



## AIR LINE PILOTS ASSOCIATION, INTERNATIONAL

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November 10, 2004

Mr. Joseph Sedor  
National Transportation Safety Board  
Major Investigations (AS-10)  
490 L'Enfant Plaza East, SW  
Washington, DC 20594

Re: FedEx 647, MD-10-10, N364FE  
Accident Number: DCA04MA011  
Memphis, Tennessee

Dear Mr. Sedor:

The Air Line Pilots Association, Intl. (ALPA), representing over 64,000 pilots flying for 43 airlines in the United States and Canada, submits the attached comments concerning the accident involving FedEx Flight 647 that occurred on 18<sup>th</sup> December 2003 at Memphis, Tennessee.

This submission contains ALPA's analysis of the facts obtained from the NTSB's investigation and additional post accident research. This submission contains several safety recommendations that are intended to prevent similar future accidents. ALPA's conclusions and recommendations are included as an attachment to this letter, as well as in the submission itself. ALPA may make an additional submission upon receipt of any or all information previously requested but not yet received from the NTSB.

ALPA believes that this accident, like all others, was the combination of many factors. This event appears to have been caused by strong, gusting winds in the final 60 seconds of flight which, along with the crew's unsuccessful attempt to arrest a high sink rate in the last ten seconds of flight. The available evidence also suggests that the flying pilot's input during the landing flare was ineffective due to her lack of experience (in both training and operations) in this variant of the aircraft.

ALPA appreciates the opportunity to have participated as a party to the investigation and hopes the attached comments, conclusions and recommendations will be of assistance as the Board concludes its investigation.

Sincerely,

A handwritten signature in cursive script that reads "Michael Bender".

Captain Michael Bender  
Accident Investigation Board  
ALPA Party Coordinator

CC: Chairman Ellen Engleman Conners  
Member Mark V. Rosenker  
Member Carol J. Carmody  
Member Richard F. Healing  
Member Deborah A. P. Hersman  
Tom Haueter, NTSB  
John Clark, NTSB  
T.R. Proven, FAA  
Alan W. Ray, FedEx Express  
William C. Steelhammer, The Boeing Company  
Thomas E. Wallace, Memphis-Shelby County Airport Authority

## **ATTACHMENT 1 - FINDINGS**

### **FINDINGS**

1. The MD-10 program has effectively improved the capability and service life of the DC-10 airframes, however, the program does not change the flying characteristics of the MD-11 or MD-10 enough to enable them to be called the same aircraft.
2. While the MD-10 and MD-11 are certified as the same type, no changes were made to the wings, flight controls or engines of the MD-10 from the DC-10. Therefore, DC-10 wind corrections should be used for the MD-10. Using the wind additive appropriate for the MD-11 reduces airspeed safety margins on MD-10 aircraft especially at low altitude while on approach.
3. The handling characteristics of the MD-11 are distinctly different than the handling characteristics of the DC/MD-10. This is due to a longer wing with winglets, a longer fuselage and a horizontal stabilizer that is 60 percent the size of the DC-10. Additionally the MD-11 has an auto pitch trim system, Longitudinal Stability Augmentation System (LSAS) with the feature that auto trims when hand flying.
4. In order to receive a common type rating, the FAA required that the MD-11 and MD-10 have flying and handling characteristics that were similar. The easiest way to accomplish this was to change the MD-11 Flight Control Computer (FCC) software to make the MD-11 fly similar to the MD-10. New FCC software, the FCC-908 load, was introduced and is required in order to fly both the MD-11 and MD-10. While most of the FCC-908 load changes have improved the handling characteristics of the MD-11, the changes have not made the MD-11 fly like the DC/MD-10.
5. Until November 2004, FedEx IOE (Initial Operating Experience) students were not required to fly more than one of the MD-10/11 type variants (MD-11, or either the MD-10-10 or the -30). The entire IOE may well have been conducted in just one version.
6. At the time the First Officer was trained, the first time a FedEx pilot performed an MD-10 landing was in the actual aircraft, and could have been many months after completing differences training.
7. The FedEx MD10-30 simulator is not being used for Proficiency Checks (PCs) due to considerations of the FAA-certified MD-11 and MD-10 training syllabus.
8. Many MD-11 pilots, especially those acting frequently as Relief First Officers (RFO's), have not been able to maintain currency in the aircraft and must get their required three takeoffs and three landings in the simulator.

9. Certifying the MD-10 with a same type rating as the MD-11 and not requiring currency in both aircraft has resulted in pilots going months and in some cases years between flying each aircraft. The First Officer in this accident was conducting only her third landing in the MD-10 in the preceding 12 months, including the one the day before.
10. Due to the FedEx fleet being composed largely of aircraft that started out with other carriers, the escape slide configurations and procedures for manual deployment vary from aircraft to aircraft. This can lead to confusion or improper deployment of the escape slide system.
11. The slides on the accident aircraft were certified to a lower standard than required by current slide requirements. These slides did not meet the current wind requirements. One slide was unusable due to fire, and the other blew under the aircraft fuselage when deployed, rendering it useless, and forcing the crew to find another means of egress from a burning aircraft.
12. Since the slide was unusable, the crew had to rely on egressing out the Captain's and First Officer's clearview windows using escape tape.
13. Because of the construction of escape tape, a thin ribbon of reinforced synthetic material, one of the crew suffered burns to the hands. If a crewmember had been incapacitated, there would have been no means to evacuate him or her safely from the burning wreckage.
14. One crewmember was injured by falling while trying to use the escape tape.
15. Prior to January 2004 there was no girt bar attached to the girt bar locking brackets at the doorsill on the FedEx MD-10 door training equipment at the Memphis, Tennessee training facility. Without the girt bar, crews are unable to train for manual slide inflation on a door that accurately models the actual aircraft.
16. During the investigation, it was found that FedEx MD-11 and MD-10 crews were not getting "hands-on" experience with escape slide manual inflation. A flight-training manager at FedEx stated that when the girt bar flap had been installed on the MD-10 door training equipment, the use of the manual inflation handle was not part of the Emergency Procedures Training (EPT) hands-on drill.
17. A FedEx check airman stated that he recalled that procedures for operating the manual lanyards attached to the slide were taught during classroom instruction. He said that demonstration and practical application of those procedures were not practiced.
18. ATC informed the Chief of Airport Fire Station #33 that there were only 3 souls on board the airplane, based solely on an erroneous assumption, not on information obtained from the flight crew or dispatch. This resulted in a smaller ARFF response in the early stages of the accident.

19. The Rural Metro Fire Department (RMFD), located on the FedEx ramp, had difficulties responding to the accident due to an incoming airplane on runway 27/9. ATC allowed that aircraft to land which delayed the RMFD fire truck for about 1 – 1½ minutes.
20. The aircraft encountered strong, variable and gusting winds during the last 60 seconds of flight.
21. According to FDR data there was a 47 degree wind shift, from 291 degrees to 338 degrees, just six seconds prior to touchdown.
22. The FDR also recorded wind gusts with speeds ranging from 24 to 33 knots one minute before touchdown.
23. Between ten and six seconds before touchdown, the FDR recorded wind speed drops from 33 knots down to 17 knots, a 16 knot decrease.
24. Two seconds before touchdown, the FDR recorded a wind increase to 21 knots, and then falls to 15 knots just after touchdown.
25. The wind sensor, one mile away from the accident site, recorded gusty and variable winds at its location during the last 10 seconds of flight.
26. At the sensor location there was a 55 degree wind shift followed by another 45 degree shift at the sensor location, during the last 10 seconds of flight.
27. At the same sensor location, wind speed drops 16 knots during the final 10 seconds of flight.
28. The aileron position data recorded on the FDR does not comply with FAA requirements.

## **ATTACHMENT 2 – SAFETY RECOMMENDATIONS**

### **SAFETY RECOMMENDATIONS**

ALPA offers the following Safety Recommendations to attempt to correct deficiencies identified during the course of this accident investigation.

#### **To the Federal Aviation Administration (FAA)**

1. Require an immediate review of wind additives for the MD-11 and MD-10 be conducted to insure the MD-10 is being operated safely.
2. When a second MD-10 simulator is added, it should be in an MD-10-10 configuration.
3. Require that operators of the MD-10 train so that IOE legs are flown in the MD-11 and both MD-10 variants.
4. Require that operators, who fly MD-11 and MD-10 aircraft, give pilots annual recurrent training on the differences in MD-10 piloting technique if they have not flown the aircraft during the previous year.
5. Require modification to the MD-10 and MD-11 windshear alert and guidance system (WAGS) to make it active until touchdown.
6. Require that all aircraft equipped with escape slides be retrofitted with slides that meet the current FAR 25.810 requirements.
7. Require operators and aircraft manufacturers to install an inertia reel at slide equipped doors to function as a backup in the event of escape slide malfunction. This will allow evacuation without the risk of “rope burns” or falling to the ground. This will also aid in evacuation of passengers or crew who may have become incapacitated.
8. Require that operators install the “Emergency Evacuation Checklist” on the pilots chart holder on both yokes. It should be printed in luminescent print to allow for visibility in low-light conditions.
9. Emergency evacuation training should be conducted by all operators on all Proficiency Training and Proficiency Checks.
10. Require operators to add training on manual inflation of the escape slide as part of the Emergency Procedures Training (EPT) hands-on drill.

11. Require all escape slide simulators to be configured and painted to more closely resemble the installation in the actual aircraft.
12. Communicate with all ARFF and air traffic control tower personnel at airports that wide body cargo aircraft operate from and convey that they sometimes transport as many as 27 persons on their wide body airplanes, many of which will be in the aft section of the plane.
13. Develop an addition to the flight training syllabus at cargo carriers that carry occupants in the rear of the aircraft, to create awareness on the part of the crewmembers on how to deal with an emergency evacuation involving passengers occupying the seat pallets in the rear of the aircraft.
14. Verify that all airports and ARFF stations have received a copy of FAA CertAlert No. 04-01, "Passengers and Crew on Cargo Aircraft".
15. The NTSB and FAA should reexamine Safety Recommendation A-03-016, which recommends that the FAA survey all other aircraft required to have flight data recorders to ensure they meet the requirements of 14 CFR Part 121.344 Appendix M, and determine if the alternate action is truly acceptable.
16. The FAA should mandate that the aircraft manufacturer should either use a different source for the aileron position data with a refresh rate at least as high as the sampling requirement, or change the current system so that it updates at a high enough rate to meet the requirement.



