

Supplemental Information
FAA Docket Number FAA-2008-0370
Federal Express Corporation Application for Exemption
From
Title 14 CFR Part 121.651(b)(2)

Introduction

Federal Express Corporation (“FedEx”) has certified an FAA approved HUD/EFVS (Head-Up Display/Enhanced Flight Vision System) for use on its widebody fleet of aircraft, beginning with the McDonnell Douglas MD-10 aircraft.

This request for exemption is submitted in accordance with Title 14 CFR Part 11.81 and FAA Docket Number FAA-2008-0370.

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Regulatory Requirements

Title 14 CFR Part 121.651(b)(2) states in part “no pilot may continue an approach past the final approach fix, or where a final approach fix is not used, begin the final approach segment of an instrument approach procedure – unless the latest weather report for that airport issued by the U.S. National Weather Service, a source approved by that Service, or a source approved by the Administrator, reports the visibility to be equal to or more than the visibility minimums prescribed for that procedure.”

This is generally known as the “Approach Ban” rule and prohibits an air carrier pilot from continuing an approach if the weather is reported to be below minimums for that approach.

Regulatory Relief

FedEx seeks an exemption to the Approach Ban aspects of Title 14 CFR Part 121.651(b)(2) which would allow for a properly EFVS equipped FedEx aircraft and a properly EFVS trained FedEx flight crew to continue an approach past the final approach

fix, or where a final approach fix is not used, begin the final approach segment of a straight-in instrument approach procedure – even if the latest weather report for that airport issued by the U.S. National Weather Service, a source approved by that Service, or a source approved by the Administrator, reports the visibility to be less than the visibility minimums prescribed for that procedure.

The EFVS technology on FedEx aircraft is the first such application by an air carrier and consists of an infrared sensor which provides real-time video imagery for display on the HUD to the pilot. The EFVS, as defined by the FAA, generates an infrared image that is conformal and aligned with external view on a HUD with essential flight instrument information. The EFVS infrared imagery is displayed on a HUD because the safety of an approach operation conducted under Title 14 CFR 91.175(l) depends on the pilot looking forward along the flight path out of the window to readily enable a transition from reliance on the EFVS infrared imagery to reliance on the outside world view without the EFVS infrared imagery.

During some reduced visibility conditions, EFVS infrared imagery may significantly improve the pilot's ability to detect objects, such as approach lights and visual references of the runway environment that may not be visible during day or night. Specifically, for straight-in Category I approach operations below the DA/MDA down to 100 feet above the runway, this EFVS infrared imagery (displayed on a HUD) becomes the approved flight visibility at the distance no less than the visibility prescribed by the instrument approach procedure being used and is a marked improvement for the pilot in terms of safety and situational awareness.

Public Interest

The public interest is served on several fronts via the proposed exemption. The EFVS technology is a major advance in safety and situational awareness for the air carrier pilot and should be promoted on a broader scale to the industry through the use of rule changes that reflect its use and capabilities.

The air carrier industry, both passenger and air cargo, is an essential component of the United States economic framework. The reliable movement of people, goods and services is vital to the public interest. Degraded weather conditions often cause delays and diversions, interrupting this movement. When this happens to a passenger air carrier flight the major inconvenience is manifest primarily to those individuals aboard the affected flight.

However, the majority of cities served by FedEx are done so with a single flight. The impact of a diverted flight goes beyond a single load of passengers, and can affect an entire city or region. FedEx is engaged in the daily transportation of time-critical goods such as pharmaceutical items, parts for a shutdown factory, legal and business documents, to name but a few. FedEx aircraft equipped with the EFVS are a unique way to increase the reliability and conduct of this critical commerce to the public.

When degraded weather conditions exist, the ability to initiate an approach - coupled with a higher likelihood of a successful completion to a landing - is also in the public interest as it saves fuel that would otherwise be necessary for diverting to an alternate airport, which may be some distance away, plus the return fuel for an eventual recovery to the original destination. Additionally, this saving is also of public interest in that the FAA Air Traffic Control System would be strained less by aircraft successfully terminating at their destinations and not adding to the ATC traffic difficulties during inclement weather through diversions.

