraft.

FAA's response: The FAA acknowledges that some enhanced flight visibility systems may not work as well as others to adequately portray the forward scene and the visual references listed in the rule. During certification of the EFVS installation, the applicant must demonstrate that pilots will be able to use the EFVS to distinctly see and identify these visual references and determine whether the enhanced flight visibility is no less than the prescribed minimum. The EFVS will be tested in a variety of environmental conditions and at several different runways. The FAA will not approve a system that is found to be prone to misidentification of the listed visual references or in other ways does not perform its intended function.

The FAA believes it is not necessary to explicitly require the EFVS to distinguish runways from taxiways. However, the rule does list specific visual references of an approach light system or a runway and touchdown zone that would distinguish a runway from other features of the airport environment, at least one of which must be distinctly visible and identifiable using the EFVS and the rule requires that the touchdown zone be distinctly visible and identifiable to the pilot. By meeting these requirements, the pilot can know that the aircraft is approaching the desired runway, and not a taxiway. If a runway feature and a touchdown zone feature cannot be distinguished from a taxiway feature, then the runway is not distinctly visible and identifiable.

The rule provides for a safe operation, because the pilot must execute a missed approach if at any time between the DH or MDA and 100 feet above the touchdown zone elevation the visual references are not distinctly visible and identifiable by using the EFVS. Furthermore, upon reaching 100 feet above the touchdown zone elevation, the pilot must be able to see and identify, without reliance on EFVS, the threshold (lights or markings) or touchdown zone (lights or markings) of the intended runway. If at 100 feet above the touchdown zone elevation, the pilot cannot see the threshold (lights or markings) or the touchdown zone (lights or markings), the pilot must execute a missed approach.

IV.12. Obstacle Clearance

Comment: One commenter stated that giving obstacle avoidance credit to EFVS is incorrect. Many nonprecision approaches are constructed such that the MDA and visibility charted provide the crew with the capability to see and avoid obstacles or obstructions in the possible paths descending from the MDA or from the terminating point of the approach.

This commenter asserted that allowing EFVS to be used in lieu of charted flight visibility may put the aircraft at serious risk, since many obstructions or obstacles are not visible to EVS sensors and thus would not be displayed to a crew relying on an EFVS to transit the area below the MDA and 100 feet above the touchdown zone elevation. Worse, according to the commenter, is the ability of EVS to see many types of natural or cultural features is generally unpredictable due to thermal characteristics.

FAA's response: The FAA agrees with the commenter that some EFVSs may not be able to consistently detect obstacles in the visual segment of an instrument approach procedure under certain conditions. Many of the obstacles the commenter refers to would not be a problem if the pilot complies with the same three requirements as § 91.175 (c) for a pilot to descend from the MDA on a nonprecision approach. The three requirements applicable to § 91.175 (c) and (l) are: (1) Pilot must observe that the enhanced flight visibility (or flight visibility) is not less than the visibility specified for the procedure; (2) at least one of the specifically listed visual references must be distinctly visible and; (3) the aircraft must continuously be in a position from which a descent to a landing on the intended runway can be made at a normal rate of descent using normal maneuvers.

If a pilot meets all of the requirements of § 91.175 (l), the pilot should have adequate visibility to see the runway environment. In addition, while an EFVS may not detect all of the obstacles the commenter refers to, an EFVS may reveal some of them. For example, there may be cues observable in the EFVS display that would indicate that an obstacle exists, other than a distinct image of an obstacle. For example, a partial obstruction of the runway may indicate terrain between the aircraft and the runway.

The FAA acknowledges a key point made by the commenter, that it is uncertain that the EFVS will always enable the pilot to detect all obstacles in the visual segment of the approach. A similar risk is present today because it is also uncertain that pilots will always be able to detect obstacles visually when operating conventionally under § 91.175 (c). Adverse visual conditions, such as low contrast, shadows, snow cover (especially coupled with falling snow and/or overcast conditions, *i.e.*, ''whiteout''), and situations of similar obstacle and background coloring can occur even when flight visibility and the other requirements for descent below MDA are satisfied.

The risk for a nonprecision approach using EFVS is significantly mitigated by the rule by only permitting reliance on an EFVS to straight-in approaches. The FAA believes it is unlikely that a pilot following straight-in instrument approach procedures will encounter an object in the flight path. The FAA does acknowledge that it is possible for an EFVS to not detect obstacles in the visual segment of an approach even if the pilot has the required enhanced flight visibility. However, the FAA believes that obstacle clearance can be maintained, if the pilot uses the recommended procedures below to fly a straight-in instrument approach procedure with a MDA, and uses the flight path vector and flight path angle reference cue displayed by the EFVS to monitor and maintain the desired vertical path and begins descent below the MDA:

(1) At the VDP, if charted, or a reasonably calculated visual descent point; or

(2) Using the descent angle published on the instrument approach procedure or if a descent angle is not published, a descent angle as high as suitable for that type of aircraft.

To clarify the FAA's intent as to which topographical features that an EFVS must detect and display, the FAA is amending proposed § 91.175 (m)(1) to state that an EFVS must be able to display topographical features of the airport environment. It is not the FAA's intent to require an EFVS to detect all obstacles while transiting the visual portion of the final approach segment.

IV.13. Weather-Related Comments

Comment: One commenter recommended that the FAA modify § 135.225 (b) and associated paragraphs to accommodate authorized operators using EFVS by allowing an approach to be initiated if reported weather minimums are lower than the minimums established for a specific EFVS. The commenter stated that reported visibility, measured by a transmissometer, is not a reliable indicator of EFVS performance at or below DH or MDA because it does not measure visibility in the same part of the electromagnetic spectrum as the EFVS. The commenter stated that this recommendation would increase the probability of a successful landing with operational and safety benefits.

FAA's Response: The FAA disagrees that modifying the reported visibility requirement for commencing the approach would increase safety. While the FAA agrees that the transmissometer does not operate in the same portion of the electromagnetic spectrum as the EFVS, its measurements are just as representative of the visibility conditions at/below 100 feet height above touchdown zone elevation as they are today. Even today, in conventional approaches, the reported visibility is not a totally reliable indicator of flight visibility at the DH or MDA, but is more representative close to the runway, where the pilot must use the visual references to complete the manual landing. This commenter's recommendations are outside the scope of the NPRM.

IV.14. Equipment-Related Weather Minimums

Comment: A commenter stated that the altitude criterion for EFVS is not based on the capability of the equipment and that specifying an absolute altitude as a minimum altitude for EFVS usage during approach and landing inhibits the incentive to advance optics technology to a level at which weather obscurations will be transparent to the EFVS. The commenter stated that by providing latitude for EFVS minimum altitude usage, the FAA could preclude additional changes to the regulation in the future or the need for imposing special conditions on equipment certification.

This commenter recommended that the minimum altitude for operation with an EFVS be predicated on the specific equipment installed and certified by the FAA (or approved by the FAA for foreign registered aircraft). The commenter proposed that the FAA change to § 91.175(l)(4) to say: ''At and below the minimum altitude at which the EFVS was certified or approved by the FAA, the * * *.''

Another commenter stated that once the performance limit for a particular EFVS is reached, the use of that particular EFVS is no longer approved for landing credits, and the requirements of § 91.175(c)(3) become applicable. As a result, § 91.175(l)(4) is no longer necessary.

FAA's response: The FAA disagrees with the commenter's premise that the transition to outside visual references at 100 feet above the touchdown zone elevation is an altitude criterion for EFVS. The rule does not establish an altitude criterion for use of EFVS, per se, nor does it establish a minimum use height, in the same sense that such limitations are placed on autopilots, for example. The purpose of the rule is to apply the same DH or MDA and visibility minima prescribed in the standard instrument approach procedure when EFVS is used (*i.e.*, EFVS does not reduce the minima), so it would be inconsistent to base an altitude criterion on the capability of a particular EFVS.

The FAA also disagrees with the comment that the rule establishes a performance limit for EFVS. Section 91.175(l)(4) requires that the pilot transition to the actual outside view by 100 feet above the touchdown zone elevation. The requirement is based on the operational need for the pilot to obtain visual contact (through the window) with the runway features to land, and is consistent with the time-tested operational concept of § 91.175(c)(3)(i). Section 91.175(l)(4) is necessary because it identifies the requirement for pilots using EFVS to make the transition to outside references by 100 feet above the touchdown zone elevation. While the commenter is correct that the references listed in (l)(4) are similar to those in listed in (c)(3), the focus of (l)(4) is on the transition to outside visual references that are especially needed for the manual landing (*e.g.*, runway threshold and touchdown zone).

The FAA recognizes that some enhanced flight vision systems may perform better than others. If, during certification, an EFVS is not found safe to use down to 100 feet above the touchdown zone elevation, then it will not be approved because it cannot perform its intended function.

IV.15. Operational Intent of the Rule

Comment: One commenter stated that in normal IFR operations, current § 91.175 requires that the pilot have clear and unobstructed visibility of the approach lights to continue below the DH or MDA. The NPRM seeks to augment the visibility requirement by permitting the use of a sensor-based imaging device in conjunction with a HUD to enhance the pilot's visibility down to the 100-foot level, at which altitude the existing visibility requirements of § 91.175 again become the operant rule, and the pilot must make the decision whether to go around or to land the airplane based on unassisted visual references only (not based on the EFVS imagery). According to this commenter, the proposed rule would apply primarily to ''fly down and take a look'' approach operations. In order to avoid controversy in application of the proposed rule, this commenter recommends that the FAA clarify the operational intent of the proposal, to include specific visibility.

FAA's response: The rule does not augment the visibility requirements of § 91.175(c), but instead provides an alternative requirement (*e.g.*, enhanced flight visibility) for operation below the DH or MDA. The use of EFVS does not alter the visibility requirements for commencing the approach. Today, part 121, 125, and 135 operators may not initiate an instrument approach procedure (§ 121.651(b), § 125.381(b), or § 135.225(b)) unless the reported visibility is equal to or more than the visibility minimums prescribed for that procedure. This requirement does not exist for part 91 operators, which implies that they may commence the approach when reported visibility is below minimums. In addition, EFVS does not affect the visibility or systems and pilot qualification requirements for Category II/III operations. By 100 feet above the touchdown zone elevation, the pilot must be able to see and identify visual references without reliance on EFVS. While use of EFVS during Category II and III operations may be permissible, such use must be specifically authorized as part of the operator's authorization for Category II and III approaches either by operations specifications for part 121, 125, or 135 operations or per § 91.189.

IV.16. Operational Benefits for Part 121, Part 125, and Part 135 Operations

Comment: Several commenters stated that there should not be any difference between part 91 and parts 121, 125, and 135 with respect to the requirements for commencing the approach with EFVS. Several commenters recommended that pilots operating under parts 121, 125, and 135 should be able to begin the approach based on having an EFVS regardless of the reported weather.

Another commenter proposed that, for part 121 and part 135, operations equipped with a certified EFVS be allowed to initiate the approach in weather conditions reported as low as 1,200 feet RVR or ¼ mile visibility.

Another commenter recommended deleting § 121.651(b) (requirements for commencing an approach) if the operator has a certified EFVS.

FAA's response: The FAA disagrees. The commenters' recommendations are outside the scope of the NPRM and would not provide for an adequate level of safety for operations conducted for compensation or hire for the following reasons. The proposal would undermine the current safety standards of not permitting a pilot to begin an instrument approach procedure if current weather reports are not available for the procedure or they report a below-authorized weather condition for operations conducted under parts 121, 125, or 135. These weather reports provide necessary safety information to pilots in addition to visibility information.

