SUBMISSION OF THE

AIR LINE PILOTS ASSOCIATION

TO THE

NATIONAL TRANSPORTATION SAFETY BOARD

REGARDING AN UPSET EVENT INVOLVING

MIDWEST AIRLINES FLIGHT 490

Union Star, Missouri

May 12, 2005

1. Executive Summary

On May 12, 2005, at about 2316 Central Daylight Time (CDT), a Boeing 717-200, operated by Midwest Airlines (MEA) as flight 490, experienced several significant pitch excursions while climbing through 19,000 feet in conditions conducive to structural icing. The airplane had departed Kansas City International airport (MCI) about 10 minutes earlier. The Captain was using the airplane's automatic flight control systems to fly the airplane and was maneuvering to avoid hazardous weather. Just prior to the initial pitch excursion he observed a "CONFIG" message on the Engine and Alert Display (EAD), and shortly thereafter both the auto-throttle system (ATS) and the autopilot disengaged. The airplane then entered into a series of significant altitude and airspeed excursions that continued for approximately 8 minutes until the crew was able to regain normal control. The crew then executed an emergency landing into Kirksville (IRK), Missouri without further incident. There were no injuries to the flight crew or passengers and no damage to the aircraft.

As party to this investigation, the Air Line Pilots Association, International (ALPA) is providing this submission to present our analyses of the factual records and provide recommendations to reduce the risk for future incidents or accidents that could occur under similar circumstances.

2. History of Flight

This was the second flight of the day for the crew and up until the time of the upset event, the trip sequence had been routine. There was rapidly changing severe weather in the area which was being carefully monitored by the crew. During their initial arrival into MCI from Los Angeles, the Captain had observed lightning in the area and requested to hold at Lincoln VOR. They eventually diverted to Omaha, Nebraska for additional fuel. After adding fuel the flight departed Omaha and landed at MCI at 2150 CDT in moderate rain.

The airplane departed the MCI gate at about 2231 CDT and according to the summary of events from the Cockpit Voice Recorder (CVR) Group Chairman's Factual Report the crew had covered all items on the COCKPIT PREP, BEFORE START, and AFTER START checklist while at the gate. As the airplane was taxied out to the departure end of the runway, the crew accomplished the TAXI checklist and subsequently the DELAYED ENGINE START checklist. They were aware that a weather system of convective activity to include cloud-to-ground lightning had quickly moved into the vicinity of MCI. The Captain advised Air Traffic Control (ATC) that they would wait on the ground until the weather system passed. The airplane remained parked near the end of the runway with one engine running for about 30 minutes as the crew waited for the weather in the area to improve. After accomplishing the BEFORE TAKEOFF checklist and monitoring a FedEx flight that

had just departed in their intended direction they departed MCI at approximately 2300 CDT. The Captain was the pilot flying (PF).

During post incident interviews there was no mention by the crew of any problems during the takeoff. The flight was in night Instrument Meteorological Conditions (IMC) and experienced a smooth ride during the climb. The Captain made use of the automation to control the airplane. The crew obtained ride reports from ATC and kept the flight attendants in their seats due to the weather in the departure area. The crew observed flashes of lighting, but was unable to discern a specific location. The Captain reported yellow returns on the cockpit weather radar and maneuvered the airplane via the autopilot to remain clear by 20 miles. At 2316:22, the flight began a 50 degree right turn towards a Northeasterly heading. There had been no anomalies up to that point, and the crew was conducting the flight in a professional and competent manner while attempting to avoid adverse weather.

At 2316:24, according to the Cockpit Voice Recorder (CVR) transcript, the Captain stated “we got a configuration alert” followed by the statement “rudder limiter fault”. Approximately 17 seconds later at 2316:41, the autopilot disconnect aural alert sounded simultaneously with the First Officer (FO) saying “okay okay down down down” as the airplane began the first of several significant oscillations in pitch, altitude, and airspeed. According to the Flight Data Recorder (FDR) readout, the Captain and FO computed airspeeds had diverged by as much as 10 knots just prior to the ATS and autopilot disconnect[1]. Approximately 5 seconds after the autopilot disconnect alert the Captain transmitted over the ATC frequency “Midex four ninety emergency” which was then repeated again to ATC several times by the FO to include at 2317:11 (30 seconds after the autopilot disconnect alert) the call “ Midex four ninety we’re out of control”. The overspeed warning aural alert could be heard on the CVR and the crew again stating several times, “up up up” followed by “down down down”. At 2318:59, according to the CVR the Captain states “we got a column disconnect”. At 2320:42, the Captain told ATC that they did not have any elevator control. There were several more cycles where the crew stated, “down down down,” followed by “up up up” until 2324:25 when the crew began their diversion to IRK. At 2330:20 the Captain told ATC that they seemed to have the aircraft under control. The flight landed without further incident at 2335:29. The CVR recording ended at 2356:47.