In this case, and unique to FedEx, the exemption will allow for a more reliable transportation system with impact for both FedEx and the public.

Safety Action Items

This system is designed to comply with the pilot visual reference requirements of Title 14 CFR Part 91.175(l) which allows a pilot conducting a straight-in approach other than a Category II or Category III, upon reaching the published DA/MDA (Decision Altitude/Minimum Descent Altitude) when required, to continue below that altitude based solely on the real-time imagery of the external topography provided by the EFVS to no lower than 100 feet above the runway, at which point the pilot must be able to see the prescribed lights or surface features as described in Title 14 CFR Part 91.175(l).

As such, the EFVS goes beyond the equivalent level of safety by improving aircraft situational awareness, providing visual cues to maintain a stabilized approach, and minimizing missed approach operations in reduced visibility conditions. However, even if a missed approach should be required, the lower height above touchdown possible in these operations are accounted for by the fact that all such EFVS equipped FedEx aircraft are already certified for a go-around maneuver up to, and including, touchdown and all FedEx pilots are routinely trained for such maneuvers. Additionally, the 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 observes the required flight visibility at the DH/MDA, EFVS usage will provide added situational awareness that may be impossible without it, especially in marginal visual meteorological conditions.

FedEx has developed a detailed training program for its pilots in the use and capabilities of the EFVS. This training consists of two detailed DVD instructional videos distributed to the pilots describing all aspects of the HUD/EFVS system and operation, a detailed revision to the approved Crew Flight Manual for the specific aircraft type, a separate ground school providing theory and operational aspects, and a four hour simulator training session whereby pilots can perform the specific training tasks and procedures.

As noted earlier FedEx aircraft equipped with EFVS, and which can successfully initiate and complete an approach, would not be added to the strain and process to the ATC system during a period of degraded weather and diversions. The result would be an

increase in safety levels brought about by a decrease in the numbers of aircraft a controller might have to deal with in very often difficult situations.

Summary

In accordance with Title 14 CFR Part 11.81 and FAA Docket Number FAA-2008-0370 FedEx seeks an exemption to the Approach Ban aspects of Title 14 CFR Part 121.651(b)(2) which would allow for a properly EFVS equipped FedEx aircraft and a properly EFVS trained FedEx flight crew to continue an approach past the final approach fix, or where a final approach fix is not used, begin the final approach segment of a straight-in instrument approach procedure – even if the latest weather report for that airport issued by the U.S. National Weather Service, a source approved by that Service, or a source approved by the Administrator, reports the visibility to be less than the visibility minimums prescribed for that procedure.

Additional Information

The Approach Ban rule was written many years ago and does not reflect the current state of technological development. Specific to this circumstance it reduces the case for increased safety and situational awareness to be gained through the use of EFVS equipment by preventing the specific operation for which it was designed, at least for U.S. air carriers.

More detailed additional information on the EFVS system description and FedEx procedures are found in Appendix A to this document.

Non-U.S. Operations

As the European Aviation Safety Agency (EASA) rules regarding the Approach Ban are under review with the intent to allow for EFVS credit, FedEx intends to operate however the ultimate rules under EASA and ICAO allow for international operations.

Appendix A
Supplementary Information

Pilot/Aircraft Description

This exemption would affect those FedEx pilots operating specific FedEx aircraft equipped with the approved HUD/EFVS system and who have received the approved training for such equipment and operations under approved FedEx Operations Specifications. The HUD/EFVS training is integrated into the existing approved training syllabus and consists of initial and recurrent subject matter introduced into the CBT (Computer Based Training) ground school syllabus, FTD (Flight Training Device) syllabus, simulator syllabus, and the IOE (Initial Operating Experience) syllabus.

The HUD is to be installed on FedEx Boeing MD-10/11 airplanes as an additional electronic display, and the EFVS provides video imagery to that display. As currently certified the MD-10/11 airplane is an Instrument Meteorological Conditions/Visual Meteorological Conditions (IMC/VMC) airplane capable of conducting Category I approaches to minimums of ½ mile or 1800 feet Runaway Visual Range (RVR), Category II approaches to minimums of 1200 feet RVR, and Category III autoland approaches to minimums of 300 feet RVR in conjunction with the appropriate ground facilities. Takeoffs may currently be conducted to minimums of 500 feet RVR.