IV.17. Part 121, Part 135, and Part 129 Operations

Comment: One commenter stated that extending the NPRM text to parts 121, 135, and 129 would be potentially unsafe as written (*e.g.*, systems strictly meeting this rule could nonetheless lead pilots and aircraft into unsafe conditions), and are as yet operationally unsupported and unjustified. It would be most inappropriate to include specific EVS provisions in parts 121, 135, and 129 in the proposal at this time. Operational utility and safety of operations as implied by the NPRM, as well as legitimate ''proof of concept,'' are far from established at this point.

The commenter stated that part 129 operators, JAA, and other European representatives recently expressed concerns about such operations, particularly considering that those EVS operations are more appropriately termed Category II or III, than Category I.

FAA's response: The FAA disagrees that part 121, part 129, and part 135 operators cannot operate safely under this rule. This rule parallels the well-tested safe approach procedures of § 91.175(c). The commenter did not identify how these operations will be unsafe. The FAA did not receive any response from the JAA or European representatives regarding this rule.

IV.18. Operational Experience Before Credit for Lower Minimums

Comment: A commenter stated that, as with any new aircraft system, EFVS operational experience must be documented prior to further consideration for EFVS credit for lower minimums. Any EFVS operational limitation should be documented within the operator's AFM supplement.

FAA's response: The FAA does not believe that operational experience is necessary for an approved EFVS used in accordance with the rule because this rule does not provide for the use of EFVS to obtain credit for lower minima. The FAA agrees that any EFVS operating limitations found during certification should be stated in the AFM/RFM supplement.

IV.19. Takeoff Minimums for EFVS

Comment: Several commenters stated that proposed §§ 91.175, 121.651, 125.381, and 135.225 make no provisions for the enhanced vision flight vision system to be used to meet takeoff visibility requirements. Given that the system can be used to meet flight visibility requirements during approach, it follows that some credit should be able to be derived for takeoff operations below the established takeoff visibility.

FAA's response: The use of EFVS to meet takeoff visibility is beyond the scope of this rulemaking. This rule applies only to approach to straight-in landing operations below DH or MDA using an EFVS. The FAA did not propose the use of EFVS during takeoff.

IV.20. Rule Should Be an Advisory Circular (AC)

Comment: Several commenters asked why the FAA proceeded by rulemaking action instead of by AC. One commenter also stated that the NPRM could inappropriately set a precedent that rulemaking is required to implement new technology when rulemaking is not required.

FAA's response: The FAA is proceeding by rule instead of AC because this rule permits the use of new technology for straight-in approach landings by in essence creating an exception to the existing regulatory prohibitions in § 91.175(c)(2). An agency is required to conduct rulemaking when it considers changing an existing policy limitation in the rules. In this case, if an EFVS is approved by the FAA, meets all the requirements of § 91.175(m) and is determined to provide an equivalent level of safety, this operational rule will provide an alternative to the flight visibility requirement of § 91.175(c)(2) and allow the operator to descend below the DH or MDA if the requirements of § 91.175(l)(2) and (l)(3) are met.

IV.21. Terminology: Category I and Advisory Circulars

Comment: Several commenters stated that in accordance with the recently published AC 120–29A, ''Criteria for Approval of Category I and Category II Weather Minima for Approach,'' dated August 12, 2002, terminology for approach categories have been changed. A Category I approach is any approach that has a DH of not less than 200 feet AGL and a visibility requirement of not less than ½ statute mile. The reference to precision and nonprecision approaches is no longer applicable and the terminology has been redefined. These commenters believed that conforming to a common terminology, as presented in AC 120–29A, provides additional clarity in the regulation.

FAA Response: The FAA disagrees with the comment that the NPRM was not consistent with the intent and direction of AC 120–29A. That advisory circular discusses the terms for Category I approaches which includes nonprecision approaches, more specifically, an approach without vertical guidance. Although this definition for a Category I approach has been more commonly used in operations specifications for part 121, part 125, part 129 and part 135 operators, the FAA wants to make it clear that an EFVS could be used with a nonprecision approach for operators not using operations specifications.

AC 120–29A also mentions the generic term ''enhanced vision system'' (EVS). While this rule does not preclude the limited use of EFVS as described in AC 120–29A, it does permit an approved EFVS to be used to determine ''enhanced flight visibility'' which is a significant additional benefit for operators who were limited to using EFVS for the purposes described in the AC.

IV.22. Coordination Through TAOARC and AWO Process

Comment: Some commenters stated that the NPRM should not be issued in its current form and any subsequent revisions to the NPRM should be coordinated through both the All-Weather Operations (AWO)

harmonization process and the FAA TAOARC processes and be consistent with other related NPRMs (*e.g.*, RNAV, Docket No. FAA–2002–14002, and Special Operating Rules for the Conduct of Instrument Flight Rules (IFR) Area Navigation Systems (RNAV) in Alaska, Docket No. FAA–2003–14305).

FAA's response: The comments about the proposed changes in terminology for approach categories in the RNAV NPRM (Docket No. FAA–2002–14002) are not within the scope of the notice for this rulemaking and are not incorporated into this final rule. The Alaska Special Federal Aviation Regulation (SFAR) only addressed en route requirements for RNAV equipment and training and did not address RNAV instrument approach procedures.

The FAA disagrees with the comment that the current wording, especially definitions, of the NPRM and any subsequent revisions to the NPRM proposals should be coordinated through both the AWO harmonization and FAA TAOARC processes, and be consistent with the other noted NPRMs. This final rule action does not preclude persons from submitting recommendations concerning EFVS through their representatives on the AWO working group.

IV.23. EFVS Flight Path Performance

Comment: One commenter stated that the proposed requirements of the NPRM pose safety concerns. According to the commenter, representatives of European authorities, and others, correctly identify that some of the proposed operations with the above systems are, and should be appropriately classified and recognized as, Category II and Category III operations. Yet the proposed EFVS do not appear to come close to meeting the path performance standards necessary for safety for such operations. (*See* AC 120–28D, ''Criteria for Approval of Category III Weather Minima for Takeoff, Landing, and Rollout.'') The NPRM cited no evidence that adequate flight path performance can be demonstrated with imaging systems alone, whether TV, imaging radar (IR), or radar based. The commenter stated that current operating history with such systems in research and development programs and military operations indicates the opposite conclusion, which is why such operations often rely on use of autoland. Further, this commenter believed, there is no evidence presented in the NPRM that the ''aircraft state or guidance elements'' cited can perform to the levels necessary for either Category II or III, and particularly not for operations below 100 feet height above touchdown (HAT), flare, and rollout, or for missed approach, where such EVS systems are likely to lead a pilot without guidance assistance.

FAA's response: The FAA disagrees. The FAA believes the commenter misunderstood the purpose and applicability of the NPRM regarding the use of EFVS in the conduct of instrument approach procedures. This rule does not permit an operator to rely on an EFVS for category II or category III type approaches when an EFVS is relied upon for enhanced flight visibility pursuant to § 91.175(l). Use of the EFVS is an alternative means to comply with flight visibility requirements. To clarify any misunderstandings concerning the applicability of this rule, the FAA is adding language in the text of the rule in § 91.175(l)(1) to limit the application of this rule to straight-in instrument approach procedures other than category II and category III operations. Advisory Circular 120–28D and AC 120–29A both provide guidance for the criteria for approval of weather minima (Category I, II, III) and the use of enhanced vision systems (EVS). The guidance provided in the ACs describe the functionality of EVS to ensure the accuracy or integrity of other flight guidance or control systems in use during Category I, II, or III operations. The proposals in the NPRM described a new kind of functionality for EVS/EFVS.

EFVS can be used to enable pilots to determine ''enhanced flight visibility'' in lieu of ''flight visibility.'' Whether EFVS approved for determining ''enhanced flight visibility'' can also be approved for ensuring the accuracy or integrity of other flight guidance or control systems will depend upon whether the candidate system can be demonstrated to be acceptable to the FAA in a proof of concept evaluation as well as meeting the approval criteria in AC 120–28D or AC 120–29A.

IV.24. Inconsistency With Terminology in AC 120.28D or AC 120.29A

Comment: One commenter stated that the NPRM terminology presented an inappropriate use and meaning of Category I. Since the 1980s in operations specifications, and since 1999 in FAA criteria, this use of Category I terminology is incorrect and inappropriate. Since the 1980s, Category I applies not only to United States ILS, GLS, and other instrument approaches in operations specifications, but since 1999 has been additionally recognized in other appropriate FAA advisory circular criteria. Hence, the use of Category I and II terminology in the NPRM is incorrect and inappropriate and should be withdrawn. Accordingly, Category I, II and III definitions should be retained for U.S. use as currently described in FAA ACs 120–29A and 120–28D, and current operations specifications. If and when ICAO definitions for Category I, II, and III are updated through FAA/JAA AWO or other harmonization activities, or otherwise agreed in ICAO, the United States should consider further amendments of these terms. Hence, these provisions are much too technology-specific, misleading, and potentially unsafe as written (*e.g.*, systems strictly meeting this rule could nonetheless lead pilots and aircraft into unsafe Category II and III conditions) and are operationally unsupported and unjustified. Other commenters made similar statements.

FAA's response: The FAA disagrees with this comment for the reasons discussed in the response to the EFVS flight path performance comment. (*See* ''IV.23. EFVS flight path performance'' above.) In addition, the FAA disagrees that this final rule will potentially result in unsafe operations as written. The FAA believes that the use of EFVS will result in an equivalent level of safety for those operators who choose to equip their aircraft with that equipment. As with any aircraft system, to ensure the safety of operations in which EFVS is used, the operator must comply with the operating limitations specified in the Airplane or Rotorcraft Flight Manual and, for commercial operators, any conditions and limitations regarding its use are specified in the operator's operations specifications.

The rule will not lead pilots and aircraft into unsafe Category II or Category III conditions. The safety of the EFVS concept of operations, unlike the concept for Category II or Category III operations (*e.g.*, higher integrity, more rigorous guidance and navigation accuracy to achieve lower minima), is that EFVS provides an alternate means to satisfy the visibility requirements without reducing the visibility minima. The rule, following an operational concept analogous to that of § 91.175(c), requires the pilot to meet the prescribed visibility minima, based on ''enhanced flight visibility'' in lieu of ''flight visibility;'' to distinctly see and identify either (1) the runway threshold and the touchdown zone, or (2) the approach light system; and, by 100 feet above touchdown elevation to see the runway references needed for a manual landing without reliance on EFVS. Further, the rule does not relieve commercial operators from the visibility requirements for commencing the

approach. Based on these facts and the clarifying language added to § 91.175(l)(1), the FAA does not believe the rule will mislead a pilot into unsafe conditions.

IV.25. EFVS Use for Category II & Category III Approaches

Comment: Several commenters recommended that EFVS be used for Category II and III approaches, which the proposed rule did not seem to permit. The EFVS use should be permitted for situational awareness and for visual approach conditions as well as for Category I, II, and III approach conditions. This should apply to autoland and to hand-flown approaches.

Commenters recommended that the FAA:

- Clarify the intended usage of a certified EFVS during a Category II or III approach.
- Allow the EFVS to be operated during a Category II or III approach.
- Clarify what is meant by ''the stringent reliability, redundancy and other criteria that would be applicable for use of EFVS for Category II and III approaches'' as stated in the EFVS NPRM.