After the flight landed in IRK, the Flight Attendants reported to the Captain that there was a “burning” odor in the cabin shortly after the event had begun. Several of the passengers also included in their statements a remark about a burning odor “like electrical wiring”.

[1] A divergence of 4 kts or greater between the Captain and FO computed airspeeds was out of tolerance as reliable data input to the airplane’s Flight Control Computers which subsequently would disengage the ATS and autopilot. See Systems Group Factual Report, Section D.9.

3. Weather

The flight departed MCI at 2300 CDT in a Northerly direction and was turning to a heading of 060 degrees when the upset occurred at 2316 CDT. The MCI weather observation at 2317 CDT was reported to be 8 miles visibility with light rain and thunderstorms. The report also noted that frequent lighting was observed, and the thunderstorm activity was moving east. At least two convective SIGMETs were issued for the area. The first, Convective SIGMET 9C, noted a line of thunderstorms 40 miles wide moving from 240 degrees at 30 knots, with tops to 45,000 feet. It warned of 2 ½ inch hail and wind gust to 70 knots. A second, Convective SIGMET 13C, noted an area of thunderstorms moving from 250 degrees at 30 knots, with tops to 45,000 feet. It also noted hail to 2 ½ inches and wind gusts to 70 knots.

According to the Meteorology Factual Report the closest upper air sounding, which was for Topeka, Kansas, was not available during the period of interest. The next closest sounding that was representative of the air mass during the time of the event was from a site located approximately 112 miles northwest of the upset location. The sounding indicated the freezing level was located at 11,921 feet, with the sounding supporting icing conditions between the freezing level and approximately 25,000 feet. At approximately 19,000 feet, the sounding indicated a 40 percent probability of severe clear icing conditions. Convective activity would increase the likelihood and probability of icing conditions.

Based upon the weather information provided, the probability of icing existed in the vicinity of the flight during the upset event. Unstable weather, including convective activity (i.e. up- and downdrafts) was also in the vicinity of the flight however, without specific vertical and horizontal wind profiles at the aircraft's location, it could not be determined if this affected the controllability and response of the airplane during the initial upset and subsequent altitude excursions.

4. Analysis

4.1 Crew Factors – Pre Upset

On the day of the event, there were no unusual findings with the flight crew duty times or prior behavior patterns. Up until the upset event a primary concern for the crew had been the weather. They had been focused on the safety of the flight and were dealing with the weather situation in a very professional manner.

An item of interest during this investigation was whether the Air Data Heat (ADH) system was functioning properly and in particular if it was activated by the crew

during the preflight phase of flight. The ADH system provides heat to prevent blockage of the airplane pitot-static system in icing conditions. The pitot tubes provide airspeed data to the airplane's onboard automation systems to include the ATS and autopilot control logic, the rudder limiter, and also the airspeed information shown on the crew displays. A malfunctioning ADH system allowing ice to form in the pitot-static system would therefore explain the rudder limiter alert, the ATS and autopilot disconnects, and airspeed anomalies. Since this event, the FAA has issued Safety Alert, SAFO 06-006, which recommends mitigation measures to prevent ADH malfunctions in Boeing 717 airplanes. In addition The NTSB has issued Safety Recommendations, A-07-55 and -56, dated September 13, 2007 that would require air data sensor heating systems automatically activate in *all* new and existing airplanes, and for those airplanes that cannot be modified, the warning systems be upgraded accordingly. ALPA supports the NTSB recommendations to the FAA which are currently still open but in acceptable status as the FAA completes their evaluation.

Although ALPA agrees with the NTSB recommendations, we would also like to address an implication in the text of the September 13, 2007 recommendation letter that suggest human error by the MEA 490 flight crew in that they failed to activate the ADH during the cockpit preparation checklist. This implication is not supported by the CVR Group Chairman's Factual Report which contains a summary statement regarding the cockpit preparation checklist actions. The CVR Report states that the crew was recorded stating challenge and response *for all items*. In addition, the likelihood of a crew intensely focused on weather neglecting to turn the ADH switch on and not notice all related annunciations seems improbable. With a normally functioning system, the cockpit visual indications would be very apparent if the switch were left in the off position, particularly at night. The amber Level One Alert, which would be illuminated if the ADH system were off, really stands out against the black background of the EAD. Post-event visual inspection of the ADH switch did not reveal direct evidence of failure, however actual testing of the switch revealed abnormally high resistance, suggesting switch failure was possible. There were reports by persons in the cabin of an electrical burning odor during the upset. The source of this odor was not resolved but could have been indicative of an electrical anomaly that adversely affected the ADH system.