**SUBMISSION OF THE  
AIR LINE PILOTS ASSOCIATION  
TO THE  
NATIONAL TRANSPORTATION SAFETY BOARD  
REGARDING THE ACCIDENT INVOLVING  
**FedEx Flight 647**  
At MEMPHIS, TENNESSEE  
ON DECEMBER 18, 2003**

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# 1. HISTORY OF FLIGHT

On December 18, 2003, at approximately 1226 CST, a McDonnell Douglas MD-10-10F, N364FE, operated by FedEx as Flight No. 647, crashed during landing at Memphis International Airport (MEM), Memphis, Tennessee. The right main landing gear collapsed during the landing rollout on Runway 36 Right approximately 15 seconds after touchdown. The airplane ultimately veered off the right side of the runway and was destroyed during a subsequent fire. Flight No. 647 was being operated under the provisions of 14 *Code of Federal Regulations* (CFR) Part 121 on an instrument flight rules flight plan.

Of the two flightcrew members and five passengers onboard the airplane, two suffered minor injuries during the evacuation.

ALPA believes that this accident, like all others, was the combination of many factors. This event appears to have been caused by strong, gusting winds in the final 60 seconds of flight which, along with the crew's unsuccessful attempt to arrest a high sink rate in the last ten seconds of flight. The available evidence also suggests that the flying pilot's input during the landing flare was ineffective due to her lack of experience (in both training and operations) in this variant of the aircraft

The accident occurred on the fourth day of the flight crew's three leg trip pairing. The captain of the flight was a company check airman who was conducting a multi-leg line check for the first officer. In addition to the flight crew, a FedEx DC-10 captain occupied the cockpit right observer jumpseat and four FedEx pilots occupied the courier seats located in the cabin directly aft of the cockpit.

The first leg was conducted in an MD-11 and departed Memphis on the evening of December 15th, 2003, with the captain acting as the pilot flying (PF). The second leg was flown in an MD-10 and departed Indianapolis on the afternoon of December 16th, 2003, bound for Oakland International Airport, Oakland, California (OAK). The flight crew remained in OAK on December 17, 2003. The accident flight was flown in an MD-10 and departed OAK on December 18, 2003, at 0632 PST for MEM. The first officer was the PF on this leg, and the flight was scheduled to arrive in MEM at 1350 CST on December 18th.

According to the flight crew, the takeoff, taxi, climb, enroute and descent segments of the flight from OAK to MEM were normal. The descent and initial approach to MEM were conducted using the autopilot and autothrottles. The crew also stated that below 10,000 feet mean sea level (MSL), they experienced light to moderate turbulence that "would come and go."

The captain stated that he received the Memphis weather via the automated terminal information service (ATIS) several times before landing at MEM. The first ATIS broadcast indicated the wind from 290 degrees at 18 knots, with gusts to 23 knots. After a discussion with the first officer, the captain programmed the flight management system (FMS) for a landing on runway 27. In the descent, the captain received an updated ATIS that indicated the wind from 320 degrees at 18 knots, with gusts to 23 knots and noted that windshear advisories were in effect.

The captain then reprogrammed the FMS for a landing on runway 36L. Memphis approach control initially advised the crew to expect runway 36L, but later switched them to runway 36R for landing. When the flight was approximately 10 miles from touchdown, approach control cleared the crew for a visual approach to runway 36R, and they were instructed to contact the air traffic control tower.

The crew contacted the MEM tower when the flight was approximately seven miles from touchdown. At that time, the tower cleared the crew to land on runway 36R and advised that there was a “gain and loss of ten knots on short final.” The first officer reported that there was a brief aural “windshear” alert, generated by the airplane’s central aural warning system (CAWS), at 1460 feet AGL. The captain stated that the alert lasted only about two seconds. Following that alert, the crew decided that conditions were still acceptable to continue the approach. According to the flight crewmembers, the visual approach to runway 36R was normal and the airplane was stabilized throughout the approach from above 1,000 feet above ground level (AGL). The crew had also made the correct wind correction/addition based on the reported winds.

The crewmembers stated that the initial rollout appeared normal, but after several seconds, the airplane began to bank and turn to the right. They said that they were unable to steer the airplane back to the left and it skidded off the right side of the runway and came to a stop in the grass. Shortly after coming to a stop, the captain stated that there was a “huge explosion”, and a fire developed on the right side to the airplane. All seven individuals on the airplane were able to successfully evacuate the airplane using the cockpit windows.

## **2. OPERATIONAL FACTORS**

The intent of the program to convert the DC-10 to the MD-10 was to extend the capability and service life of the DC-10 airframes. The conversion process entails numerous changes to the way systems operate and the cockpit layout and displays, all with the goal of turning a three-pilot aircraft (the DC-10) into a two-pilot aircraft (the MD-10). The flight characteristics of the MD-10 remain the same as the DC-10. In an attempt to achieve a common type rating, the flight control computer software of the MD-11 was altered with the intent of making the MD-11 and MD-10 have similar handling qualities. In ALPA’s view, the changes to both aircraft do not successfully change the MD-11 or MD-10 enough to enable them to be flown as though they were the same aircraft. In fact, the three variants (MD-11, MD-10-10 and MD-10-30) all have unique characteristics, including: engines, fuselage and wing span differences, as well as weight differences.

### **A. Operations and Training**

The modifications to the DC-10 system controls have resulted in the elimination of the requirement for a flight engineer by automating a number of aircraft system control functions. While these changes help a two pilot crew monitor systems, because of the inherent differences of the MD-10 and MD-11, not only is the workload higher for the crew, but the two aircraft

actually fly very differently. The FAA has determined that the MD-10 and MD-11 may be operated under a common type rating. In other words a pilot with an MD-11 type rating can fly both the MD-11 the MD-10 after completing difference training for the MD-10. Currency on each aircraft individually is *not* required by the FAA or the operator. In practice, this means FedEx pilots may fly only one of the two for an extended period, and then fly the other with no requirement for *any* refresher training. It may also mean that a pilot may fly both aircraft (MD-11 and MD-10) on the same trip, in some cases on back-to-back legs.

The FedEx Pilots Association (FPA), which represented the pilots flying for FedEx Express until mid-2002, and has since merged with the Air Line Pilots Association, International, had several major concerns with the common type rating for the MD-11 and MD-10. The FPA made these objections known to the FAA<sup>1</sup>. The FAA responded that these FPA concerns would be taken into account by the FOEB, but in the end, they were not adequately addressed (APPENDIX A).<sup>2,3</sup>

While there are many commonalities between the MD-10 & MD-11, there are differences that are of a safety concern. These differences were not individually considered to be safety critical items by the FAA. However, ALPA feels that all the differences in combination could lead to confusion on the flight deck as well as increased pilot workload and the consequent distraction from basic flying tasks, especially during a critical phase of flight.

These differences include:

- Full Authority Digital Engine Control (FADEC) - the MD-10 is not modified with FADEC, but the MD-11 is.
- Autobrakes - only some MD-10s have autobrakes; all MD-11s have autobrakes.
- Handling Characteristics - the MD-11 has distinctly different handling characteristics than the DC/MD-10 because of a longer wing with winglets, a longer fuselage, and a horizontal stabilizer that is 60 percent the size of the DC-10. Additionally the MD-11 has an auto pitch trim system, Longitudinal Stability Augmentation System (LSAS), with the feature that auto trims when hand flying. The MD-10 versions require manual trim inputs.

The FAA also required that the MD-11 and MD-10 have flying and handling characteristics that were similar. The easiest way to accomplish this was to change the MD-11 Flight Control Computer (FCC) software load and make the MD-11 fly more like the MD-10. Early in the program, the MD-11 FCC software was known as the FCC-907 load and did not achieve the goal of making the MD-11 fly like a DC-10. A new FCC-908 load was introduced and is required in

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<sup>1</sup> 3 Feb. 2001 letter from Michael Weiland, Pres. FPA to Jane F. Garvey FAA Administrator

<sup>2</sup> 23 Feb. 2001 letter from Jane F. Garvey FAA Administrator to Michael Weiland, Pres. FPA

<sup>3</sup> 4 Jan. 2001 letter from Thomas E. McSweeney FAA Associate Admin. For Regulation and Certification To Michael Weiland, Pres. FPA

order to fly both the MD-11 and MD-10. A number of the changes in the FCC-908 load reflect the attempt to correct for differences in pitch and speed control of the two aircraft. These changes include:

- Pitch Rate Damper (PRD) 30 percent active below 16,500 feet, instead of phasing out by 15,000 feet .
- Pitch Attitude Protection down to 0 feet.
- Positive Nose Lowering (PNL) of 3 degrees nose down elevator on landing with main wheel spin-up and additional 1-degree nose down elevator with spoilers greater than 10 degrees.
- Auto Throttle and AP/FD Speed Protection.

The Pitch Rate Damper and leverage of the elevators, due to the longer fuselage on the MD-11, have not substantially countered the reduced size of the elevator and horizontal stabilizer. During the flare and landing phase most pilots use some power to counter the sink rate instead of applying elevator as used in many aircraft. While most of the FCC-908 load changes have improved the handling characteristics of the MD-11, the changes have not made the MD-11 fly like the DC/MD-10.