Another commenter proposed that the rule state: ''Any approach using EFVS will de facto be equivalent to a CAT2+ type of approach, as there is no more flight visibility requirements and EFVS can be used down to 100 ft.'' The commenter stated that in order to be consistent with current rules and to ensure a correct level of safety, approaches conducted with EFVS systems should offer a sufficient safety level and architecture compatible with current Category II rules. The commenter stated that EFVS software design assurance levels should be the same as for equipment used to support Category II and Category III operations. Therefore, the commenter stated, EFVS-based operations should require that: (1) The aircraft is equipped with at least 2 DO–178B Level B qualified ILS receivers, with comparison monitors; (2) ILS or MLS ground transmitters used during an EFVS approach should comply with Category II safety level; and (3) EFVS sensor imaging process should ensure that no picture lockup can happen. EFVS sensor image processing software should be at least DO–178B level C qualified.

FAA's response: The final rule does not permit an operator to rely on an EFVS for Category II and III approach procedures, and the final rule does not change the requirements for Category II and III operations. Any future proposed use of EFVS for Category II and III operations must comply with current regulatory requirements found in §§ 61.67 and 61.68, 91.189 through 91.193, 121.651(d)(3), 121.567, 125.325 or 135.78 that Category II and Category III operations must be authorized by the Administrator. Advisory Circulars AC 120.29A and AC 120.28D provide guidance concerning the stringent reliability, redundancy and other criteria for equipment used in Category II and Category III operations.

Proposed revisions to § 91.175(l) do not have provisions for Category II and III operations because that section only applies to straight-in approach operations, *i.e.,* approaches with a DH or MDA no less than 200 feet HAT. The NPRM did not intend to unconditionally prohibit the use of EFVS during Category II and Category III approaches. If EFVS is used during Category II or Category III operations, it is only in addition to the other required equipment, procedures, crew qualifications and so on, provided that the EFVS does not interfere or degrade the low visibility operation. The requirements and criteria for the equipment, procedures, training, maintenance, and airport features to be used for Category II and Category III approaches are well established and must still be complied with, regardless of EFVS. The use of EFVS in Category II or III operations, unlike its use for operations under § 91.175(l), does not result in operational credit (*e.g.,* a pilot using an EFVS on a Category II or III operation cannot fly lower than a pilot not using an EFVS in a Category II or III operation.)

The operational approval that permits an operator to conduct Category II and/or Category III approach operations must include specific provisions for the use of EFVS during such operations. EFVS must first be demonstrated to be suitable during such operations. Airborne systems used for Category II and III operations were first certified to comply with airworthiness criteria found in AC 120–28D or AC 120–29A, as applicable. EFVS changes the installed configuration of those airborne systems, and there should be airworthiness demonstrations to show that the new system configuration still complies with the applicable criteria. The FAA anticipates that there will be visibility conditions where ''flight visibility,'' but not ''enhanced flight visibility,'' is lower than the prescribed approach minima. It is important to recognize the differences between a Category II approach and an instrument approach using an EFVS under § 91.175(l), even when flown in such conditions. Category II approaches require a runway facility that satisfies the Type II criteria found in ICAO Annex 10. The Category II instrument approach procedure specifies decision height and visibility minima that are less than for a Category I ILS approach to the same runway. The airborne equipment must meet specific performance and integrity criteria outlined in AC120–29A and its Appendix 3.

Essentially, Category II and Category III operations depend on improved flight path performance and integrity as mitigation for lower visibility conditions. Instrument approach procedures other than Category II or Category III that are based on compliance with § 91.175 (l) and (m), use EFVS as an alternative means that would allow the use of an EFVS to determine enhanced flight visibility and would permit the descent and operation below the DH. The Category I ILS instrument approach procedure, which specifies a decision height and minimum visibility, is not changed when using EFVS in compliance with the rule change proposed in the NPRM. Essentially, the rule permits descent based on ''enhanced flight visibility'' rather than ''flight visibility'' being no less than the visibility prescribed in the instrument approach procedure. The FAA disagrees that an approach using EFVS is the *de facto* equivalent of a Category II or Category III approach.

Advisory Circular guidance for certification of EFVS, and perhaps even a technical standard order (TSO), might be issued in future. In the mean time, issue papers and special conditions may be used to certify EFVS based on its ability to perform its intended function and the required characteristics as specified in the rule, a system safety assessment, and existing certification criteria for software, programmed logic devices, head-up displays, and other criteria, as applicable to the EFVS design. In addition to criteria contained in issue papers from previous certifications, industry documents, such as Society of Automotive Engineers (SAE) Aerospace Standard (AS) 8055 and Aerospace Recommended Practices (ARP) 5288, provide a useful starting point for guidance material.

The FAA will consider the commenter's proposed minimum software design assurance level A for certain EFVS functions during the certification process. The FAA requires a system safety analysis, including a functional hazard assessment that will provide a basis for the design assurance levels of software-based functions, in accordance with well-established certification processes. As many commenters stated, part 91 is not the

place for certification requirements. The FAA limits its list of required features and characteristics of EFVS in § 91.175 (m) to the minimum needed to satisfy operational requirements.

IV.26. Compliance With § 91.1039

Comment: A commenter states that it has a strong interest in the NPRM's applicability to § 91.1039 IFR takeoff, approach, and landing minimums, under ''Subpart K—Fractional Ownership Operations'' as proposed on July 18, 2001 (66 FR 37520). This commenter believed that the community regulated under that proposed subpart K would achieve significant safety benefits and operational efficiencies given access to the full use of EFVS.

FAA's response: The FAA agrees. The amendment to § 91.175 applies to operators conducting operations under part 91 subpart K (*see* final rule at 68 FR 54568). The requirements in § 91.1039 will supplement those in § 91.175.

IV.27. Definitions—Italics and Capitalization

Comment: One commenter requested clarification of the italics and capitalization in the definition of EFVS.

FAA's response: The definition of EFVS contains no italics or capitalization, except for the title. The title was italicized in the same format as all part 1 definitions.

IV.28. Definitions—Scope of Enhanced Flight Vision Systems

Comment: One commenter recommended broadening the definition of EFVS and stated the definition of enhanced flight visibility is unjustified and inappropriate. Also, the commenter said that it unfairly targets or favors one technology and without more operating experience could be unsafe.

FAA's response: The FAA disagrees with this comment because the intent of this rule is to provide a basis for the use of imaging sensor technologies that can provide a real time display of the external scene. The FAA will ensure the safety of an EFVS system during the certification process.

IV.29. Definitions—Examples of Enhanced Flight Vision Systems

Comment: A commenter recommended deleting examples of EFVS technology listed in the definition of EFVS, because including those examples would inhibit the development of new technologies due to a lack of regulation and future certification guidelines.

FAA's response: The FAA disagrees with this comment. Simply listing examples of current EFVS technology in the definition of EFVS does not preclude the use of other EFVS technologies.

IV.30. Definitions—Enhanced Vision Systems

Comment: Several commenters suggested using the term enhanced vision system (EVS) instead of EFVS because EVS is an industry-recognized term.

FAA's response: The FAA considered the terminology to be used for EFVS, including alternatives such as the commonly used ''enhanced vision system.'' There are a variety of systems labeled EVS and a number of EVS definitions which the FAA believes could be confused with the system definition and operational concept found in § 91.175 (l) and (m). The FAA needed to define the term ''enhanced flight visibility'' and the system that provides it, so it was logical to label that system with a name that built on enhanced flight visibility; hence ''enhanced flight vision system.'' To be clear that not all systems now called EVS would necessarily be capable of supporting compliance with § 91.175 (l) and (m), the FAA will continue to use the term EFVS.

IV.31. Definitions—Topography and Enhanced Flight Vision Systems

Comment: Another commenter recommended removing the term topography from the definition of EFVS.

FAA's response: The FAA disagrees with this comment. The term topography was included in the definition of EFVS to be clear that the system would display objects on the ground and landscape.

IV.32. Synthetic Vision Systems

Comment: Several commenters suggested changing the definition of synthetic vision. One commenter asked that the FAA begin to identify the enabling benefits of lower-cost computer-generated SVS for use in smaller general aviation airplanes, and to ensure that SVS operational capabilities occur in concert with the development of SVS equipment.

FAA's response: As stated in the NPRM, synthetic vision system is defined to distinguish it from enhanced flight vision system; this rulemaking applies only to enhanced flight vision system. The FAA did not propose the situation where SVS might be authorized in the future.

IV.33. Enhanced Ground Visibility Systems

Comment: One commenter suggested adding the term ''enhanced ground visibility.'' The commenter proposed defining enhanced ground visibility as the average forward horizontal distance, from the cockpit of an aircraft on the ground, at which prominent topographical objects or buildings may be clearly distinguished and identified by day or night by a pilot using an EFVS.

FAA's response: The FAA disagrees because this is not within the scope of this rulemaking.

IV.34. Straight-in Approaches

Comment: One commenter stated that the NPRM would allow EVS to be used on all straight-in approaches. These are allowed to be up to ±30 degrees to the runway centerline. TERPS allow the angular intercept to be displaced from the threshold for Category I approaches. The vast majority of HUD visual systems have only ±15 degrees of visual (30 degrees total) of display capability. EVS as defined in the NPRM may not be capable of even imaging or displaying the runway environment of many ''straight-in'' approaches.

FAA's response: The rule is not limiting or predicated upon the field-of-view from a specific system. The rule simply states that if the pilot can see the required visual references at the DH or MDA using the EFVS, then he or she can continue the approach. If the field-of-view on the proposed system is limiting, the pilot would not be able to see the required visual references and could not continue the approach below the DH or MDA.

IV.35. Flight Visibility or Enhanced Flight Visibility

Comment: A commenter noted that the NPRM would require that the pilot must deliberately choose which, differing rule—§ 91.175(c) or § 91.175(l)—he or she will use to conduct an approach. This imposes upon each general aviation or commercial/transport pilot the need to mentally maintain the differences between two highly similar rules on an approach-by-approach basis. Further, the rules do not specify if the pilot is free to switch between the requirements of the two differing rules during the approach to his best advantage or if he must choose a rule set before the approach and then stick with it regardless of the advantage to switching to the other rule set.

FAA's response: This rule was written to parallel existing § 91.175(c),

therefore, for a pilot to gain the benefit of using an EFVS, he or she must know and comply with the different, but parallel requirements of § 91.175(l). If a pilot begins an approach using a certified EFVS and the visual references using natural vision become more prominent, the pilot may continue the approach by satisfying the requirements of § 91.175(c).

Conversely, if a pilot begins an approach using natural vision, and the visual references using natural vision appear less prominent, the pilot may continue the approach by satisfying the requirements of § 91.175(l).

IV.36. Reduced Approach Minima

Comment: One commenter proposed an alternative revision of § 91.175 and claimed that it updates certain outdated provisions and provides a basis for approval of future system or capabilities that can be shown to provide equivalent or better performance than currently acceptable systems or procedures. The commenter noted that the successful provisions of § 91.175 were developed, used, and improved over many years to achieve a high level of safety when operating an aircraft during reduced visibility conditions. Additionally, the commenter stated that current rules related to instrument approach procedures implicitly allow (*e.g.*, by use of Administrator authorizations under § 91.175(a) or provisions such as § 121.567 operations specifications) for the use of new technologies such as enhanced flight vision systems, required navigation performance, certain forms of GPS-related augmentation, or visual reference enhancing sensors, without having to directly address a specific performance standard for such authorizations.

FAA's response: The FAA disagrees with the commenter's proposed rule amendment and believes it would be incorrect to predicate authorization for EFVS to be used in lieu of the current provisions of § 91.175(c) based solely on the limited authority stated in § 91.175(a) for the Administrator to authorize instrument approach procedures other than those prescribed in part 97. The FAA believes it is more appropriate and more helpful to the public to publish the amended rule because it more clearly describes the requirements for operations using the EFVS to achieve an equivalent level of safety to the provisions of § 91.175(c).