The HUD/EFVS reinforces these existing operations through certification and operational approval to conduct straight-in Category I approaches from the DH/MDA down to 100 feet Height Above Touchdown (HAT) based on visual cues provided to the pilot by the EFVS in accordance with the January 9, 2004 amendment of Title 14 CFR Parts 91.175 and 121.651. The HUD provides the complete and necessary flight display in accordance with Title 14 CFR Part 91.175(l) to provide pilot operation of the aircraft in all phases of flight. The EFVS imagery, together with appropriate aircraft state and position reference symbology, is presented to the pilot on the HUD. The aircraft state and position reference data are presented in the form of symbology overlaying the EFVS imagery. The data are derived from existing aircraft systems and the guidance commands as displayed on the HUD are primarily derived from the same flight director commands provided to the Captain's head-down primary flight display (PFD). The EFVS is mounted in the nose radome above and to the left (looking forward) of the weather radar such that the EFVS has a clear and unobstructed forward field-of-view aligned at 5 degrees down relative to the aircraft's longitudinal axis and has minimal parallax. FedEx has installed an EFVS HIDE/SHOW Switch on the Captain's Control Wheel to allow the Captain to toggle between EFVS imagery display on and off.

FedEx MD-10/11 Company and FAA certification flight testing demonstrated that the flight director commands were displayed on the HUD in a manner which allowed accurate monitoring of the approach by the pilot. In addition, this flight testing demonstrated that the EFVS display had no detrimental effects for the pilot monitoring an approach.

The flight testing included precision and non-precision approaches, in reduced visibility conditions with rain and/or fog, to demonstrate the MD-10/11 EFVS function. During IMC approach operations, the EFVS AUTO and MANUAL gain mode were

demonstrated alternately to allow for comparison of EFVS gain and image characteristics. Additional flight testing was conducted in VMC/IMC with an appropriate vision restriction device for the pilot's external view. Evaluation of EFVS for other flight phases (taxi, takeoff and landing) and airplane system level failures (one engine inoperative, slat/flap configuration anomalies, etc) were also performed to determine the acceptability and assess crew workload.

Current Approach Procedures

The current FedEx flight crew procedures for approaches reflect the philosophy of maximizing safety through the use of monitored approach procedures for all low visibility approaches in conjunction with standardized callouts for all approach operations.

The monitored approach procedure calls for the Captain to ensure that the First Officer (F/O) has physical control of the airplane at a point well prior to the final segment of the approach with the autopilot engaged. The Captain then continues to monitor the progress of the approach. The Captain, upon reaching the "approaching minimums/alert height" altitude shifts his/her vision outside the airplane and searches for outside visual references throughout the remainder of the approach. For a Category III approach the Captain also assumes physical control of the airplane at this point. For a Category I or II approach the Captain does not assume control of the airplane until the necessary visual cues are present.

The F/O remains heads down throughout the remainder of the approach and calls out altitudes and any observed deviations from acceptable approach tolerances or autoflight anomalies and may, at any point up to touchdown, call for a go-around. During the landing rollout the F/O remains heads down to monitor localizer/mode deviations and gives guidance as necessary.

These operations are reflected in the approved FedEx Crew Flight Manual for the Boeing MD-10/11 airplane and describe the appropriate crewmember callouts and actions for each type of approach currently flown by FedEx.

HUD/EFVS Integrated Approach Procedures

Based on these existing procedures and callouts for the FedEx MD-10/11 airplane, the integration of the HUD/EFVS will be seamless with minimal change. With reference to the January 9, 2004 amendment of Title 14 CFR Part 91.175(l), the approach regime for a straight-in Category I approach is the segment that may be performed based solely on the EFVS imagery.

No new callout is required for descending below the DH/DA/MDA when the Captain is flying the airplane as the F/O will have the ability to callout "**HUD Fail**" if a system failure is detected and displayed via the HUD annunciator function located on the F/O

instrument panel. The Captain will either have the non-EFVS visual cues, be able to continue, or will execute a go-around.