ALPA feels the training available to the accident crew was inadequate. Originally, in FedEx Transition/Upgrade training, the student was not required to fly all three variants (MD-11, MD-10-30, and MD-10-10) during Initial Operating Experience (IOE). He or she may well have flown all of the IOE in only one of the variants, and not operate the others for an extended period of time. Although this has been changed since the accident, many pilots may not have flown all of the versions of the common type rating and may still not be current, much less proficient in one version or the other. For recurrent training, the annual Proficiency Checks (and the associated Warm-Up) are conducted only in the MD-11 simulators. The Proficiency Training (PT) session may be accomplished in the MD-10-30 simulator. The MD-10-30 simulator is not currently being used for Proficiency checks due to constraints of the FAA-approved syllabus. FedEx has only one MD-10 trainer, a MD-10-30, not the more distinctly different MD-10-10.

It is also significant that flying, much less landing, an MD-10 was not even required by the FAA or FedEx to be part of Initial Operating Experience (IOE) for the flight crew. A pilot could do any or all of his or her IOE in any one of the variants, or any combination of them, but there was no FAA or FedEx requirement to fly more than one to become fully qualified. This deficiency has now been remedied by FedEx Express, and FedEx IOE students are, as of November 2004, now required to fly several MD-10 as well as MD-11 legs.

## **B. Approach Speed Addition Differences on the MD-11, MD-10 and DC-10**

In the DC-10, as with most transport aircraft, crews adjust the approach speed for winds by adding half the steady wind component plus the full gust to the reference speed per the certified flight manual (CFM), page 7-1-6-2. The MD-11 requirement is to adjust the approach speed by adding the greater of half the steady wind component over 20 knots or the full gust to the reference speed (CFM 7-1-5-2). The MD-10, in spite of having the same wing and tail as the DC-10, uses the MD-11 procedure. All variants use a minimum of reference plus 5 knots for the approach speed.

For example, per the CFM, an approach to runway 36 with winds of 360 degrees at 30 knots would use a  $V_{REF}$  plus 15 knots for the DC-10. The MD-10, however, would fly 10 knots slower for the same reference speed (half the wind over 20 knots equals 5 knots). Similarly, a five knot gust would raise the DC-10 speed an additional five knots, but would result in no speed change at all for the MD-10, which would still use the standard 5 knots added to  $V_{REF}$  for the approach speed.

On the accident flight, the crew added four knots above what was required by the CFM. Even with this addition, the speed was below what would have been required by the DC-10 CFM. This puts the crew in a very dangerous position by giving them an approach speed below what the DC-10 would have required.

## **C. Full Authority Digital Engine Control (FADEC)**

The MD-11 includes the installation of FADEC, while the MD-10 does not. The engines used on the MD-10 are a generation older than those used on the MD-11. Because of this, the pilot's throttle input and the functioning of the auto-throttles are very different between the two aircraft. This, coupled with issues of currency on each aircraft type, can lead to pilot difficulties during high workload phases of flight.

The MD-11 has FADEC; the MD-10 has a hydro-mechanical fuel control and basic auto-throttle, which does not control each engine individually. Without FADEC the first engine that reaches the selected N1 rating/limit, causes all power lever movement to stop. Thus all engines will remain at that setting and may not have advanced to their individual rating/limit. Additionally, there is no engine performance limiting with the auto-throttle disengaged as is the case with FADEC equipped engines. Should an emergency rapid increase of the thrust levers be required, pilot attention is needed to adjust the engines instead of directing attention to flight path and/or mechanical problems. With FADEC, pilots can simply push the power levers to the FADEC "bar", which provides protection for the engines from damage without further attention or concern of over boosting.

With only a 2 person crew on the MD-10, the absence of FADEC can be critical in a high-workload situation. At least one pilot must divert his or her attention to engine fine-tuning while FADEC would allow both pilots to pay attention to the take-off or landing task, and not be

distracted. Additionally, should a crew switch from an MD-11 to an MD-10 during a turn-around, or infrequently fly the MD-10, absence of FADEC could lead to exceeding engine limits inadvertently, especially in an emergency where it may be difficult to immediately recall that FADEC is not installed, and where no FADEC “bar” would prevent firewall thrust from being selected.

#### **D. Currency**

Maintaining landing currency in both the MD-11 and MD-10 is not required. Attempting to gain experience in both types has proven to be challenging for pilots because of the long stage lengths and the limited number of landings on some pairings. With the FAA authorizing the MD-10 and MD-11 to have a common type rating, it is possible and legal for a pilot to go months or even years without landing an MD-10 or an MD-11, and yet still be considered fully qualified in both aircraft. The different piloting techniques in the two aircraft can lead to hard landings in the MD-10 versions if a pilot is not accustomed to the increased control inputs required in the shorter aircraft. The First Officer in this accident was conducting her third landing in an MD-10 in the last 12 months. Her previous MD-10 landing was two days before the accident, and prior to that she had not been the landing pilot in an MD-10 since 23 April, 2003, her first MD-10 landing since 2 December, 2002.

#### **E. Handling Characteristics**

The MD-11 is a derivative of the DC-10. The MD-11 fuselage is lengthened and the horizontal tail reduced to approximately 60%. The tail reduction is partially offset by the additional leverage and is intended to reduce aerodynamic drag. The smaller tail, however, also reduces stability. The MD-11 also has an auto pitch trim system known as LSAS. This system assists the pilot in hand flying the aircraft. The two versions of the MD-10, the -10 and the -30, also have differences in their wing designs, size and also their engine power available, resulting in yet more significant changes in pilot technique, especially in the landing phase. The pilot must always keep aware of which aircraft version (MD-10-10, MD-10-30, and MD-11) is being flown in order to apply the right amount of flight control input at the right time. If these differences are not kept in the forefront of the pilot’s mind, the incorrect landing technique can result in tail strikes or hard landings.

Because of numerous tail strikes in the MD-11, FedEx and Boeing developed special training for all MD-11 pilots. This training has greatly reduced the number of tail strikes by retraining pilots to arrest high sink rate with power instead of pitch. This action is unnatural and much different than the MD-10 procedures and techniques. The MD-11 pilot must also override the auto-throttles, and not apply additional elevator to arrest the sink rate. This action could cause confusion to a pilot who is assigned to fly the MD-10 after regularly flying the MD-11.

The digital flight data recorder (DFDR) showed that the first officer did make an attempt at a flare at about 30 feet, but that there was no noticeable change in pitch or rate of descent. Per the

MD-10 manual, 30 feet is the right height to begin the flare. The flare and throttle technique are necessarily different for the MD-10 and MD-11 for the reasons discussed above. ALPA feels that the inputs made by the flying pilot in this accident may well have been appropriate for the MD-11, but were ineffective for the MD-10 she was actually flying. This is the crux of our concerns of differences between the MD-10 and the MD-11, and the more subtle but definitely present differences between the MD-10-10 and the MD-10-30.

#### **F. Windshear Alert and Guidance System**

Both the MD-10 and MD-11 are equipped with a windshear alert and guidance system (WAGS). However, during landing approach, the system is only active until 50 feet AGL. On some other aircraft types (for example the 747-400), WAGS remains active until landing. Thus, in performing the landing maneuver, an MD-11 or MD-10 pilot has no cues that suggest a hazardous wind condition unless one of the pilots sees an abrupt change in airspeed that may indicate such a condition. In order to identify that abrupt change, one pilot's attention would have to be focused almost exclusively on the airspeed, excluding all other parameters.

#### **G. Simulator Back Drive Activity**

On September 30<sup>th</sup>, 2004, the Operations Group met at the Boeing simulator facility in Long Beach, California, to observe a simulator "back drive" activity in which the data from the FedEx 647 accident was used to drive the simulator. However, the activity was conducted in an MD-11 simulator, using an MD-10-30 database, which was selectively adjusted (the Boeing representative describe the adjustments as "degraded") to replicate an MD-10-10. The simulation was run multiple times, from an altitude of 500 feet to two seconds after touchdown. The aircraft appeared to be aligned with the centerline at approximately 130-140 feet. The simulator then showed the aircraft drifting to the right and crabbing slightly into the wind. At touchdown, it appeared that the ailerons and rudders were close to the neutral position. As was noted in the Operations Group Factual report, based on what was observed in the simulator sessions, the group was unable to reach consensus on what, if any, different crew actions would have been appropriate.

Because this activity was conducted in an MD-11 simulator, using adjusted MD-10-30 data, ALPA is concerned about the fidelity of the simulation. The group discovered during the activity that the simulator will fly like an MD-10 with the autopilot engaged, but when off, it reverts to an MD-11. The simulation was flown to runway 25 Right at LAX rather than the accident runway. Since the simulated approach was not conducted into runway 36 Right at MEM, any combined effects of terrain and winds were not included in the analysis and thus remain unknown. The wind data used for the simulation was derived from the aircraft's flight data recorder. Since the data was derived, and not actually sampled at the rate used in the simulation, the effect of wind on the flight cannot be conclusively determined. Also, the thrust lever angle (TLA) is not recorded on the FDR. The simulation used data from the  $N_1$  parameter on the FDR. Without TLA, the accuracy of the power inputs by the crew in the simulation

cannot be known. At touchdown, the primary flight display (PFD) indicated 7 degrees of pitch, but the FDR only indicated 5.6 degrees. This discrepancy on a basic flight parameter in the simulation suggests the simulator activity was, at best, an approximation of actual events and should not be used to form specific conclusions.