IV.37. Natural Vision

Comment: One commenter questioned the validity of comparisons, stated in the NPRM, of EFVS imagery to natural vision for satisfying the visual requirements for continuing the approach. In particular, the commenter asked why the visual references as viewed in the EFVS imagery (using an imaging sensor operating in either infrared (IR) sensor or millimeter (mm) wave parts of the electromagnetic spectrum) may be any less natural if displayed to the pilot in the visual part of the spectrum.

FAA's response: The FAA believes the comparisons of EFVS imagery and natural vision to be valid rationale for publishing the amended rule. Section 91.175(l) provides an option to use EFVS to satisfy visual requirements for the approach that are analogous to the time-tested provisions of § 91.175(c), and thereby makes operational benefits available to those who wish to equip with an EFVS.

IV.38. AC 120–29A

Comment: Another commenter noted that AC 120–29A, section 4.3.4.4(b), Specified Visual Reference, provides some credit to HUD synthetic symbology as supplemental information to external red lights. The commenter suggested that in the future, when the combination of a HUD and EFVS will be certified as an airborne equipment, it may be that some other supplemental aids will be identified, and that criteria to establish practicable minima (*i.e.*, visibility prescribed) will have to be defined.

FAA's response: AC 120–29A, paragraph 4.3.4.4, describes concepts upon which FAA Order 8400.13a, Procedures for the Approval of Category II Operations and Lower Than Standard Category I Operations on Type I Facilities, is founded for approving Category I ILS operations with lower than standard minima and Category II operations at Type I facilities. Unlike the provisions of the amended rule, authorizations based on FAA Order 8400.13a require, as a prerequisite, flight crew members and installed airborne systems that are approved and authorized for Category III operations. Unlike operations authorized per FAA Order 8400.13a, operations conducted under provisions of the amended rule do not reduce the approach minima.

IV.39. Runway Environment as a Visual Reference

Comment: One commenter asked if the pilot can descend below basic minimums (usually 200 feet) on a Category I glide slope beam, using runway-environment cues obtained solely from the EFVS.

FAA's response: If the visual references of § 91.175(l)(3), the approach light system (if installed) or the runway threshold and the touchdown zone of the intended runway, are distinctly visible and identifiable to the pilot at the DH or MDA using an EFVS, the pilot can continue the descent to an altitude of 100 feet above the touchdown zone elevation. The pilot must then see, using natural vision, the required visual references of § 91.175(l)(4) that identify the runway environment without reliance upon the EFVS to land the aircraft.

IV.40. Barometric Altitude

Comment: One commenter stated that no criteria are given on an acceptable means to determine the altitude at 100 feet above the touchdown zone elevation. Radar altitude may be inappropriate since there are no controls on terrain prior to the runway threshold for nonprecision approaches and not appropriate controls for Category I ILS approaches.

FAA's response: The pilot may use the barometric altimeter to determine when the airplane has reached 100 feet above the touchdown zone elevation of the runway of intended landing.

IV.41. Reliance on EFVS

Comment: A commenter requested clarification of the words ''without reliance on the EFVS'' as stated in § 97.175(l)(4). Would this require turning off the EFVS?

FAA's response: The rule does not require the EFVS to be ''turned off.'' The HUD/EFVS displays aircraft performance and navigation information, while the normal visual cues are being enhanced for increased situational awareness and safety. However, the pilot cannot rely on the EFVS to display the required visual references in § 91.175(l)(4), once the pilot descends below 100 feet above the touchdown zone elevation.

IV.42. Touchdown Zone Determination

Comment: One commenter stated that EFVS as defined by the rule is not capable of allowing part 121 and part 135 operators to make the determination to touchdown within the touchdown zone of the runway of intended landing. HUD-style inertial flight path vector symbology can be utilized to determine where current descent rates are taking the aircraft, but they require that the EVS sensor provide indications as to the beginning and end of the touchdown zone.

FAA's response: As is true today, parts 121 and 135 operators must manage the descent rate so that the touchdown will occur within the touchdown zone of the runway of intended landing. The FAA believes

that an EFVS can provide sufficient imagery so that the pilot can define the touchdown zone. If the pilot does not have sufficient required visual cues either with the EFVS display or looking out of the window to satisfy this requirement, then a missed approach must be executed.

IV.43. Training

IV.43.a. AFM & RFM Limitations

Comment: One commenter asked the FAA to consider removing the reference in § 91.175(l)(5)(iii) to compliance with the AFM and RFM limitations section, because it is redundant to an existing rule. Section 91.9 already requires that a pilot comply with the operating limitations specified in the AFM or RFM. Restating it here might cause part 121, part 125, and part 135 operators, listed in § 91.175(l)(5)(i), to think they do not have to comply with the AFM limitations.

FAA's response: The FAA agrees and has changed § 91.175(l)(5)(iii) to delete references to the AFM and RFM. The additional requirements of parts 121, 125 and 135 are addressed in each of those respective parts and are mandated in the operator's operations specifications. The operators, once certified, are required to comply with the provisions of the operations specifications and all approved or accepted training and/or checking programs. The operator is responsible for the training and checking of each pilot using the EFVS if authorized under the pertinent and applicable parts of the Code of Federal Regulations. Operations conducted under part 91 do not require training or checking on the EFVS, although pilots who operate EFVS equipped aircraft are potentially subject to being checked on such EFVS equipment during currency and proficiency checks of part 61.

IV.43.b. No Additional Training

Comment: A commenter noted that no additional training for the use of EFVS should be required under part 61 for general aviation pilots operating under part 91.

FAA's response: FAA agrees that a specific training requirement for the use of EFVS for part 91 operators does not need to be added to the rule. However, a Flight Standardization Board (FSB) did evaluate one system and determined that additional crew training was required, documented the required training in the FSB report and all pilots operating aircraft subject to that FSB report with the FAA evaluated EFVS system will have an operating limitation in the AFM requiring pilot training.

IV.43.c. Additional Training and Proficiency

Comment: One commenter stated that the rule does not address part 61 as far as pilot training requirements, but does address parts 121, 125, and 135 and states that operations under 91 would be authorized. The rule requires pilots to be proficient and qualified in accordance with part 61. Part 61 covers basic instrument qualifications under § 61.57 and an additional requirement for Category II operations under § 61.67. The commenter suggested that additional training and proficiency requirements for operations (involving) EFVS should be established to ensure the same level of safety as for Category II operations, since this new technology is going to allow pilots to operate at lower than normal minimums.

FAA's response: The FAA believes that pilot training requirements for applicants under the Airline Transport Pilot and Aircraft Type Rating, Practical Test Standards for Airplane and Airline Transport Pilot and Aircraft Type Rating, Practical Test Standards for Helicopter should remain pilot certificate specific. Pilots obtaining certificates under the provisions of part 61 are subject to testing and proficiency checks under § 61.58, may need to obtain training in order to pass the check on all of the installed equipment on an aircraft, and must, at the least, demonstrate proficiency in the use of the installed equipment to the same standards required for the original issuance of the certificate. Also, all pilots who conduct operations under part 91 must meet the currency requirement of § 61.56, which may include the aircraft and equipment. The FAA is not proposing to modify the existing pilot requirements of part 61.

The FAA disagrees with the commenter's reasoning that additional training and proficiency requirements are necessary for EFVS operations because the new technology will enable pilots to operate at lower than normal minimums. The use of EFVS does not reduce approach minimums; EFVS is an alternate to the requirements of § 91.175(c).

Part 61 does not require training prior to authorizing Category II/III operations or other procedures beyond the initial pilot certification process. Nor does the FAA believe that it is appropriate to mandate training requirements beyond that of the initial certification process or flight review process for operators under part 91 conducting standard instrument approach procedures.

IV.43.d. Crew Training

Comment: One commenter stated that due to the specifics of interpreting an IR image, crew training will be an important issue and needs to be carefully addressed. The commenter comments that specific simulation models need to be defined as they exist for Category III HUD landing system qualifications, and that typical and worst case situations must be defined for simulator use (windshear, crosswind, visibility, obstructions, *etc.*) in order to ensure that the crew can reach an acceptable proficiency level with the system. Crew qualification should be based on performance obtained in the simulator.

FAA's response: The FAA disagrees with limiting crew training to the simulator. Holders of air carrier certificates and commercial operator's certificates are held to higher standards and are therefore required to provide FAA-approved training programs developed for the type of operation to be conducted. Such programs, whether training or checking and testing, may take advantage of any appropriate FSB Report issued.

While the FSB Report is not regulatory in nature it provides the FAA principal inspector with guidance as to the proper content, duration, and intent of any training program submitted for approval or acceptance in accordance with the operating rule. In addition, facilities that provide training on behalf of manufacturers rely on recommended training such as an FSB Report when developing training and checking programs for their customers.

IV.44. Requirements for the Airplane Flight Manual (AFM)

Comment: One commenter stated that the operational limitations for an EFVS should be included in the AFM and not included in a rule.

FAA's response: The FAA agrees with the commenter that some operating limitations, in addition to those specified in this final rule, may be placed in an AFM or RFM, depending on the certification evaluation of a particular applicant's EFVS. The FAA disagrees that all operating limitations should be specified in the AFM or RFM.

IV.45. Air Carrier Operations Specifications Requirements

Comment: One commenter stated that the NPRM includes a proposed requirement to obtain operations specifications authorization for air carriers (proposed § 91.175(l)(6)). Operations specifications approval is always required for decreased

minimums, but EFVS does not change the minimums. The EFVS allows the pilot to visually acquire the cues specified in § 91.175 to descend below DH, but does not affect the minimums given on the approach procedure. Therefore, operations specifications approval should not be required. The requirement for operations specifications approval adds an unwarranted financial burden on the operator, and may take a very long time to achieve because most principal operations inspectors do not have the background knowledge to make this evaluation. The FAA certification pilots and engineers are required to accomplish extensive testing to validate the EFVS. The commenter considers that there is no reason to require an additional approval, beyond that achieved by STC.

FAA's response: The FAA agrees that use of EFVS does not change the instrument approach minima. However, the FAA believes that § 91.175(l)(6) should not be revised to incorporate the commenter's recommendation. Part 119 and part 125 certificate holders and part 129 operations specifications holders that use a HUD today for the conduct of instrument approach procedures require authorization in their operations specifications. This authorization includes training on the equipment and procedures to fly instrument approach procedures. Likewise, the EFVS, which also includes a HUD, will require training in the use of a HUD symbology and procedures developed by the operator for the specific equipment being used. The FAA also does not agree that this is an unwarranted financial burden on the operator or that principal inspectors will not have the background or knowledge to evaluate the air carrier's program. Principal inspectors routinely authorize operations that require a HUD and in fact work directly with the operator to develop these programs and procedures. To assist the principal inspectors, the FAA will provide handbook guidance.

IV.46. Foreign Aircraft Certification

Comment: One commenter states that the proposed rule violated existing bilateral agreements, and precludes the possibility of the FAA ever accepting an EFVS approval by another authority through the bilateral process without additional rulemaking. Another commenter stated that this proposed rulemaking seems to introduce discrimination towards non-U.S. manufacturers.

FAA's response: The intent of the rule, referenced in § 91.175(l)(7), was to be fully consistent with the provisions of existing bilateral agreements for aircraft certification. Under such an agreement, a non-U.S. aviation authority may, on behalf of the FAA, find compliance to FAA certification requirements. The FAA would validate such findings and issue a U.S. type certificate (*i.e.*, type certificate, amended type certificate, or supplemental type certificate, as applicable). U.S. type certificates would be available for installation of non-U.S. manufactured EFVS, just as they are for installation of other types of equipment today, whether manufactured in the U.S. or not.