For a straight-in Category I approach when the Captain is flying the airplane the F/O will back up the automatic altitude callout of “100”. The Captain will either continue the landing maneuver, signifying that the visual requirements of Title 14 CFR Part 91.175 are met, or execute a go-around maneuver and callout “**Go-around**”, signifying they are not.

No changes are necessary to the existing Category II/III monitored approach procedures as these operations are not based on the use of the HUD/EFVS, even though it may be displayed as an integrity monitor during the approach.

HUD/EFVS Operational Concept and Procedures, Straight-in Category I Approaches

FedEx’s normal operating concept for straight-in Category I approaches is to conduct a mandatory monitored approach in the case of a non-precision procedure when the reported ceiling is below 1000 feet and/or the reported visibility is less than 3 miles.

FedEx’s HUD/EFVS operational concept states that the function of the EFVS is to aid the pilot in visually acquiring the runway environment and therefore allowing the Captain to monitor the integrity of the approach by providing visual cues of the aircraft’s position and path with respect to the runway in the form of a video image.

Upon commencing a standard instrument approach, the crew will use approved FedEx flight approach procedures to maneuver the aircraft to the published Category I DA or MDA.

When using the EFVS imagery during the approach, the crew flies a manual or autopilot coupled approach (with or without monitored approach procedures as appropriate) using the raw data and flight director symbology presented on the HUD and concurrently monitors the independently derived enhanced external visual view provided by the EFVS. During an EFVS/HUD Category I straight-in approach the F/O monitors the approach using the raw data information and instrument comparators presented to him head down.

The EFVS imagery provides the Captain with an independent means of monitoring the approach guidance and aircraft position with respect to the runway. The Captain is essentially flying in accordance with the visual scene criteria for instrument approaches below the published Category I DH or MDA. This intrinsically provides a fail-safe capability without the need for extensive internal system monitoring, high integrity position references, or extensive runway light on the ground. During the approach, the pilot, if reliant on the EFVS, must be able to see and identify the visual references as stated in revised Title 14 CFR Part 91.175(l) in order to confirm that the aircraft is in a position to continue the approach. The Title 14 CFR Part 91.175(l) visual references include:

- (i) Approach light system (if installed); or
- (ii) The following visual references in both paragraphs (1)(3)(ii)(A), (B)
 - (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) 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.

At the published DA or MDA the F/O will call "**MINIMUMS**". If the Captain fails to see one of the visual references stated in Title 14 CFR Part 91.175(l), or there is a disagreement between the EFVS imagery and the HUD approach symbology (i.e., symbolic runway, glideslope and localizer presentations), the pilot must execute a go-around.

From the published DA or MDA, the Captain continues the approach using the HUD guidance cues and monitors the integrity of the raw data, with the EFVS external visual scene presented by the EFVS imagery. The F/O monitors the aircraft's position using the head down displays. At the 100-ft. "see to land" point the F/O calls "**100 Feet**" if the **airplane's automatic call-out system fails to do so**. The Captain responds by completing the landing maneuver if he/she has verified the appropriate aircraft positioning using the external visual scene without reliance on the EFVS imagery. If not, the Captain executes a go-around using the standard HUD symbology.

During the flare, the Captain controls the aircraft using the external visual scene without reliance on the EFVS image of the visual scene. During rollout the pilot controls the aircraft on the runway centerline using the external visual references without reliance on the EFVS image of the runway and runway lighting.

Missed Approach Procedures

A missed approach procedure will be executed if after passing the published Category I DA or MDA, visual reference is lost or a reduction in visual reference occurs which prevents the Captain from continuing to verify that the aircraft will safely touch down in the runway touchdown zone, or if upon reaching 100 feet AGL the required non-EFVS visual cues are not present.

If, at any time during the descent from the published DA or MDA, the crew becomes aware of any malfunction of the aircraft and/or HUD/EFVS system or if the aircraft deviates from the stabilized approach profile (i.e. on glideslope, on localizer and the aircraft is tracking so as to remain within the lateral confines of the extended runway), the Captain or F/O will call "**Go-around**" and the crew will initiate the missed approach.