### **Findings:**

- The MD-10 program has effectively improved the capability and service life of the DC-10 airframes, however, the program does not change the flying characteristics of the MD-11 or MD-10 enough to enable them to be called the same aircraft.
- While the MD-10 and MD-11 are certified as the same type, no changes were made to the wings, flight controls or engines of the MD-10 from the DC-10. Therefore, DC-10 wind corrections should be used for the MD-10. Using the wind additive appropriate for the MD-11 reduces airspeed safety margins on MD-10 aircraft especially at low altitude while on approach.
- The handling characteristics of the MD-11 are distinctly different than the handling characteristics of the DC/MD-10. This is due to a longer wing with winglets, a longer fuselage and a horizontal stabilizer that is 60 percent the size of the DC-10. Additionally the MD-11 has an auto pitch trim system, Longitudinal Stability Augmentation System (LSAS) with the feature that auto trims when hand flying
- In order to receive a common type rating, the FAA required that the MD-11 and MD-10 have flying and handling characteristics that were similar. The easiest way to accomplish this was to change the MD-11 Flight Control Computer (FCC) software to make the MD-11 fly similar to the MD-10. New FCC software, the FCC-908 load, was introduced and is required in order to fly both the MD-11 and MD-10. While most of the FCC-908 load changes have improved the handling characteristics of the MD-11, the changes have not made the MD-11 fly like the DC/MD-10.
- Until November 2004, FedEx IOE (Initial Operating Experience) students were not required to fly more than one of the MD-10/11 type variants (MD-11, or either the MD-10-10 or the -30). The entire IOE may well have been conducted in just one version.
- At the time the First Officer was trained, the first time a FedEx pilot performed an MD-10 landing was in the actual aircraft, and could have been many months after completing differences training.
- The FedEx MD10-30 simulator is not being used for Proficiency Checks (PCs) due to considerations of the FAA-certified MD-11 and MD-10 training syllabus.

- Many MD-11 pilots, especially those acting frequently as Relief First Officers (RFO's), have not been able to maintain currency in the aircraft and must get their required three takeoffs and three landings in the simulator.
- Certifying the MD-10 with a same type rating as the MD-11 and not requiring currency in both aircraft has resulted in pilots going months and in some cases years between flying each aircraft. The First Officer in this accident was conducting only her third landing in the MD-10 in the preceding 12 months, including the one the day before.

### **Recommendations:**

1. Require an immediate review of wind additives for the MD-11 and MD-10 be conducted to insure the MD-10 is being operated safely.
2. When a second MD-10 simulator is added, it should be in an MD-10-10 configuration.
3. Require that operators of the MD-10 train so that IOE legs are flown in the MD-11 and both MD-10 variants.
4. Require that operators, who fly MD-11 and MD-10 aircraft, give pilots annual recurrent training on the differences in MD-10 piloting technique if they have not flown the aircraft during the previous year.
5. Require modification to the MD-10 and MD-11 windshear alert and guidance system (WAGS) to make it active until touchdown.

## **3. METEOROLOGY**

By looking at the meteorological data gathered during the investigation, it is evident that while the winds that appear to have been present during landing were within limits, the exact winds affecting the aircraft during the landing flare were not measured outside the aircraft. The shifting, gusty winds contributed to the sequence of events that led to the accident.

### **A. General Synopsis**

Wind Measuring Equipment (formerly part of a Low Level Wind Shear Alert System [LLWAS]) located at MEM provided information about the wind speed and direction on the day of the accident. The sensor is located approximately 1 statute mile northwest of the accident site and is mounted 80 feet above the ground. Data derived from the sensor is a 2-minute average updated approximately every 10 seconds. It should be noted that a gust will not be registered unless it is 9.6 knots or greater than the sustained wind. This system only gives a sample of winds at 80 feet, one mile northwest from where the aircraft came to rest, not in the actual approach path of the aircraft.

Data from the sensor indicated that the sustained wind speed increased from 14 knots at 1824:53Z (1224:53 LST) to about 23 knots at 1826:45Z (1226:45 LST). During this period of time, a maximum gust of 29 knots was registered. Graphical display of all data showed that there were numerous shifts in the sustained wind from 1800Z to 1845Z, as well as a number of reported gusts.

According to the Meteorology factual report, during the last 10 seconds of the approach, the sustained winds were out of 320 degrees at a speed of 18 - 19 knots, with gusts to 29 knots. The Aircraft Performance Group factual report presents winds shifting from 295 degrees to approximately 350 degrees and back to 305 degrees, all within the last 10 seconds of flight. Also during this time, the wind speed at the sensor location starts at 33 knots, goes down to 17 knots at landing with a 24 knot gust five seconds before landing.

### **Findings:**

- The wind sensor, one mile away from the accident site, recorded gusty and variable winds at its location during the last 10 seconds of flight.
- At the sensor location there was a 55 degree wind shift followed by another 45 degree shift at the sensor location, during the last 10 seconds of flight.
- At the same sensor location, wind speed drops 16 knots during the final 10 seconds of flight.

## **4. SURVIVAL FACTORS**

Thanks to the fast and professional response of the fire and rescue crews that responded to the accident, there were no serious injuries. Since this was a nonfatal accident, this serves as an excellent opportunity to look at the survival factors aspects of the accident, as well as the ARFF response. The accident crew had difficulty exiting the aircraft due to an evacuation slide failure. In addition, there was confusion about how many people were on board the aircraft. Neither of these issues resulted in a fatal or serious injury in this accident, but the potential hazard is clear. Finally, ALPA's review of the overall evacuation experience suggests that there are several improvements that could be made to aid the crew in the event of an emergency evacuation.

### **A. Escape Slide Issues**

Due to the FedEx fleet being composed largely of aircraft that started out with other carriers, the escape slide configurations and procedures for manual deployment vary from aircraft to aircraft. This can lead to confusion for occupants or improper deployment of the escape slide system. The slides on the accident aircraft were certified to a lower standard than the current slide requirements, and does not meet the current wind requirements. After the accident, one of the

two installed slides was not useable to the presence of fire, and the other blew under the aircraft fuselage when deployed, rendering it useless and forcing the crew to find another means of egress from a burning aircraft.

The FedEx MD-10-10 involved in this accident was equipped with both escape slides and escape tape. The escape slides are located at doors L1 and R1, and are activated when the slide system is armed and the door is opened. The slides can be manually deployed by using the manual deploy handles. A DC-10 Jumpseat Briefing Guide was found in a pocket on the back of the lavatory door. Figure 6 in the briefing guide, under “Emergency Exits”, illustrated how to inflate the slide if it does not automatically inflate. The figure shows an arrow pointing to the girt bar flap assembly that instructs the user to 1. Lift Flap, and 2. Pull Handle. In the diagram on the Jumpseat Briefing Guide, it is difficult to determine which handle to pull: the one marked “PULL” or the red triangular handle (the red triangular handle is the one that should be pulled). This diagram is misleading, and could cause the crew to pull the wrong handle, releasing the slide from the aircraft.

Two aircraft escape tapes (thin ribbons of reinforced synthetic material) are located above the clearview windows in the cockpit. These are intended to allow crewmembers to evacuate escape from the aircraft by rappelling down the fuselage. If one of the crewmembers had been injured or unconscious after the accident, there would have been no safe way to evacuate that person from the aircraft. If the L1 slide had not malfunctioned, other crewmembers could have assisted in evacuating an injured or unconscious person from the aircraft. The L1 doorsill of this MD-10 was too high after the accident (16 feet, 10 inches) to be easily used to evacuate an injured or unconscious person without causing greater injuries.

While there are risks to persons using evacuation slides, it is unlikely that two crewmembers would have been injured as was experienced in the evacuation of FedEx 647. The first officer suffered second degree friction burns to her hands while using the escape tape. One of the jumpseat riders also suffered abrasions to his shoulder, neck and back during the evacuation. Because of the risks of using the escape tape, and the inability of incapacitated crewmembers to use it, a safer alternate egress method, such as inertia reels, must be incorporated. An inertia reel would allow an injured or incapacitated crew member to be slowly lowered to the ground. The inertia reels allows a speed-controlled descent from the aircraft cabin to the ground, reducing the potential for injuries from escape tape and impact with the ground.

## **B. FedEx Slide Training and Training Aids**

When the Survival Factors group visited the FedEx training center in Memphis, they determined that prior to January 2004, there was no girt bar attached to the girt bar locking brackets at the doorsill on the MD-10 door training device. Without the girt bar, crews are unable to properly train for manual slide inflation. A flight-training manager at FedEx stated that when the girt bar flap had been installed on the MD-10 door trainer, the use of the manual inflation handle was not part of the Emergency Procedures Training (EPT) hands-on exercise. A FedEx check airman stated that he recalled that procedures for operating the manual lanyards attached to the

slide were taught during classroom instruction. He said that demonstration and practical application of those procedures were not practiced. It was also noted that the escape slide simulator at FedEx was not configured and painted to closely resemble the installation in the actual aircraft. This can lead to difficulties when attempting to manually inflate the escape slide.

## **C. ARFF Response**

### **1. Confusion about Souls on Board**

The Chief of Memphis Airport Station #33 was originally informed by the Memphis air traffic control tower (ATCT) that there were 3 people on board flight 647. The ARFF Chief further stated that he was not aware of any FedEx airplanes that carried more than 10 people on board their flights. During the investigation, FedEx representatives informed the Safety Board that they sometimes transport as many as 27 persons on their wide body airplanes. Because of this, the FAA issued CertAlert No. 04-01, "Passengers and Crew on Cargo Aircraft" (Attachment B) on March 1, 2004. This CertAlert states:

A recent aircraft accident has demonstrated a potential problem with determining the passenger and crew loading on cargo aircraft.

The incident aircraft was a cargo MD-10 (old DC-10). At the time of this incident, the ARFF crew at the airport assumed that the cargo MD-10 would have no more than 3 crew members aboard, total. When the incident occurred, it became a no notice Alert 3, without time for Air Traffic (ATCT) personnel to request the routine Alert information including "souls on board."

Arriving ARFF units were surprised to see 7 personnel egress the aircraft. A briefing with the cargo operator after the accident revealed that on its MD-10 aircraft, there could be as many as 27 personnel on board, at any time. Additionally, in some configurations personnel are located in the rear of the fuselage section. This is usually used during livestock transportation with the handlers in the rear, but may occur for other reasons.

If, after the accident, the crew was unable to advise ARFF of the total personnel on board, some passengers could be trapped based on an assumption of expected and limited crew.

The FAA suggests that airport operators and/or ARFF crews contact their cargo operators and explore avenues to determine the number of personnel that could possibly be expected on a particular aircraft. If possible, pre-plan with cargo operations for a way to obtain personnel manifests for incoming flights. At the minimum, expect that there could be a far greater number of personnel aboard than expected.