The FAA revises the language in § 91.175(l)(7) to clarify that the FAA does not discriminate against foreign operators or non-U.S. manufacturers.

IV.47. Equipment Requirements for Subpart C

Comment: One commenter stated that the proposed rulemaking did not clearly define equipment requirements, and that there was no proposed rulemaking regarding EFVS in subpart C of part 91. The commenter asked the FAA to clarify EFVS equipment requirements and establish an EFVS TSO that clarifies the design requirements for enhanced flight vision sensors or equipment, excluding the HUD.

FAA's response: The FAA disagrees that a requirement for EFVS equipment should be added to part 91 subpart C. The rule allows for the use of an EFVS to determine ''enhanced flight visibility'' in lieu of ''flight visibility.'' An EFVS is not required equipment, except for those operators choosing to use this alternative method of operation below DH or MDA.

Advisory Circular guidance for certification of EFVS, and perhaps even a TSO, might be issued in the future. In the meantime issue papers and special conditions may be used to certify EFVS based on its ability to perform its intended function and the required characteristics as specified in the rule, a system safety assessment, and existing certification criteria for software, programmed logic devices, head-up displays, and other criteria, as applicable to the EFVS design. In addition to criteria contained in issue papers from previous certifications, industry documents, such as Society of Automotive Engineers (SAE) Aerospace Standard (AS) 8055 and Aerospace Recommended Practices (ARP) 5288 provide a useful starting point.

IV.48. Clarification on Maneuvering

Comment: A commenter requested that the FAA clarify the meaning of the phrase ''which is suitable for maneuvering the aircraft'' as stated in § 91.175(l)(7).

FAA's response: The FAA means that the EFVS display, because it is being used as the pilot's primary flight reference during the approach, at least down to 100 feet above the touchdown zone elevation, needs to provide effective visual feedback to the pilot for manual control of the airplane. In particular, the alignment and motion of the EFVS imagery, attitude and guidance symbology must faithfully represent airplane motions, without significant jitter, jerkiness, or latency (*i.e.*, display lag, slow update rate) that would adversely affect the pilot's ability to manually control the airplane with satisfactory precision, stability and workload. In addition to EFVS display dynamics, many other factors such as field of view, control of display luminance, clutter, and display blooming could significantly degrade pilot performance and workload while manually controlling the airplane in the approach.

IV.49. Certification of an EFVS

Comment: Several commenters noted that the EFVS features and characteristics specified in the proposed § 91.175(m) were certification requirements, not operational requirements, and should be deleted from the rule and moved to parts 23 and 25 and/or associated advisory material. Another commenter said that the specified characteristics are not quantified and lack detail without reference to a Minimum Operational Performance Specification (MOPS) or some other technical standard. Certification requirements, processes, and regulations need to be developed and issued expeditiously.

FAA's Response: The FAA believes that in order to safely and effectively perform approach operations under the provisions of § 91.175(l), there are certain essential characteristics and features that must comprise the EFVS. Therefore, the FAA believes this list specified in paragraph (m) constitute operational requirements. The items in this list were deliberately stated in general terms, well enough to capture the essential requirements but without over-specifying the system design to permit as much design flexibility as possible.

The operationally essential features of the EFVS are that the image and spatially referenced flight symbology is displayed so that they are aligned with and scaled to the external view (conformally) on a HUD with essential flight instrument information. The image must be conformal because it

provides an alternative, enhanced forward view that could be used in lieu of flight visibility to meet the prescribed visibility requirements.

The imagery must be displayed on a HUD because the FAA believes that the safety of an approach operation conducted under § 91.175(l) depends on the pilot looking forward along the flight path (*i.e.*, looking at and through the imagery to the out-of-the window view) to readily enable a transition from reliance on the EFVS imagery above 100 feet height above the touchdown zone elevation to reliance on the out-the-window view without reliance on EFVS. The FAA believes that if the pilot must scan up and down between a head down display of the image and the out-the-window view, then the transition would be hindered by the delay of repeatedly re-focusing from one view to the other.

The imagery must be displayed with essential flight instrument information because the FAA believes that once the EFVS is being relied on for descent and operation below DH, or MDA, it should become the de facto primary flight reference. The pilot requires continuous awareness of the flight information while using the EFVS imagery. This awareness would be unsatisfactorily degraded by repeated scanning from head up, to head down, and back.

IV.50. Performance-Based Advisory Materials

Comment: Several commenters said that an advisory circular or advisory material is needed to support the rule, but that the development of new advisory material need not delay adoption of a suitable enhanced vision system rule. Another commenter recommended the FAA begin work on an AC to establish airborne equipment certification standards, training, and AFM endorsements that ensure that the items referenced in § 91.175 are distinctly visible with the EVS.

Another commenter requested that the FAA draft specific EVS technical and system design language, along with suggested certification methodologies and place in appropriate advisory material.

Still another commenter saw advisory material as the means for certification through performance standards. This commenter noted that the proposed § 91.175(m)(1) of the rule, which addresses features and characteristics, states: ''An electronic means to provide a display of the forward external scene topography (natural or manmade features of a place or region especially in a way to show their relative positions and elevation) through the use of imaging sensors, such as a forward looking infrared, millimeter wave radiometry, millimeter wave radar, and low-light level image intensifying.'' Similar wording also appears in the EFVS definition in part 1. Neither the rule nor the definition should cite specific current-generation technology, but rather should reflect a performance or implementation requirement that can be further developed in advisory material. For example, the sensor-based imaging elements of the EFVS shall be appropriately located on the aircraft, shall employ a sensor technology appropriate to the intended function, and the combination of the sensor and HUD shall provide resolution and other system attributes coincident with the generation of a high-quality conformal image. Certification criteria for future EFVS should be the subject of an AC. As an example, the use of a HUD system is required in the proposed rule. The commenter believed this language may not stand the test of time and therefore requests that the language be changed to reflect the use of a display and symbology set certified for the intended function.

FAA's response: The FAA believes that § 91.175(l) and (m) provide operational requirements that are not specific to a particular technology design. The FAA agrees that advisory material for certification of EFVS will be useful, but not that such material should replace § 91.175(m), which specifies essential operational requirements for EFVS. At this time, until more experience is gained with the potential variations of EFVS designs, it is premature to establish such guidance. Until such guidance is available, issue papers and special conditions may be used to certify EFVS based on its ability to perform its intended function and required characteristics as specified in the rule, a system safety assessment, and existing certification criteria for software, programmed logic devices, head-up displays, and other criteria, as applicable to the EFVS design. In addition to criteria contained in issue papers from previous certifications, industry documents, such as Society of Automotive Engineers (SAE) Aerospace Standard (AS) 8055 and Aerospace Recommended Practices (ARP) 5288 provide a useful starting point. The FAA expects that a working committee of the Society of Automotive Engineers (SAE) or similar group will undertake further efforts to develop industry certification standards for EFVS that could support EFVS advisory material.

The FAA believes it is necessary to include § 91.175(m) in the rule because the alternative means outlined in § 91.175(l) for descent and operation below DH or MDA requires an EFVS with such features and characteristics. Other technology solutions for conducting low visibility approach and landing operations, such as SVS, would require a different operational.

IV.51. Display Comments

IV.51.a. Head-Up or Head-Down Displays

Comment: There were several comments stating that the FAA should allow both a head-up display or a head-down display for EFVS in paragraph (m) and should permit alternate display locations. One commenter suggested revising paragraph (m)(2) to say, ''The EFVS sensor imagery and aircraft flight symbology (*i.e.*, at least airspeed, vertical speed, aircraft attitude, heading, altitude) are presented on head-up display or other certified display within the pilot's primary field of view and clearly visible to the pilot flying in his or her normal position and line of vision and looking forward along the flight path.'' This commenter also stated that when transitioning from ''enhanced flight visibility'' to ''flight visibility'' the pilot would only make a slight change in focus, very similar to the transition taking place when conducting currently regulated approaches down to low minimums.

FAA's response: The FAA disagrees with the recommendation to permit any certified head-down display for EFVS.

The rule requires that EFVS include a head-up display rather than the alternative of a head-down display because the pilot is conducting an instrument approach procedure in lower visibility conditions, but with no change in the prescribed instrument approach minima and must accomplish several visually-related judgments and control tasks in quick succession. While the regulatory requirements for the use of EFVS are analogous to the conventional requirements for descent and operation below DH or MDA, the pilot needs to use the imagery, the flight reference information, and eventually the outside view, at the same time. The pilot must be able to look for the outside visual references in the same location as they appear in the EFVS image and readily see them as soon as visibility conditions permit, without any delays or distraction due to multiple head-up/head-down transitions.

When scanning between the head-up and head-down views, it takes additional time for the pilot to reacquire the information in each view and for the pilot's eyes to readjust for differences in light level and changes in focus between

optical infinity and the distance to the instrument panel (on the order of 24 inches). Repeated scanning between the head-up and head-down views would be distracting, increase pilot workload and potentially degrade path performance during a critical phase of flight.

These effects are avoided by displaying the EFVS imagery and flight information on the HUD. Between the DH or MDA and 100 feet, the pilot will be able to look for the outside visual references in the same location as they appear in the EFVS image and readily see them as soon as visibility conditions permit, without any delays or distraction due to multiple head-up/head-down transitions and without interruption of the view of essential flight information.

IV.51.b. Head-Up Display

Comment: One commenter stated that HUD presentation and modern display symbols including flight path vector, reference flight path angle, and horizon marks (and ideally airspeed error and trend) have been repeatedly shown to dramatically decrease workload and increase landing accuracy when overlaying the actual runway environment.

FAA's response: The FAA agrees with the commenter that additional head-up display symbology should be required for the EFVS. Section 91.175(m)(2) is therefore amended to require a FPV and a flight path angle reference cue. Because this rulemaking has created an exception to the time-tested existing safety standards in § 91.175(c), it is within the scope of the notice to tighten the conditions for such an exception at the final rule stage when, as here, potential safety problems and solutions are identified by commenters. In other words, the exception language as originally proposed would not have required FPV as a condition for the EFVS to be used, adding FPV as a required feature narrows the proposed exception and thus is within the scope of the proposed exceptions.

IV.51.c. Guidance, Flight Path Vector (FPV), and Other Symbology

Comment: Several commenters stated that the rule should specifically require additional items of flight information, including the flight path, guidance, conformal flight path vector (FPV) and cues for energy state control.

One commenter stated that the rule is not clear about the need for guidance in the EFVS display and recommends that the rule be amended to include a requirement for flight director or some form of command guidance, conformal presentation of FPV, and cues for energy state control.

In a related comment, another person stated that the FAA should continue to require the use of HUD, that ILS guidance should also be displayed on the HUD, and that the EFVS should have a head-up guidance system, not just a HUD.

Similarly, other commenters stated that the FAA omitted the FPV, an important symbology cue, in its list of required features and characteristics of EFVS in paragraph (m). This symbology cue combines drift angle and flight path angle to show where the aircraft is actually going (also known as velocity vector) as opposed to where the nose is pointed (longitudinal axis).

FAA's response: The FAA agrees with the comments that the rule should be revised to require EFVS to display flight path (*i.e.*, the intended approach path as shown by lateral and vertical path deviation indications), command guidance, a conformal FPV, and a flight path angle reference cue. The FAA does not agree that the rule should be revised to mandate other suggested symbology cues, such as cues for energy state control, airspeed error and trend.

The FAA has revised the rule to require that the EFVS display lateral and vertical approach path deviation indications (*e.g.*, localizer, glideslope or course deviation indications (CDI)) and command guidance (*e.g.*, repeat display of head down flight director, or HUD unique command guidance cue) as appropriate for the kind of approach to be flown. The rule requires approach path deviations because they are essential to conduct the approach and the pilot must not be required to scan head down for the information. The rule requires command guidance because, when available and appropriate for the approach being flown, it reduces pilot workload, increases path tracking performance, and was found essential for ILS approaches during proof of concept evaluation of a previously certified enhanced vision system. For types of approaches without a vertical navigation aid, (*e.g.*, localizer-only, or VHF omni-range station (VOR)), neither vertical path deviation indications nor vertical guidance is required. The FAA believes that the addition of a FPV and a flight path angle reference cue provides effective tools to monitor and maintain a safe vertical path from the DH/MDA to the desired touchdown point on the runway. These changes are within the scope of the notice because in proposed § 91.175(m)(2) the FAA listed broad examples of the types of flight symbology that would be required for safety purposes. The items listed in § 91.175(m)(2) were intended to be the minimum flight symbology features on the HUD. The FAA is adding similar flight symbology requirements to the final rule. By adding these additional required features, the FAA is narrowing the circumstances under which an EFVS could be used as an exception to the existing standards in § 91.175(c).

The rule does not explicitly specify other flight symbology cues, such as those recommended by the commenters, because the FAA does not have sufficient data to mandate them unconditionally. Such cues have been essential features of previously approved HUD landing guidance systems, but the intended function of these systems (*e.g.*, Category III landings) is different from EFVS, which is used to satisfy § 91.175(l). Nevertheless, the FAA recognizes that such cues have been found to enhance pilot performance, reduce workload, and believes they might mitigate characteristics of EFVS imagery, compared to natural vision in visual meteorological conditions (VMC), that are significant for maneuvering the airplane. The FAA believes that the entire EFVS, which includes the image, flight information and graphic symbology, not just the imagery alone, must be suitable for maneuvering the airplane. The FAA will evaluate each EFVS, including the symbology cues, for its ability to satisfy the operational and safety objectives of the rule, including its suitability for maneuvering the airplane. Based on products already certified, the FAA anticipates that most, if not all EFVS designs would include such features anyway.

IV.51.d. EFVS for Situational Awareness

Comment: One commenter stated that the FAA should not preclude the use of EFVS for situational awareness.

FAA's response: This rule addresses only EFVS used to permit descent and operation below the DH or MDA, when flight visibility minima are not met.

IV.51.e. Design Eye Position

Comment: One commenter stated that a pilot's normal seating position may not coincide with the design eye point, the position at which the cockpit equipment was designed and certified. The commenter stated that the position from which the pilot views the EFVS HUD is critical to clearly seeing the EFVS imagery and flight symbology and recommended that § 91.175(m)(2) be revised to read: ''The EFVS sensor imagery and aircraft flight symbology (*i.e.,* at least airspeed, vertical speed, aircraft attitude, heading, altitude) are presented on a head-up display so that

they are clearly visible to the pilot viewing from the design eye position and looking forward along the flight path.''

FAA's response: The FAA agrees with the commenter that the position from which the pilot views the EFVS HUD is significant. The most significant effect of a displacement from design eye position is that some displayed information may not be visible to the pilot. For certification of head-up displays, the FAA uses criteria described in AC 25.773–1 (Pilot compartment view design considerations) and an FAA issue paper titled ''Head-up display (HUD) installation, system design policy and guidance,'' which will also be applied to EFVS, that concerns variations of the pilot's viewpoint that constitute what has been called the ''head motion box.'' This head motion box has minimum dimensions in three axes and when the pilot's eyes view the HUD while located in this volume, all essential information must be visible in the HUD. The FAA agrees with the intent of the commenter's recommendation, but believes that the recommended revision is not necessary, because current HUD certification criteria will be applied to EFVS and if the essential information is not clearly visible from the design eye point, the EFVS could not perform its intended function.

IV.51.f. Display Conformality and Parallax Errors

Comment: One commenter noted that there is no requirement in § 91.175 (m) regarding where the EFVS sensor is installed on the airplane. The commenter stated that it is of the utmost importance that EFVS imagery is displayed conformally with the outside view and that parallax error must be very small, as it is with currently-certified HUD guidance systems. The commenter recommended that the FAA revise the rule to add a requirement that the EFVS sensor be installed in a location such that the image is conformal to the outside view with no more than 4 milliradians (mrad) of parallax error.

FAA's response: The FAA agrees with the commenter that the EFVS HUD display must be conformal and that excessive parallax error, due to the displacement of the sensor location from the pilot's line of sight, would not be acceptable. Parallax is one error source that degrades conformality. In fact, all HUD's currently certified for approach and landing operations, with and without imagery, have this design feature. Therefore, the FAA revised § 91.175 (m)(2) to require that the EFVS imagery, attitude symbology, FPV and other cues referenced in the imagery and outside view must be presented aligned with, and scaled to, the external view. This change is within the scope of the rulemaking because an identified shortcoming in the draft exception (*i.e.,* § 91.175(l)), to the longstanding § 91.175(c) standard, is being corrected by narrowing the kinds of devices that would meet the exception criteria.

As the commenter stated, conformality of the image and any associated symbology means, that the angular orientation and scale match the external view. Objects visible both in the image and out the window would line up exactly when viewed by the pilot in the normal seated position (*i.e.*, at the design eye point). As the runway threshold, approach light system, and so forth come into view out the window, they would show up in the same location as they already appear in the EFVS image.

This operational rule will not quantitatively specify the maximum parallax (*i.e.*, alignment) error, because the error can vary with distance (*i.e.*, more angular error at short distances) and an acceptable limit may depend on the intended function. The amount of parallax error that is acceptable for an approach with a transition to outside visual cues no lower than 100 feet above the touchdown zone elevation might differ from what is needed for a landing system. Industry standards, for example Society of Automotive Engineers (SAE) Aerospace Standard AS8055 ''Minimum Performance Standards for Head-Up Display (HUD),'' contain different values than those recommended by the commenter.

During EFVS certification, the FAA will evaluate the display to determine that the display is sufficiently conformal to the outside view for its intended function, and that parallax error, if any, is not excessive or misleading to the pilot.

Some information displayed in the HUD is not ''spatially referenced'' and therefore does not need to be conformal. For example, airspeed, vertical speed, altitude and some other data can be shown in a variety of non-conformal formats, such as linear tapes and round dials. Both conformal and non-conformal heading formats have been found acceptable.

IV.51.g. Power System for an EFVS

Comment: One commenter stated that in case of a single failure between 200 feet and l00 feet (engine or generator), a total loss of enhanced vision would occur while the pilot most needs the EFVS to maintain clearance with obstacles and to maintain runway alignment. The commenter proposed that the rule should specify that the EFVS design would guarantee the segregation between EFVS failures and failures affecting aircraft path control and performance (ILS and HUD should not be powered by the same electrical source as the EFVS for instance).

FAA's response: The FAA disagrees that this requirement should be added to the operational rule. In cases where the EFVS fails between the decision height and 100 feet above the touchdown zone elevation, the rule, § 91.175(e), requires that a missed approach be executed if the requirements of (c) or (l) are not met. However, airworthiness certification requirements for EFVS system architecture, redundancy and independence of power supplies may result from compliance with the system safety requirements (*e.g.*, § 23.1309, § 25.1309, *etc.*).

IV.51.h. Independent Displays

Comment: One commenter requested clarification as to whether the HUD must be independent of the head-down primary instruments.

FAA's response: Flight information (*e.g.*, airspeed, altitude, direction, attitude, path deviation) displayed on a pilot's EFVS HUD does not need to be independent from the flight information displayed on the pilot's head down primary flight references. Based on past experience with HUD's approved as flight display for Category II and Category III approach operations, this independence is not necessary. However, as the certification rules require, the pilot's and co-pilot's displays of flight information must be independent.

IV.52. Comments on Economic Evaluation

Comment: A commenter stated that the NPRM could create significant unnecessary cost obstacles for both operators and manufacturers in the United States by inappropriately and unfairly favoring technology that is not mature, may not work, and may not be safe, compared with other proven technologies. This situation has significant indirect competitive costs, design costs, liability costs, and aircraft operating penalty costs, which are not addressed by the NPRM.

FAA's response: The FAA disagrees. Because the rule is optional, the FAA believes that the available technology should be allowed, especially when it can enhance safety during low visibility conditions. The FAA disagrees with the statement that this technology is unsafe

when used in accordance with the operating rules adopted today.

V. Contact With Aircraft Manufacturer for Confirmation of Performance Capabilities

During the comment period, several FAA employees worked with one aircraft manufacturer to evaluate the operational and technical performance in the use of an EVS-equipped aircraft and simulator system. This was necessary to confirm performance and limitations of this technology in an operational environment.

VI. Differences Between the NPRM and Final Rule

As discussed under ''III. Related Rulemaking Actions,'' the FAA included some terminology in the EFVS NPRM that had been proposed earlier in the RNAV NPRM. Because, as of the issuance of this final rule, the RNAV rulemaking action has not been completed, those proposed changes are not being adopted. Specifically those proposed changes are as follows.

In §§ 91.175(c), 121.651(c) and (d), 125.381(c)(2), and 135.225(c)(3)(ii) the terms ''DA'' and ''DA/DH'' are not adopted in this final rule. Therefore, all proposed references to ''DA'' and ''DA/DH'' read ''DH.''

In §§ 125.381(c)(1)(i) and 135.225(c)(1)(i) the words ''precision approaches'' are replaced with the abbreviation ''ILS.''

In § 121.651(d), the word ''person'' is replaced by the word ''pilot.'' Also, the proposed change replacing the words ''an instrument approach procedure other than a Category II or Category III'' with ''a Category I precision approach'' is not adopted. In addition, the proposed change replacing the words ''a operative ILS and an operative PAR, and both'' with ''an operative PAR and another operative precision instrument approach system, and both the PAR and the precision approach'' is not adopted.

In §§ 125.381(c)(1)(i) and 135.225(c)(1)(i) the term ''APV'' is not adopted in this final rule. Therefore, all proposed uses of the term APV are deleted.

In addition, as a result of comments received, the FAA revises the final rule as follows:

Category I operations—Section 91.175(l) is amended to include in the rule text that this exception only applies to a ''* * * straight-in instrument approach procedures other than Category II or Category III * * *.''

Visual references—Under § 91.175 (l)(3) of this final rule, the visual references that the pilot can use at the DH or MDA to continue the approach are clarified such that ''runway threshold and the touchdown zone,'' as proposed in the NPRM, includes the approach light system, if installed, or both the runway threshold and the touchdown zone. This is discussed in detail under ''IV.3. Visual cues (visual references)'' above. Combined, these references form a pattern of recognition whereby the pilot may safely continue the descent to 100 feet above the touchdown zone elevation.

Qualification requirement—Section 91.175(l)(5) is revised to change the qualification requirement to one of currency and to delete reference to the limitations specified in the Airplane or Rotorcraft Flight Manual.

Additional operational requirements—Section 91.175(m)(2) is revised to include the additional operational requirements of command guidance, path deviation indications, and flight path vector, flight path angle reference cue to be displayed on the HUD. This change narrows the scope of acceptable EFVSs by stating only those systems that have these additional features will be permitted to operate under § 91.175(l).