If there had been additional occupants in the rear of the aircraft, and with the length of time that the fire crews experienced knocking down the fire, there could have been occupants or crew that possibly could not have been rescued. It is necessary to educate ARFF and ATCT personnel at all airports, that a cargo aircraft can contain more than just the operating crew, and that it should be given the same response that a passenger aircraft would receive.

## **2. ARFF and ATC Communications**

The Rural Metro Fire Department (RMFD), located on the FedEx ramp, had difficulties responding to the accident due to an incoming airplane on runway 27/9. ATC allowed that aircraft to land which delayed the RMFD fire truck for about 1 – 1½ minutes.

The Manager of Airport Operations commented on why he thought the Memphis Air Traffic Control Tower (MATCT) required RMFD to hold at Runway 9/27 and await the landing of a commercial airplane before proceeding to the accident site. He thought that the MATCT may have not understood the magnitude of the accident or the intensity of the airplane fire, and there may have been some confusion when the MATCT first communicated with RMFD.

### **D. Evacuation Checklist**

Based on our review of all survival factors in this accident, ALPA feels it would be appropriate to install the “Emergency Evacuation Checklist” on the pilots chart holder on both yokes. It should be printed in luminescent print to allow for visibility in low-light conditions. This simple change could save a crew a couple of minutes, resulting in increased survival prospects for the crew as well as any other occupants.

### **Findings:**

- Due to the FedEx fleet being composed largely of aircraft that started out with other carriers, the escape slide configurations and procedures for manual deployment vary from aircraft to aircraft. This can lead to confusion or improper deployment of the escape slide system.
- The slides on the accident aircraft were certified to a lower standard than required by current slide requirements. These slides did not meet the current wind requirements. One slide was unusable due to fire, and the other blew under the aircraft fuselage when deployed, rendering it useless, and forcing the crew to find another means of egress from a burning aircraft.
- Since the slide was unusable, the crew had to rely on egressing out the Captain’s and First Officer’s clearview windows using escape tape.
- Because of the construction of escape tape, a thin ribbon of reinforced synthetic material, one of the crew suffered burns to the hands. If a crewmember had been incapacitated,

there would have been no means to evacuate him or her safely from the burning wreckage.

- One crewmember was injured by falling while trying to use the escape tape.
- Prior to January 2004 there was no girt bar attached to the girt bar locking brackets at the doorsill on the FedEx MD-10 door training equipment at the Memphis, Tennessee training facility. Without the girt bar, crews are unable to train for manual slide inflation on a door that accurately models the actual aircraft.
- During the investigation, it was found that FedEx MD-11 and MD-10 crews were not getting “hands-on” experience with escape slide manual inflation. A flight-training manager at FedEx stated that when the girt bar flap had been installed on the MD-10 door training equipment, the use of the manual inflation handle was not part of the Emergency Procedures Training (EPT) hands-on drill.
- A FedEx check airman stated that he recalled that procedures for operating the manual lanyards attached to the slide were taught during classroom instruction. He said that demonstration and practical application of those procedures were not practiced.
- ATC informed the Chief of Airport Fire Station #33 that there were only 3 souls on board the airplane, based solely on an erroneous assumption, not on information obtained from the flight crew or dispatch. This resulted in a smaller ARFF response in the early stages of the accident.
- The Rural Metro Fire Department (RMFD), located on the FedEx ramp, had difficulties responding to the accident due to an incoming airplane on runway 27/9. ATC allowed that aircraft to land which delayed the RMFD fire truck for about 1 – 1½ minutes.

### **Recommendations:**

1. Require that all aircraft equipped with escape slides be retrofitted with slides that meet the current FAR 25.810 requirements.
2. Require operators and aircraft manufacturers to install an inertia reel at slide equipped doors to function as a backup in the event of escape slide malfunction. This will allow evacuation without the risk of “rope burns” or falling to the ground. This will also aid in evacuation of passengers or crew who may have become incapacitated.
3. Require that operators install the “Emergency Evacuation Checklist” on the pilots chart holder on both yokes. It should be printed in luminescent print to allow for visibility in low-light conditions.

4. Emergency evacuation training should be conducted by all operators on all Proficiency Training and Proficiency Checks.
5. Require operators to add training on manual inflation of the escape slide as part of the Emergency Procedures Training (EPT) hands-on drill.
6. Require all escape slide simulators to be configured and painted to more closely resemble the installation in the actual aircraft.
7. Communicate with all ARFF and air traffic control tower personnel at airports that wide body cargo aircraft operate from and convey that they sometimes transport as many as 27 persons on their wide body airplanes, many of which will be in the aft section of the plane.
8. Develop an addition to the flight training syllabus at cargo carriers that carry occupants in the rear of the aircraft, to create awareness on the part of the crewmembers on how to deal with an emergency evacuation involving passengers occupying the seat pallets in the rear of the aircraft.
9. Verify that all airports and ARFF stations have received a copy of FAA CertAlert No. 04-01, "Passengers and Crew on Cargo Aircraft".

## **5. AIRWORTHINESS**

There were no preexisting structural problems with the aircraft, and it was airworthy at touchdown. The right main landing gear contacted the runway at approximately 14.4 feet per second which exceeded the structural limits of the landing gear.

## **6. FLIGHT DATA RECORDER**

This section is intended to provide an analysis of the data obtained from the Flight Data Recorder (FDR) installed on this aircraft. This was accomplished through a review of the FDR data and review of the FDR Study.

### **A. Wind Recorded on the FDR**

During the final 62 seconds of the approach, the aircraft encountered strong, gusty winds. The wind shifted from 295 degrees to 323 degrees between 12:25:22 and 12:25:30 (see Figure 1). In the next four seconds the wind continues to shift directions, going to 338 degrees, a 47 degree shift, just six seconds prior to touchdown. The wind then shifts back to 302 degrees approximately two seconds from touchdown. At the same time, there are several wind gusts. The wind for the final minute of flight averages approximately 28 knots, with speeds ranging

from 24 to 33 knots (see Figure 2). Between 12:25:38 to 12:25:42, the wind increases from 28 knots up to 33 knots. During the next four seconds (between ten and six seconds before touchdown) the wind speed drops from 33 knots down to 17 knots, a 16 knot decrease. Two seconds before touchdown, the wind increases to 21 knots, and then falls to 15 knots just after touchdown.

During this time, the sink rate of the right main landing gear (RMLG) increased after touchdown of the left main landing gear (LMLG), resulting in a firm touchdown of the RMLG. While the first officer made an eight degree input on the control column correctly at 30 feet to start the flare, the input was insufficient to arrest the descent in the time before touchdown. In the final 120 feet of the approach, the head wind drops 9 knots, from 20 knots per hour to 11 knots per hour.

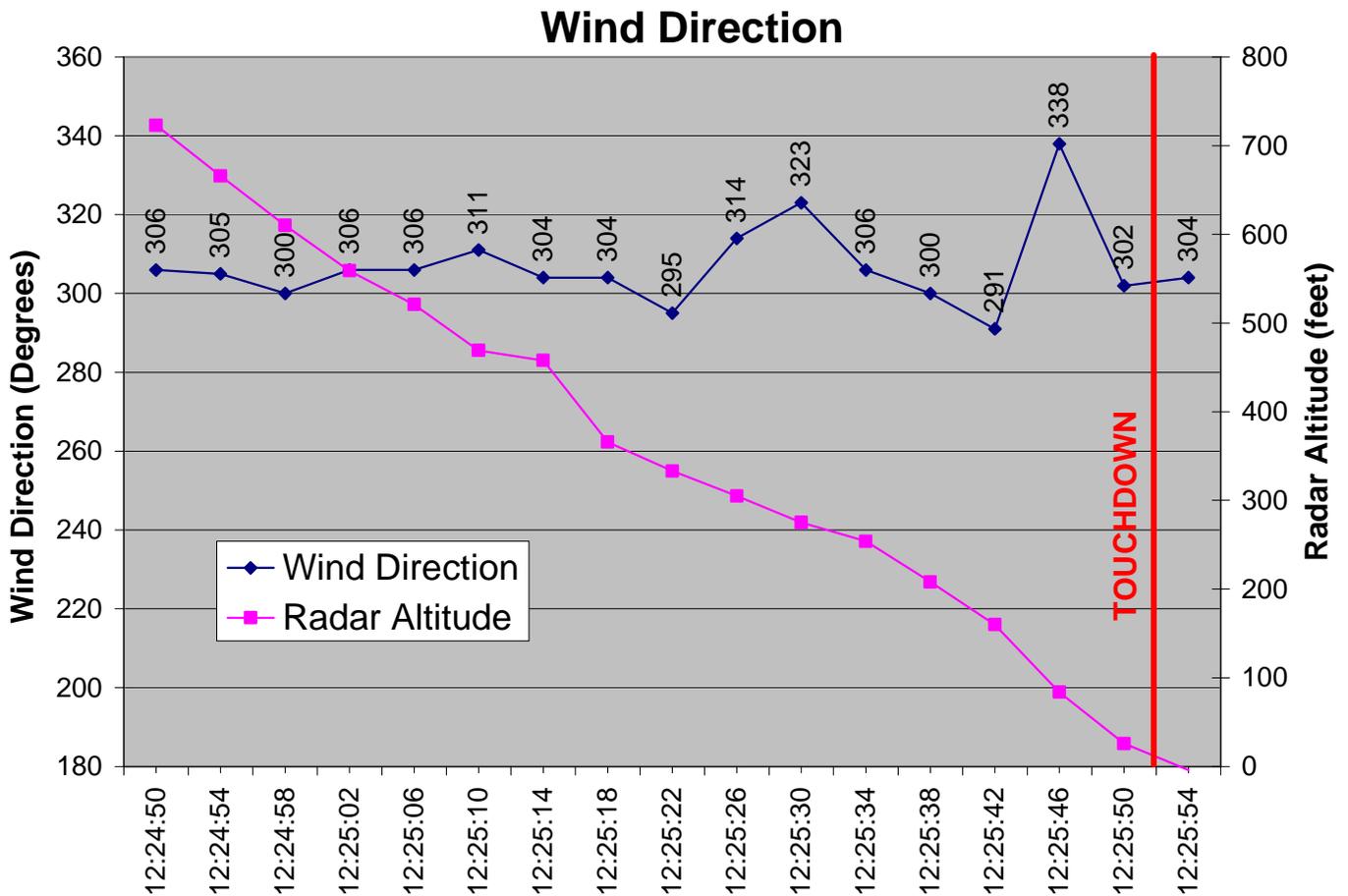


Figure 1

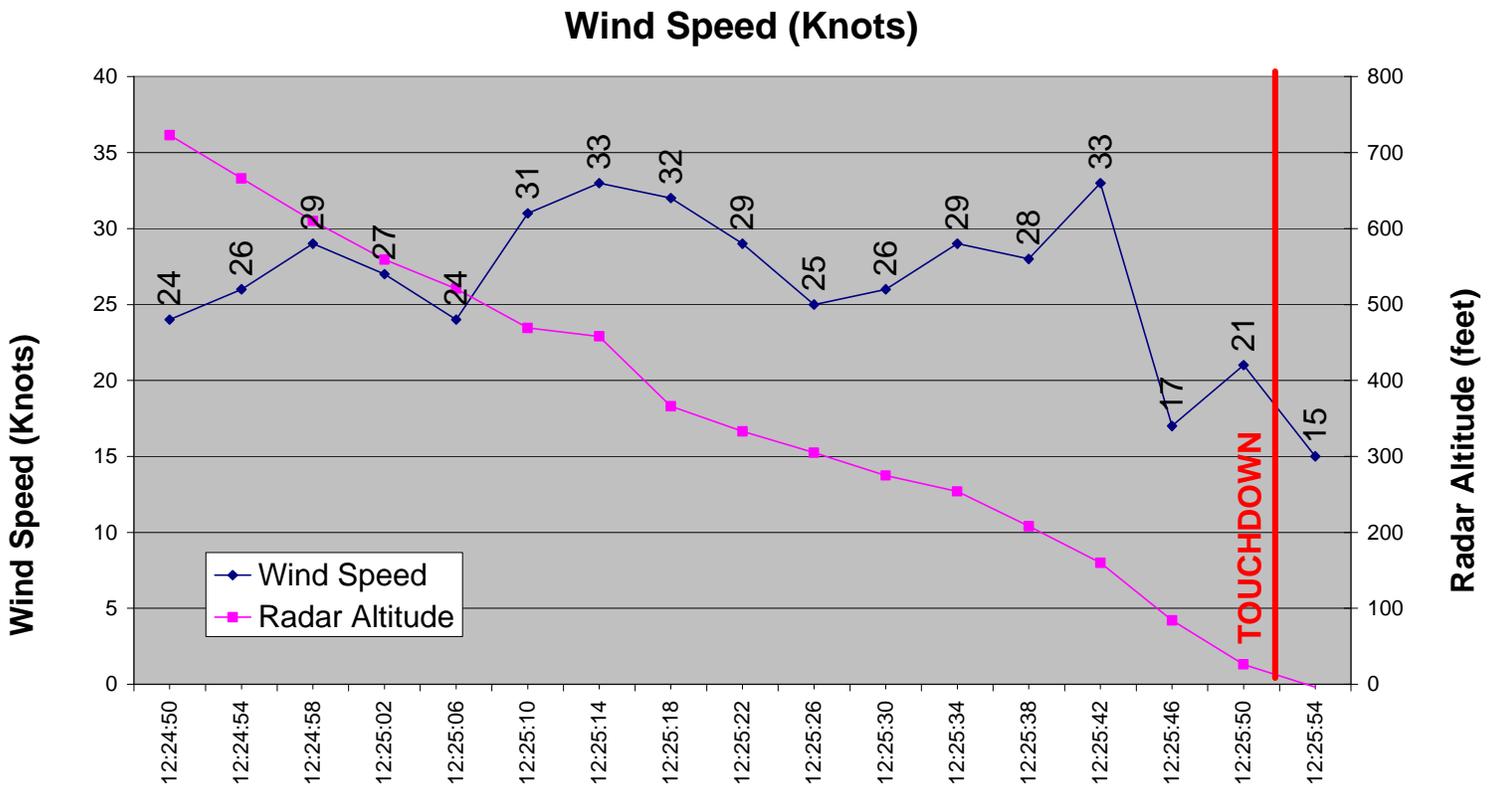


Figure 2

### B. Aileron Sampling

While not a factor in the accident, the FDR group found that the parameters recorded for aileron position on this recorder does not meet the requirements of 14 CFR Part 121.344 Appendix M. The FDR is recording values 4 times per second for each aileron position; however, the update rate of the data source is not sufficient. The FDR Study found:

The values for each aileron form 6 sets of triplets followed by a doublet of repeated values over a 5 second period. This is an update rate of approximately 700 ms, not the required 500 ms rate. The Safety Board has found similar problems with other aircraft FDR systems and has issued Safety Recommendation A-03-015, which addresses the other specific aircraft with this problem, and Safety Recommendation A-03-016, which recommends that the FAA survey all other aircraft required to have flight data recorders to ensure they meet the requirements of 14 CFR Part 121.344 Appendix M.

The FAA conducted a study into the cost of complying with Safety Recommendation A-03-016. The FAA replied in a letter to the NTSB dated August 11<sup>th</sup>, 2004:

The FAA conducted a preliminary review of the impact of complying with this safety recommendation. To do what the Board is asking will require evaluating more than 6,500 aircraft, with an approximate cost of \$3,500 to analyze each aircraft. This is an enormous economic impact on the industry. Consequently, my staff contacted your staff to discuss this safety recommendation. It was agreed that it would be more cost effective to query the aircraft manufacturers on design criteria for data collection on their individual aircraft models rather than evaluate specific aircraft for compliance with the parameter requirements of 14 CFR 121.344, Appendix M. Consequently, the FAA will request that aircraft manufacturers not covered in the response to Safety Recommendation A-03-15 provide the FAA with design criteria on their flight data recorders for obtaining Appendix M data. Upon completion of this design assessment, the FAA will be able to identify necessary changes to bring affected aircraft into compliance. I will keep the Board informed of the FAA's progress on this safety recommendation.

The NTSB responded to the FAA in a letter dated January 28<sup>th</sup>, 2004. The letter stated:

The Safety Board notes that the FAA conducted a preliminary review of the financial impact of complying with this safety recommendation. This review showed there is an enormous economic impact on the industry for collecting this information. As a more cost-effective alternative, the FAA plans to request that aircraft manufacturers provide the FAA with design criteria for their FDR systems. Upon completion of this design assessment, the FAA will identify necessary changes to bring affected aircraft into compliance. The Safety Board agrees that the FAA's proposal to query manufacturers on design criteria for data collecting on their individual aircraft models is a cost-effective alternative method of satisfying this recommendation. The Board urges the FAA to include cockpit display manufacturers in the planned design assessment. The Board believes that the involvement of these manufacturers is critical in identifying the fundamental cause of the FDR discrepancies. Pending completion of the survey of manufacturers on FDR design criteria for obtaining Appendix M data, and the identification and mandating of necessary changes to bring affected aircraft into compliance with Part 121.344, Appendix M, Safety Recommendation A-03-16 is classified "Open-Acceptable Alternate Response."

While the financial burden may be high for a study of all installed FDRs, this accident makes it clear that some additional action must be taken in order to ensure that FDR systems accurately and reliably receive and record actual aircraft system performance parameters. The NTSB and FAA should reexamine this recommendation, and determine if the alternate action is truly acceptable.

According to the NTSB, it has been suggested that one solution to the repeating values in the aileron parameters would be to selectively ignore several of the samples of the recorded data resulting in the aileron positions being alternately sampled. This would provide the required sample rate, but would not give good data. The FDR Study found:

Although the requirements allow for the control surfaces to be alternately sampled to produce the required sampling rate, the intent of the requirement is that the sampled parameter be able to uniquely determine the position of all related surfaces within a window of time equal to the sampling rate, 500 ms in this case. The solution of alternately sampling all four aileron positions would not meet this requirement because the aileron system in the MD-10 is equipped with a lockout mechanism that locks out a pair of ailerons during certain conditions. A data point from a locked out aileron could not provide any indication of the position of the non-locked out ailerons. Using this method, the two pairs of ailerons, inboard and outboard, would have to be alternately sampled separately for this aircraft. However, using two pairs of alternately sampled aileron parameters would not meet the requirement that the parameters indicate the positions of the ailerons within the 500 ms window if the data came from the current source. As seen in the Aileron Sampling Plot in the FDR Study, the update of each of the aileron parameters for each pair are updated within 250 ms of each other. Using the current data source and update rate, it is possible that both aileron position FDR samples in an alternately sampled pair could represent data from two different sources which occurred within 250 ms of each other, not 500 ms apart as it would appear in the data map, thus effectively increasing the sample rate interval to 1000 ms, not the required 500 ms interval. Although selectively choosing certain samples from FDR plot could yield the desired results, the samples will drift because of the difference in the update and sample rates and the possibility that the recorder is capturing redundant samples cannot be eliminated.

Alternately sampling control surfaces from a source that is not updated frequently enough to meet the requirements does not alleviate the problem, it hides it and introduces an unknown latency into the system. In order to meet the requirement, the data stream being captured by the FDR system must be updated with a freshly sampled value at least as frequently as the required sample rate for the parameter.

To solve this problem we must either use a different source for the aileron position data with a refresh rate at least as high as the sampling requirement, or change the current system so that it updates at a high enough rate to meet the requirement.

### **Findings:**

- The aircraft encountered strong, variable and gusting winds during the last 60 seconds of flight.
- According to FDR data there was a 47 degree wind shift, from 291 degrees to 338 degrees, just six seconds prior to touchdown.
- The FDR also recorded wind gusts with speeds ranging from 24 to 33 knots one minute before touchdown.