EFVS display—Section 91.175 (m)(2)(i) is added to include the additional operational requirement that the EFVS imagery and external scene topography must be presented so that they are aligned with and scaled to the external view. The FAA is also adding (m)(2)(ii) to specify the essential features and intended function of the ''flight path angle reference cue.'' In order to perform its intended function, the cue needs to be set by the pilot to the desired value for the approach, the pilot needs to see the cue in the context of pitch scale to verify that it is correctly set, and it needs to be shaped and located so as to allow the pilot to monitor the airplane's vertical path. This is a descending path along the selected glide path angle and is anchored to the desired touchdown point. To accommodate these changes, paragraph (m)(3) is redesignated as (m)(2)(iii); paragraph (m)(4) is redesignated as (m)(3); and (m)(5) is redesignated as (m)(4).

Topographical features—The FAA is amending § 91.175 (m)(1) to state that an EFVS must be able to display topographical features of the airport environment. It is not the FAA's intent to require an EFVS to detect all obstacles to ensure obstacle clearance in the visual portion of the final approach segment.

VII. Discussion of the Final Rule

Possible operational benefits—This final rule will not require the use of an EFVS. However, using an EFVS would allow operations in reduced visibility conditions that would not otherwise be possible.

Category I operations—This final rule will retain the existing straight-in-landing instrument approach minima for other than a Category II or III approach, and will authorize the pilot to use FAA-certified EFVS imaging-sensor technologies to determine enhanced flight visibility. This final rule will allow a pilot to fly straight-in-landing instrument approach procedures other than Category II and III procedures and descend below the DH or MDA using an EFVS.

Category II and Category III ILS approach procedures—The final rule does not prohibit the use of an EFVS for Category II and III ILS approach procedures. The use of EFVS during Category II or Category III operations must be specifically authorized by the Administrator. Any future proposed enhanced flight vision systems for these approaches would have to comply with the more stringent reliability, redundancy, other criteria as discussed in the FAA's response to comments and as prescribed in applicable sections of 14 CFR and applicable advisory circulars. But the use of EFVS in Category II or III ILS approaches does not lower minimums that would otherwise apply for aircraft not equipped with EFVS conducting Category II or III ILS approaches.

Visual references—Section 91.175 (c)(3) lists ten visual references, of which only one is required for the pilot to descend below the DH or MDA. The visual references are: (1) The approach light system, (2) threshold, (3) threshold markings, (4) threshold lights, (5) runway end identifier lights, (6) visual glideslope indicator, (7) touchdown zone or touch down zone markings, (8) touchdown zone lights, (9) runway or runway markings, and (10) the runway lights identifying the approach end of the runway. If the approach light system is used as the reference, the pilot may not descend below 100 feet above the touchdown zone elevation unless the red terminating bars or the red side row bars are also distinctly visible and identifiable. As a parallel, under paragraph (l)(3), the final rule states that, when using an EFVS, the approach light system (if installed), or the runway threshold (lights or markings), and the runway touchdown zone (lights or markings) would have to be distinctly visible and identifiable to the pilot before descending below the DH or MDA for the pilot to continue the approach. *See* the discussion under

''IV.3. Visual cues (visual references)'' above.

Because the imaging-sensor technologies may not sense or display all of the identifying features of the visual references (*e.g.*, may not distinguish colors of lights), the FAA in this final rule is clarifying the visual references listed in § 91.175(l)(3), as discussed under ''IV.3. Visual cues (visual references)'' above. Taken together, these visual references form a pattern of recognition for the pilot to safely continue the approach to 100 feet. At 100 feet above the touchdown zone elevation and below, there would have to be sufficient flight visibility (without reliance on an EFVS) for the lights or markings of the threshold; or the lights or markings of the touchdown zone of the intended runway to be distinctly visible and identifiable to the pilot to continue to a landing.

Pilot qualifications—To use the EFVS equipment while conducting an instrument approach procedure under this final rule, the pilot(s) must be current and proficient in accordance with existing applicable requirements in part 61, 121, 125 or 135. Each foreign pilot would have to be qualified in accordance with the requirements of the operator's State civil aviation authority. Foreign air carriers will be required to comply with this rule and their operations specifications. For all operators, this will include knowledge of the EFVS requirements, operational procedures, and limitations as prescribed in the approved Airplane or Rotorcraft Flight Manual for the specific system.

Certification process—An EFVS used under this final rule would have to provide the pilot with sufficient guidance and visual cues so that the pilot could manually maneuver the aircraft to a landing on the intended runway. The sensor image alone may not be suitable to maneuver the aircraft. For the pilot(s) to maximize situational awareness while maneuvering the aircraft in the visual segment of the instrument approach procedure, at low altitudes and reduced visibility conditions, the FAA requires that several key components be provided by an EFVS to provide an adequate level of safety. The EFVS sensor imagery must be presented on a HUD that is centrally located in the pilot's primary field of view and in the pilot's line of vision along the flight path. The imagery must be real-time, independent of the navigation solution derived from the aircraft avionics, and must be clearly displayed so that it does not adversely obscure the pilot field of view through the cockpit window.

Aircraft flight symbology, such as airspeed, vertical speed, attitude, heading, altitude, command guidance (*e.g.*, repeat display of head down flight director, or HUD unique command guidance cue) as appropriate for the kind of approach to be flown, and lateral and vertical approach path deviation indications (*e.g.*, localizer, glideslope or course deviation indications (CDI)) must be provided. A flight path angle reference cue and FPV also must be displayed on the HUD and be clearly visible so that the pilot can monitor and maintain a safe vertical path from the DH/MDA to the desired touchdown point on the runway.

The displayed sensor imagery and aircraft symbology may not adversely obstruct the pilot's vision looking through the aircraft's forward windshield. The EFVS imagery, attitude symbology, FPV and other cues which are referenced to the imagery and outside view must be presented so that they are aligned with and scaled to the external view.

The FAA will conduct the certification and evaluation process in accordance with published guidance and current policy. The FAA will also evaluate the capabilities, operational procedures, training and limitations for the specific system as it is designed and flight-tested. In all cases, the applicant for an airworthiness type design will provide the FAA's Aircraft Certification Office (ACO) with a certification plan. The FAA will evaluate the plan to determine if it is addressed by current regulations or if special conditions would have to be established for the certification. The EFVS will be evaluated in an operational context to determine if the system provides an equivalent level of safety when in operation compared to the present rules. The operator of a foreign-registered aircraft must comply with all of the applicable EFVS requirements of this rule.

VIII. Paperwork Reduction Act

The Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)) requires that the FAA consider the impact of paperwork and other information collection burdens imposed on the public. The FAA has determined that there are no new information collection requirements associated with this final rule.

IX. International Compatibility

In keeping with United States obligations under the Convention on International Civil Aviation, it is the FAA's policy to comply with International Civil Aviation Organization (ICAO) Standards and Recommended Practices to the maximum extent practicable. The FAA has determined that there are no ICAO Standards and Recommended Practices that corresponded to these regulations.

X. Economic Evaluation

Changes to regulations must undergo several economic analyses. First, Executive Order 12866 directs each Federal agency proposing or adopting a regulation to only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic impact of the regulatory changes on small entities. Third, the Trade Agreements Act (19 U.S.C. 2531–2533) prohibits agencies from setting standards that create unnecessary obstacles to the foreign commerce of the United States. In developing U.S. standards, the Trade Agreements Act requires agencies to consider international standards and, where appropriate, as the basis of U.S. standards. Fourth, the Unfunded Mandates Reform Act of 1995 (Pub. L. 104–4) requires agencies to prepare a written assessment of the costs, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local, or tribal governments, in the aggregate, or by the private sector, of $100 million or more annually (adjusted for inflation).

In conducting these analyses, FAA has determined that this rule: (1) Has benefits that justify its costs, is not a ''significant regulatory action'' as defined in section 3(f) of Executive Order 12866, and is not ''significant'' as defined in DOT's Regulatory Policies and Procedures; (2) will not have a significant economic impact on a substantial number of small entities; (3) will not create barriers to international trade; and (4) does not impose an unfunded mandate on state, local, or tribal governments, or on the private sector.

For regulations with an expected minimal impact the above-specified analyses are not required. The Department of Transportation Order DOT 2100.5 prescribes policies and procedures for simplification, analysis, and review or regulations. If it is determined that the expected impact is so minimal that the proposal does not warrant a full evaluation, a statement to that effect and the basis for it is included in proposed regulation.

This rule will allow, but does not require, operators to use an enhanced flight vision system on board their

aircraft. Therefore, this final rule will not impose any cost on any operator. As discussed above under ''II. Discussion of the Proposed Rule,'' the FAA believes that this final rule will provide operational benefits and improve the level of safety.

XI. Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) establishes ''as a principle of regulatory issuance that agencies shall endeavor, consistent with the objective of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the business, organizations, and governmental jurisdictions subject to regulation.'' To achieve that principle, the RFA requires agencies to solicit and consider flexible regulatory proposals and to explain the rationale for their actions. The RFA covers a wide-range of small entities, including small businesses, not-for-profit organizations and small governmental jurisdictions.

Agencies must perform a review to determine whether a proposed or final rule will have a significant impact on a substantial number of small entities. If the determination is that it will, the agency must prepare a regulatory flexibility analysis as described in the RFA.

However, if an agency determines that a proposed or final rule is not expected to have a significant economic impact on a substantial number of small entities, section 605(b) of the RFA provides that the head of the agency may so certify and a regulatory flexibility analysis is not required. The certification must include a statement providing the factual basis for this determination, and the reasoning should be clear.

The FAA certifies that this rule will not have a significant economic impact on a substantial number of small entities. This rulemaking will allow the operators the option of using an EFVS but the use of such a system is not mandated. Therefore, this rulemaking will not impose any cost on any operators

XII. International Trade Impact Analysis

The Trade Agreement Act of 1979 prohibits Federal agencies from establishing any standards or engaging in related activities that create unnecessary obstacles to the foreign commerce of the United States. Legitimate domestic objectives, such as safety, are not considered unnecessary obstacles. The statute also requires consideration of international standards and, where appropriate, that they be the basis for U.S. standards.

This final rule allows EFVS to be used by foreign as well as U.S. operators; therefore, there is a neutral effect on foreign operators. In addition, the rule imposes no unnecessary obstacles to the foreign commerce of the United States.

XIII. Unfunded Mandates Assessment

The Unfunded Mandates Reform Act of 1995 (the Act), enacted as Pub. L. 104–4 on March 22, 1995 is intended, among other things, to curb the practice of imposing unfunded Federal mandates on State, local, and tribal governments. Title II of the Act requires each Federal agency to prepare a written statement assessing the effects of any Federal mandate in a proposed final agency rule that may result in an expenditure of $100 million or more expenditure (adjusted annually for inflation) in any one year by State, local, and tribal governments, in the aggregate, or by the private sector; such a mandate is deemed to be a ''significant regulatory action.''

The final rule does not contain such a mandate. Therefore, the requirements of Title II of the Unfunded Mandates Reform Act of 1995 do not apply.

XIV. Executive Order 13132, Federalism

The FAA has analyzed this proposed rule under the principles and criteria of Executive Order 13132, Federalism. The FAA has determined that this action would not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, we determined that this notice does not have federalism implications.

XV. Environmental Analysis

FAA Order 1050.1D defines FAA action as that may be categorically excluded from preparation of a National Environmental Policy Act (NEPA) environmental impact statement. In accordance with FAA Order 1050.1D, appendix 4, paragraph 4(j), this proposed rulemaking action qualifies for a categorical exclusion.

XVI. Energy Impact

The energy impact of this proposed rule has been assessed in accordance with the Energy Policy and Conservation Act (EPCA) (Pub. L. 94–163, as amended; 42 U.S.C. 6362) and FAA Order 1053.1. The FAA has determined that the proposed rule is not a major regulatory action under the provisions of the EPCA.

List of Subjects

14 CFR Part 1

Air transportation.

14 CFR Part 91

Agriculture, Air traffic control, Aircraft, Airmen, Airports, Aviation safety, Freight.

14 CFR Part 121

Air carriers, Aircraft, Airmen, Aviation safety, Charter Flights, Safety, Transportation.

14 CFR Parts 125 and 135

Aircraft, Airmen, Aviation safety.

The Amendments

■ In consideration of the foregoing, the Federal Administration Aviation amends chapter I of 14 CFR as follows:

PART 1—DEFINITIONS AND ABBREVIATIONS

■ 1. The authority for part 1 continues to read as follows:

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

■ 2. Amend § 1.1 by adding the following definitions in alphabetical order to read as follows:

§ 1.1 General definitions.

* * * * *

Enhanced flight visibility (EFV) means the average forward horizontal distance, from the cockpit of an aircraft in flight, at which prominent topographical objects may be clearly distinguished and identified by day or night by a pilot using an enhanced flight vision system.

Enhanced flight vision system (EFVS) means an electronic means to provide a display of the forward external scene topography (the natural or manmade features of a place or region especially in a way to show their relative positions and elevation) through the use of imaging sensors, such as a forward looking infrared, millimeter wave radiometry, millimeter wave radar, low light level image intensifying.

* * * * *

Synthetic vision means a computer-generated image of the external scene topography from the perspective of the flight deck that is derived from aircraft attitude, high-precision navigation solution, and database of terrain, obstacles and relevant cultural features.

Synthetic vision system means an electronic means to display a synthetic vision image of the external scene topography to the flight crew.

* * * * *

■ 3. Amend § 1.2 by adding the following abbreviation in alphabetical order to read as follows:

§ 1.2 Abbreviations and symbols.

* * * * *

EFVS means enhanced flight vision system.

* * * * *

PART 91—GENERAL OPERATING AND FLIGHT RULES

■ 4. The authority citation for part 91 continues to read as follows:

Authority: 49 U.S.C. 106(g), 1155, 40103, 40113, 40120, 44101, 44111, 44701, 44709, 44711, 44712, 44715, 44716, 44717, 44722, 46306, 46315, 46316, 46504, 46506–46507, 47122, 47508, 47528–47531, articles 12 and 29 of the Convention on International Civil Aviation (61 Stat. 1180).

■ 5. Amend § 91.175 by revising paragraphs (c) introductory text, (d), and (e)(1) introductory text, and by adding paragraphs (l) and (m) to read as follows:

§ 91.175 Takeoff and landing under IFR.

* * * * *

(c) *Operation below DH or MDA.* Except as provided in paragraph (l) of this section, where a DH or MDA is applicable, no pilot may operate an aircraft, except a military aircraft of the United States, at any airport below the authorized MDA or continue an approach below the authorized DH unless—

* * * * *

(d) *Landing.* No pilot operating an aircraft, except a military aircraft of the United States, may land that aircraft when—

(1) For operations conducted under paragraph (l) of this section, the requirements of (l)(4) of this section are not met; or

(2) For all other part 91 operations and parts 121, 125, 129, and 135 operations, the flight visibility is less than the visibility prescribed in the standard instrument approach procedure being used.

(e) * * *

(1) Whenever operating an aircraft pursuant to paragraph (c) or (l) of this section and the requirements of that paragraph are not met at either of the following times:

* * * * *

(l) *Approach to straight-in landing operations below DH, or MDA using an enhanced flight vision system (EFVS).* For straight-in instrument approach procedures other than Category II or Category III, no pilot operating under this section or §§ 121.651, 125.381, and 135.225 of this chapter may operate an aircraft at any airport below the authorized MDA or continue an approach below the authorized DH and land unless—

(1) The aircraft is continuously in a position from which a descent to a landing on the intended runway can be made at a normal rate of descent using normal maneuvers, and, for operations conducted under part 121 or part 135 of this chapter, the descent rate will allow touchdown to occur within the touchdown zone of the runway of intended landing;

(2) The pilot determines that the enhanced flight visibility observed by use of a certified enhanced flight vision system is not less than the visibility prescribed in the standard instrument approach procedure being used;

(3) The following visual references for the intended runway are distinctly visible and identifiable to the pilot using the enhanced flight vision system:

(i) The approach light system (if installed); or

(ii) The following visual references in both paragraphs (l)(3)(ii)(A) and (B) of this section:

(A) The runway threshold, identified by at least one of the following:

(*1*) The beginning of the runway landing surface;

(*2*) The threshold lights; or

(*3*) The runway end identifier lights.

(B) The touchdown zone, identified by at least one of the following:

(*1*) The runway touchdown zone landing surface;

(*2*) The touchdown zone lights;

(*3*) The touchdown zone markings; or

(*4*) The runway lights.

(4) At 100 feet above the touchdown zone elevation of the runway of intended landing and below that altitude, the flight visibility must be sufficient for the following to be distinctly visible and identifiable to the pilot without reliance on the enhanced flight vision system to continue to a landing:

(i) The lights or markings of the threshold; or

(ii) The lights or markings of the touchdown zone;

(5) The pilot(s) is qualified to use an EFVS as follows—

(i) For parts 119 and 125 certificate holders, the applicable training, testing and qualification provisions of parts 121, 125, and 135 of this chapter;

(ii) For foreign persons, in accordance with the requirements of the civil aviation authority of the State of the operator; or

(iii) For persons conducting any other operation, in accordance with the applicable currency and proficiency requirements of part 61 of this chapter;

(6) For parts 119 and 125 certificate holders, and part 129 operations specifications holders, their operations specifications authorize use of EFVS; and

(7) The aircraft is equipped with, and the pilot uses, an enhanced flight vision system, the display of which is suitable for maneuvering the aircraft and has either an FAA type design approval or, for a foreign-registered aircraft, the EFVS complies with all of the EFVS requirements of this chapter.

(m) For purposes of this section, ''enhanced flight vision system'' (EFVS) is an installed airborne system comprised of the following features and characteristics:

(1) An electronic means to provide a display of the forward external scene topography (the natural or manmade features of a place or region especially in a way to show their relative positions and elevation) through the use of imaging sensors, such as a forward-looking infrared, millimeter wave radiometry, millimeter wave radar, and low-light level image intensifying;

(2) The EFVS sensor imagery and aircraft flight symbology (*i.e.*, at least airspeed, vertical speed, aircraft attitude, heading, altitude, command guidance as appropriate for the approach to be flown, path deviation indications, and flight path vector, and flight path angle reference cue) are presented on a head-up display, or an equivalent display, so that they are clearly visible to the pilot flying in his or her normal position and line of vision and looking forward along the flight path, to include:

(i) The displayed EFVS imagery, attitude symbology, flight path vector, and flight path angle reference cue, and other cues, which are referenced to this imagery and external scene topography, must be presented so that they are aligned with and scaled to the external view; and

(ii) The flight path angle reference cue must be displayed with the pitch scale, selectable by the pilot to the desired descent angle for the approach, and suitable for monitoring the vertical flight path of the aircraft on approaches without vertical guidance; and

(iii) The displayed imagery and aircraft flight symbology do not adversely obscure the pilot's outside view or field of view through the cockpit window;

(3) The EFVS 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; and

(4) The display characteristics and dynamics are suitable for manual control of the aircraft.

PART 121—OPERATING REQUIREMENTS: DOMESTIC FLAG, AND SUPPLEMENTAL OPERATIONS

■ 6. The authority citation for part 121 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 40119, 41706, 44101, 44701–44702, 44705, 44709–44711, 44713, 44716–44717, 44722, 44901, 44903–44904, 44912, 46105.

■ 7. Amend § 121.651 by revising paragraphs (c) introductory text and (d) introductory text to read as follows:

§ 121.651 Takeoff and landing weather minimums: IFR: All certificate holders.

* * * * *

(c) If a pilot has begun the final approach segment of an instrument approach procedure in accordance with paragraph (b) of this section, and after that receives a later weather report indicating below-minimum conditions, the pilot may continue the approach to DH or MDA. Upon reaching DH or at MDA, and at any time before the missed approach point, the pilot may continue the approach below DH or MDA if either the requirements of § 91.175(l) of this chapter, or the following requirements are met:

* * * * *

(d) A pilot may begin the final approach segment of an instrument approach procedure other than a Category II or Category III procedure at an airport when the visibility is less than the visibility minimums prescribed for that procedure if that airport is served by an operative ILS and an operative PAR, and both are used by the pilot. However, no pilot may continue an approach below the authorized DH unless the requirements of § 91.175(l) of this chapter, or the following requirements are met:

* * * * *

PART 125—CERTIFICATION AND OPERATIONS: AIRPLANES HAVING A SEATING CAPACITY OF 20 OR MORE PASSENGERS OR A MAXIMUM PAYLOAD CAPACITY OF 6,000 POUNDS OR MORE; AND RULES GOVERNING PERSONS ON BOARD SUCH AIRCRAFT

■ 8. The authority citation for part 125 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701–44702, 44705, 44710–44711, 44713, 44716–44717, 44722.

■ 9. Amend § 125.381 by revising paragraph (c) to read as follows:

§ 125.381 Takeoff and landing weather minimums: IFR.

* * * * *

(c) If a pilot initiates an instrument approach procedure based on a weather report that indicates that the specified visibility minimums exist and subsequently receives another weather report that indicates that conditions are below the minimum requirements, then the pilot may continue with the approach only if, the requirements of § 91.175(l) of this chapter, or both of the following conditions are met—

(1) The later weather report is received when the airplane is in one of the following approach phases:

(i) The airplane is on a ILS approach and has passed the final approach fix;

(ii) The airplane is on an ASR or PAR final approach and has been turned over to the final approach controller; or

(iii) The airplane is on a nonprecision final approach and the airplane—

(A) Has passed the appropriate facility or final approach fix; or

(B) Where a final approach fix is not specified, has completed the procedure turn and is established inbound toward the airport on the final approach course within the distance prescribed in the procedure; and

(2) The pilot in command finds, on reaching the authorized MDA, or DH, that the actual weather conditions are at or above the minimums prescribed for the procedure being used.

* * * * *

PART 135—OPERATING REQUIREMENTS: COMMUTER AND ON-DEMAND OPERATIONS

■ 10. The authority citation for part 135 continues to read as follows:

Authority: 49 U.S.C. 106(g), 44113, 44701–44702, 44705, 44709, 44711–44713, 44715–44717, 44722.

■ 11. Amend § 135.225 by revising paragraph (c) to read as follows:

§ 135.225 IFR: Takeoff, approach, and landing minimums.

* * * * *

(c) If a pilot has begun the final approach segment of an instrument approach to an airport under paragraph (b) of this section, and the pilot receives a later weather report indicating that conditions have worsened to below the minimum requirements, then the pilot may continue the approach only if the requirements of § 91.175(l) of this chapter, or both of the following conditions, are met—

(1) The later weather report is received when the aircraft is in one of the following approach phases:

(i) The aircraft is on an ILS final approach and has passed the final approach fix;

(ii) The aircraft is on an ASR or PAR final approach and has been turned over to the final approach controller; or

(iii) The aircraft is on a nonprecision final approach and the aircraft—

(A) Has passed the appropriate facility or final approach fix; or

(B) Where a final approach fix is not specified, has completed the procedure turn and is established inbound toward the airport on the final approach course within the distance prescribed in the procedure; and

(2) The pilot in command finds, on reaching the authorized MDA or DH, that the actual weather conditions are at or above the minimums prescribed for the procedure being used.

* * * * *

Issued in Washington, DC, on January 5, 2004.

Marion C. Blakey,

Administrator.

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