- Between ten and six seconds before touchdown, the FDR recorded wind speed drops from 33 knots down to 17 knots, a 16 knot decrease.
- Two seconds before touchdown, the FDR recorded a wind increase to 21 knots, and then falls to 15 knots just after touchdown.
- The aileron position data recorded on the FDR does not comply with FAA requirements.

### **Recommendations:**

1. The NTSB and FAA should reexamine Safety Recommendation A-03-016, which recommends that the FAA survey all other aircraft required to have flight data recorders to ensure they meet the requirements of 14 CFR Part 121.344 Appendix M, and determine if the alternate action is truly acceptable.
2. The FAA should mandate that the aircraft manufacturer should either use a different source for the aileron position data with a refresh rate at least as high as the sampling requirement, or change the current system so that it updates at a high enough rate to meet the requirement

## **7. COCKPIT VOICE RECORDER**

**Not a factor.**

## **8. AIRPLANE PERFORMANCE**

The airplane encountered strong, gusting winds in the final 60 seconds of flight. These winds produced significant, rapid changes in both the headwind and crosswind components acting on the aircraft. These rapid changes, in turn, affected the airplane performance and the ability of the flying pilot to react to the changes. DFDR data shows that a flare was begun at the appropriate height of 30 feet, but the control input was insufficient to arrest the sink rate prior to ground contact. The First Officer manipulated the aileron and rudder consistent with the crosswind that appears to have been present, i.e. left aileron with right rudder. The airplane touched down first on the left main landing gear, followed by the right. The performance group identified elevator movement from approximately 2 3/4 deg airplane nose up to 12 3/4 degree airplane nose up at about the same time that the right gear touches down. The right main landing gear contact occurred at approximately 14.4 feet per second, exceeding the structural limits of the landing gear.

## 9. MATERIALS LABORATORY REPORT

**Not a factor.**

## 10. FINDINGS

1. The MD-10 program has effectively improved the capability and service life of the DC-10 airframes, however, the program does not change the flying characteristics of the MD-11 or MD-10 enough to enable them to be called the same aircraft.
2. While the MD-10 and MD-11 are certified as the same type, no changes were made to the wings, flight controls or engines of the MD-10 from the DC-10. Therefore, DC-10 wind corrections should be used for the MD-10. Using the wind additive appropriate for the MD-11 reduces airspeed safety margins on MD-10 aircraft especially at low altitude while on approach.
3. The handling characteristics of the MD-11 are distinctly different than the handling characteristics of the DC/MD-10. This is due to a longer wing with winglets, a longer fuselage and a horizontal stabilizer that is 60 percent the size of the DC-10. Additionally the MD-11 has an auto pitch trim system, Longitudinal Stability Augmentation System (LSAS) with the feature that auto trims when hand flying
4. In order to receive a common type rating, the FAA required that the MD-11 and MD-10 have flying and handling characteristics that were similar. The easiest way to accomplish this was to change the MD-11 Flight Control Computer (FCC) software to make the MD-11 fly similar to the MD-10. New FCC software, the FCC-908 load, was introduced and is required in order to fly both the MD-11 and MD-10. While most of the FCC-908 load changes have improved the handling characteristics of the MD-11, the changes have not made the MD-11 fly like the DC/MD-10.
5. Until November 2004, FedEx IOE (Initial Operating Experience) students were not required to fly more than one of the MD-10/11 type variants (MD-11, or either the MD-10-10 or the -30). The entire IOE may well have been conducted in just one version.
6. At the time the First Officer was trained, the first time a FedEx pilot performed an MD-10 landing was in the actual aircraft, and could have been many months after completing differences training.
7. The FedEx MD10-30 simulator is not being used for Proficiency Checks (PCs) due to considerations of the FAA-certified MD-11 and MD-10 training syllabus.
8. Many MD-11 pilots, especially those acting frequently as Relief First Officers (RFO's), have not been able to maintain currency in the aircraft and must get their required three takeoffs and three landings in the simulator.

9. Certifying the MD-10 with a same type rating as the MD-11 and not requiring currency in both aircraft has resulted in pilots going months and in some cases years between flying each aircraft. The First Officer in this accident was conducting only her third landing in the MD-10 in the preceding 12 months, including the one the day before.
10. Due to the FedEx fleet being composed largely of aircraft that started out with other carriers, the escape slide configurations and procedures for manual deployment vary from aircraft to aircraft. This can lead to confusion or improper deployment of the escape slide system.
11. The slides on the accident aircraft were certified to a lower standard than required by current slide requirements. These slides did not meet the current wind requirements. One slide was unusable due to fire, and the other blew under the aircraft fuselage when deployed, rendering it useless, and forcing the crew to find another means of egress from a burning aircraft.
12. Since the slide was unusable, the crew had to rely on egressing out the Captain's and First Officer's clearview windows using escape tape.
13. Because of the construction of escape tape, a thin ribbon of reinforced synthetic material, one of the crew suffered burns to the hands. If a crewmember had been incapacitated, there would have been no means to evacuate him or her safely from the burning wreckage.
14. One crewmember was injured by falling while trying to use the escape tape.
15. Prior to January 2004 there was no girt bar attached to the girt bar locking brackets at the doorsill on the FedEx MD-10 door training equipment at the Memphis, Tennessee training facility. Without the girt bar, crews are unable to train for manual slide inflation on a door that accurately models the actual aircraft.
16. During the investigation, it was found that FedEx MD-11 and MD-10 crews were not getting "hands-on" experience with escape slide manual inflation. A flight-training manager at FedEx stated that when the girt bar flap had been installed on the MD-10 door training equipment, the use of the manual inflation handle was not part of the Emergency Procedures Training (EPT) hands-on drill.
17. A FedEx check airman stated that he recalled that procedures for operating the manual lanyards attached to the slide were taught during classroom instruction. He said that demonstration and practical application of those procedures were not practiced.
18. ATC informed the Chief of Airport Fire Station #33 that there were only 3 souls on board the airplane, based solely on an erroneous assumption, not on information obtained from the flight crew or dispatch. This resulted in a smaller ARFF response in the early stages of the accident.

19. The Rural Metro Fire Department (RMFD), located on the FedEx ramp, had difficulties responding to the accident due to an incoming airplane on runway 27/9. ATC allowed that aircraft to land which delayed the RMFD fire truck for about 1 – 1½ minutes.
20. The aircraft encountered strong, variable and gusting winds during the last 60 seconds of flight.
21. According to FDR data there was a 47 degree wind shift, from 291 degrees to 338 degrees, just six seconds prior to touchdown.
22. The FDR also recorded wind gusts with speeds ranging from 24 to 33 knots one minute before touchdown.
23. Between ten and six seconds before touchdown, the FDR recorded wind speed drops from 33 knots down to 17 knots, a 16 knot decrease.
24. Two seconds before touchdown, the FDR recorded a wind increase to 21 knots, and then falls to 15 knots just after touchdown.
25. The wind sensor, one mile away from the accident site, recorded gusty and variable winds at its location during the last 10 seconds of flight.
26. At the sensor location there was a 55 degree wind shift followed by another 45 degree shift at the sensor location, during the last 10 seconds of flight.
27. At the same sensor location, wind speed drops 16 knots during the final 10 seconds of flight.
28. The aileron position data recorded on the FDR does not comply with FAA requirements.

## **11. SAFETY RECOMMENDATIONS**

ALPA offers the following Safety Recommendations to attempt to correct deficiencies identified during the course of this accident investigation.

### **To the Federal Aviation Administration (FAA)**

1. Require an immediate review of wind additives for the MD-11 and MD-10 be conducted to insure the MD-10 is being operated safely.
2. When a second MD-10 simulator is added, it should be in an MD-10-10 configuration.
3. Require that operators of the MD-10 train so that IOE legs are flown in the MD-11 and both MD-10 variants.

4. Require that operators, who fly MD-11 and MD-10 aircraft, give pilots annual recurrent training on the differences in MD-10 piloting technique if they have not flown the aircraft during the previous year
5. Require modification to the MD-10 and MD-11 windshear alert and guidance system (WAGS) to make it active until touchdown.
6. Require that all aircraft equipped with escape slides be retrofitted with slides that meet the current FAR 25.810 requirements.
7. Require operators and aircraft manufacturers to install an inertia reel at slide equipped doors to function as a backup in the event of escape slide malfunction. This will allow evacuation without the risk of “rope burns” or falling to the ground. This will also aid in evacuation of passengers or crew who may have become incapacitated.
8. Require that operators install the “Emergency Evacuation Checklist” on the pilots chart holder on both yokes. It should be printed in luminescent print to allow for visibility in low-light conditions.
9. Emergency evacuation training should be conducted by all operators on all Proficiency Training and Proficiency Checks.
10. Require operators to add training on manual inflation of the escape slide as part of the Emergency Procedures Training (EPT) hands-on drill.
11. Require all escape slide simulators to be configured and painted to more closely resemble the installation in the actual aircraft.
12. Communicate with all ARFF and air traffic control tower personnel at airports that wide body cargo aircraft operate from and convey that they sometimes transport as many as 27 persons on their wide body airplanes, many of which will be in the aft section of the plane.
13. Develop an addition to the flight training syllabus at cargo carriers that carry occupants in the rear of the aircraft, to create awareness on the part of the crewmembers on how to deal with an emergency evacuation involving passengers occupying the seat pallets in the rear of the aircraft.
14. Verify that all airports and ARFF stations have received a copy of FAA CertAlert No. 04-01, “Passengers and Crew on Cargo Aircraft”.
15. The NTSB and FAA should reexamine Safety Recommendation A-03-016, which recommends that the FAA survey all other aircraft required to have flight data recorders to ensure they meet the requirements of 14 CFR Part 121.344 Appendix M, and determine if the alternate action is truly acceptable.

16. The FAA should mandate that the aircraft manufacturer should either use a different source for the aileron position data with a refresh rate at least as high as the sampling requirement, or change the current system so that it updates at a high enough rate to meet the requirement.

# **APPENDIX A**

## **Correspondence on Common Type Rating**

# FEDEX PILOTS ASSOCIATION

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1669 Kirby Parkway, Suite 202 • Memphis, TN 38120  
(901) 752-8749/1-888-372-4339  
Fax (901) 752-9097/1-888-542-8831  
e-mail: fedexpa@fedexpilot.org  
<http://www.fedexpilot.org>

FEBRUARY 3, 2000

VIA OVERNIGHT LETTER

**Jane F. Garvey, Administrator**  
**Federal Aviation Administration**  
**National Headquarters**  
800 Independence Ave., S.W.  
Washington, D.C. 20591

Re: Inherent Safety Problems with the allowance of a Common Type Rating for those pilots flying the MD-10 and MD-11

Dear Administrator Garvey:

On behalf of the 3600 pilots it represents, the FEDEX PILOTS ASSOCIATION (FPA) urges careful **deliberation** and caution regarding a same-type rating certification for the MD-10 and the MD-11 aircraft. Safety is a cornerstone of our organization and the possibility of this **same-type** certification raises significant concerns. Previously, we voiced dismay at the overall **aircraft** certification process with NTSB Chairman Hall. At the time, our comments expressed astonishment that all **aircraft** are certified to **land only on both main landing gear**. (This is possible *only* when there are no crosswinds.) This **discussion** arose out of a meeting on the loss of a FedEx MD-11 aircraft during **landing** at Newark Airport. Since that time, we have lost another MD-11 in a landing accident at Subic Bay, Philippines. In the interests of safety and preventable **mishaps**, we now go on record protesting the single type MD-10/MD-11 rating.

The Boeing Company, in conjunction with the Federal Express Corporation (FedEx), has embarked upon a program that will convert Boeing DC-10 aircraft to MD-10's. This conversion deletes the position of flight engineer with, in our opinion, **inadequate** measures to address his or her absence, especially in an **emergency situation**. **Although** the FPA supports the economic benefit to FedEx and accepts the **conversion of the DC-10 aircraft**, we oppose the proposition that a single type rating on **both aircraft** provides the **same** level of safety that individual **type** ratings provide. The **differences** between the MD-11 and MD-10 are too great to warrant a same-type **rating**.

Certainly, there is significant economic benefit to FedEx accrued through the same-type rating for both aircraft. However, the FPA assumes an array of risks as our pilots' lives and careers become unnecessarily jeopardized. The FPA believes that safety concerns must override commercial interests in this case.

The history of the Boeing MD-11 speaks for itself. It has the highest rate of fatal events compared to other airliners.<sup>1</sup> It should be noted that the MD-11 is a derivative of the DC-10, an aircraft with the 2<sup>nd</sup> highest rate of fatal events.<sup>2</sup> **The FPA believes** combining these two aircraft types with reduced systems automation and operated under a same-type rating is ill advised.

Every phase of flight in the MD-11 presents its own unique challenges that warrant specialized attention. Before the implementation of specific training to counter fundamental pilot reactions, tail strikes on takeoff and landing were a statistical certainty. In cruise, extreme pitch sensitivity demands extra care from the pilots as fatalities have already occurred in this usually "safe" phase of flight<sup>3</sup>. In addition, all Flight Management System (FMS) aircraft are especially demanding to operate in the approach and landing environment when last minute changes are made to landing instructions. Modifying the handling characteristics, then requiring a pilot to switch back and forth between aircraft, exacerbates the complexity and we fear will result in more mishaps.

The MD-11 can currently be dispatched with *only* one system in "manual" mode in acknowledgement of the high workload on the **pilots in** critical phases of flight. **The MD-10** would *always* have at least one system in "manual." During an **emergency**, automation is supposed to provide the support of **the** missing third pilot. Obviously, the third pilot is not available on the MD-10 or the MD-11. On the MD-10, automation **may not be there either**. These are very difficult **aircraft to** fly in the best of circumstances, **and the FPA** maintains that safety is best served when the pilots are specialized in an individual **aircraft**. The MD-10 and the MD-11 are not the same aircraft.

Pilots that are required to fly the majority of their careers in the middle of the night are continually faced **with** the issue of fatigue. As you are aware, pilots under supplemental rules are not guaranteed predeparture crewrest and are often unsure of what time of day or night they will be called to duty. This inexplicable lapse in **protection is an** oversight in desperate need of correction. An MD-10/MD11 same-type **rating** would have a detrimental impact on a tired pilot's response time. The differences on the flight deck will have few visual cues, but in actual aircraft response, the differences would be striking and potentially dangerous.

The FAA, the manufacturer, and FedEx have been apprised of our evaluation of the problems and our proposed solution. The FAA must require separate, independent type ratings for those pilots flying the MD-10 and the MD-11. As our National Airspace System grapples with the increasing saturation of our skies and "hublock" at our airports, pilots are tasked with more and more complicated maneuvers to increase frequency and reduce separation. An MD-10 pilot forced to fly an MD-11 under a same type rating introduces an unwarranted and unneeded new risk to the mix.

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<sup>1</sup> Todd Curtis, *AirSafe.com, Safety Information for the Airline Passenger*, (Revised Jan. 11, 2000)  
[http://www.airsafe.com/events/models/rate\\_mod.htm](http://www.airsafe.com/events/models/rate_mod.htm).

<sup>2</sup> Id.

<sup>3</sup> China Eastern 583, April 6, 1993 (2 fatalities)

Captain Dave Wells, Chairman of the FPA Safety Committee, First Officer Dan DeLane, Chairman of the FPA Accident Investigation Committee, and I look forward to meeting with you for further discussion. We are committed to working with the FAA to resolve the issue.

Very truly yours,



Michael J. Weiland

**President; FEDEX PILOTS ASSOCIATION**

cc: Chairman Hall, National Transportation Safety Board  
Congressman James L. Oberstar  
Congressman Ralph M. Hall  
Robert Cowell, Principal Operation Inspector, Federal Aviation Administration  
Captain Duane Woerth, President, Air Line Pilots Association  
Captain Robert Miller, President, **Independent** Pilots Association  
Captain Dave Wells, FPA Safety Committee Chairman  
**First** Officer Dan DeLane, FPA Accident Investigation Committee **Chairman**  
Edgar N. James, Attorney .

AFS-2100  
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JAN 4 2001

Mr. Michael J. Weiland  
President  
FedEx Pilots Association  
1669 Kirby Parkway, Suite 202  
Memphis, Tennessee 38120

Dear Mr. Weiland:

The Administrator has asked me to respond to you in followup to previous discussions between the Federal Aviation Administration (FAA) and you regarding the remaining concerns of the FedEx Pilots Association (FPA) and the Coalition of Airline Pilots Association about the MD-10 common type rating.

Since your meeting with us in October, the FAA headquarters staff has been in contact with FedEx's FAA inspectors in the Certificate Management Unit (CMU) regarding the following FPA concerns: (1) the consolidation of skills and knowledge in the Flight Standardization Board's (FSB) report relative to the slow introduction of MD-10's into the FedEx fleet; and, (2) the effect of the complexity of the FedEx system on pilot training requirements.

1. While the slow delivery rate of MD-10 aircraft might seem to present a consolidation of skills issue, there are several good reasons that prove this to be an advantage, not a concern. First, FedEx only recently certified an MD-10 flight simulator; therefore, the FAA had approved a limited number of highly qualified pilots (i.e., check airmen, etc.) to serve as pilots for the beginning of revenue operations. Most of the pilots in this initial cadre group were participants in the actual MD-10 flight test program, and FedEx trained this initial cadre of pilots using the FSB's approved Master Differences Requirements (MDR) training format. These same pilots are now flying the MD-10 and MD-11 aircraft for FedEx and are assisting in determining if any reverse differences need to be considered when a pilot returns to flying the MD-11. Presently, this is giving the FAA and FedEx the ability to evaluate the introduction of the MD-10; and, to date, this program has not identified any areas of concern.

An additional advantage is that the presence of only two MD-10 aircraft gives the CMU an opportunity to provide a high frequency of en route surveillance. FedEx plans to take delivery of its third MD-10 aircraft this month.

The FAA intends to monitor closely, as it has to date, the training and performance of the line crews as they progress through their qualifications. The FAA is continually monitoring the application of the differences program for the MD-10, and the FAA is committed to an ongoing and aggressive program of surveillance.

The Flight Control Computer (FCC) 908 Load, now installed in all FedEx MD-11 aircraft and simulators, provides the MD 11 with handling characteristic capabilities similar to the MD-10. This may be the most significant consideration in this entire program, and the CMU inspectors indicate that all results were outstanding after performing before-and-after evaluations of this software in FedEx's two Memphis-based MD-11 simulators.

At the request of the CMU, FedEx is evaluating whether a consolidation of knowledge and skills is still appropriate because the substance of the differences between the MD-10 and MD-11 no longer involve pilot skills. The present direction is to require pilots to reaccomplish initial differences training if they have not flown the aircraft in a 24-month period following initial training, and MD-10 differences training will continue to be a part of annual recurrent training. The present forecast is that when the MD-10 fleet is 23 to 25 percent of the total fleet, which should occur within 1 to 3 years, the frequency of MD-10 exposure would negate the need for consolidation requirements.

2. We acknowledge that FedEx does have its own unique cargo operations and, as such, has its own unique FAA-approved operations training program. Actual training levels established by FedEx to meet its unique operations, while maintaining an acceptable level of safety and proficiency, are under the constant scrutiny and review of the FAA's CMU.

In closing, the FAA established dedicated CMU's in order to have knowledgeable and qualified personnel onsite on a day-to-day basis, to oversee air carriers' training and check airman programs. These FAA inspectors have the responsibility and authority to assist in the development and implementation of any changes in FedEx's FAA-approved training program, as well as make recommendations to the FSB regarding any necessary changes in the MDR's. I encourage you to continue working with the CMU and FedEx to resolve any detailed issues with differences training

Sincerely,

**Original Signed By**

**Thomas E. McSweeney**

Thomas E. McSweeney  
Associate Administrator for  
Regulation and Certification

cc: AOA-3  
ADA-2  
AVR-1  
AFS-1 (20004490)  
AFS-200

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