As noted above failure of the ADH in the presence of icing conditions could cause discrepant airspeed data which, in turn, would cause the ATS and autopilot to automatically disengage. The NTSB Systems Group Chairman's Factual Report documents that if the airspeed is above 100 knots calibrated airspeed (CAS) the autopilot will be automatically disengaged if the Flight Control Computers detect that the Captain and FO CAS are split by at least 4 knots. According to the FDR information the Captain and FO computed airspeeds were split by at least 4 knots at 11 seconds prior to autopilot disconnect and as much as a 10 knot split at 5 seconds before disconnect. Consequently, when the automation abruptly disengaged the crew had to revert to manual flying in night IMC as they were in a turn to the right. In addition the airspeed information on the crew displays would have been incorrect.

4.2 Crew Factors – Upset

According to all accounts, the first indication to the crew of an aircraft problem was the configuration alert about the rudder limiter. Up until this point the crew was focused on avoiding adverse weather while using the automation to control the airplane. Eventually their actions led to successfully recovering from the situation. However their initial response upon transitioning to manual control reinforces the critical importance of good Crew Resource Management (CRM), upset recovery training, and the proper role and design of automation in the cockpit. Upon autopilot disconnect both crew members took hold of the controls to manually fly the airplane. This is consistent with their statements, the FDR information, and the Aircraft Performance Study Report. At the time the configuration alert activated the airplane was rolling to the right in response to a heading change initiated by the Captain via the autopilot. Upon autopilot disconnect both the Captain's and FO's airspeed indications, which had begun to diverge, were decreasing at a rate consistent with a lack of air data sensor heating as the airplane had climbed into colder temperatures. The FO's indicated airspeed was decreasing at a higher rate than the Captain's and had gone from approximately 250 to 170 knots in less than 4 seconds. It was at this time that the FO began saying "…down down down" and the net control column force transitioned from about 20 pounds airplane nose up to 25 pounds airplane nose down (AND). It is possible the AND input was the crew, in particular the FO, reacting to a perceived loss of airspeed. It is not clear from the CVR transcripts when during the event sequence that the crew first realized the airspeed display information was suspect and therefore not to be relied upon.

Another contributing factor to the initial upset could have been temporary disorientation. At the time the FO took hold of the control wheel, the airplane was rolling to the right with a vertical acceleration near 1.5 g's. It is not known if the either pilot was looking straight ahead at the instruments or if he may have been reflexively looking to the right (the direction of turn) in spite of the fact that they were in night IMC. The turn, g-load and any rapid head movement could have contributed to spatial disorientation as the crew took over from the automation and applied their basic airmanship skills and training. In addition, given the weather in the vicinity was unstable, it can not be conclusively ruled out that atmospheric turbulence contributed to the upset. In any event, once the initial upset occurred the crew now had a critical situation that required them to work together and apply good CRM to achieve the safest possible operation.

According to the Captain's statement in the Operational Factors Report he consciously tried to use minimum control pressure on the flight controls to recover. The Captain's rationale to use small control inputs was sound and based upon a legitimate concern to not overstress the airplane. Contrary to normal procedures however, the FO also took hold of the controls to assist in the recovery. The Captain did not elect to overrule this assistance. Consequently as they both tried to recover control of the airplane they were, for portions of the maneuvering, inadvertently

opposing each others' control column movements which likely led to the control column disconnect. Although not trained to fly the airplane with both pilots making inputs when there was a column disconnect, the crew adapted to the situation and regained control of the airplane. According to his statement, the Captain eventually relinquished control to the FO as the PF. Even though this crew was able to recover the airplane, normal procedures for transfer of control were not followed and need to be reinforced in CRM and upset recovery training.

The cockpit automation and also the crew displayed airspeeds which had misleading information during the upset provided no help to the crew in the recovery of the aircraft. Training for upset situations in highly automated aircraft was included in Midwest Airlines training curriculum at the time of the event, and has since been updated (See: *B717 FCOM Fleet Bulletin No 2006-02 AIRSPEED: LOST, SUSPECT, OR ERRATIC effective 04/01/06 which now states: "Disregard IAS/flight director pitch bar and high speed warnings. Use pitch attitude or FPA as the primary flight reference)*. However the dynamics of an upset are unique and all possible scenarios cannot be anticipated or replicated in a training environment. In the real situation, a crew has to immediately transition to basic flying skills using what ever information available. User knowledge and understanding of the airplane systems and in particular the limits of the automation are essential. Any lost time or improper actions during these critical moments of transition could have catastrophic consequences even before the crew realizes which parameters should be disregarded. In the case of the MEA 490 event, the Boeing 717 onboard systems detected that the calibrated airspeeds were diverging which led to disengagement of the flight control automation and discrepant airspeed indications on the pilot displays. The crew had to comprehend this while transitioning to manual flight in night IMC during a turning maneuver. Since the time of this event, both ALPA and the NTSB have stressed the importance of CRM, upset recovery training, and the need to maintain basic stick and rudder skills in a highly automated environment. The circumstances of this event reinforced that importance.

5. Findings and Recommendations

5.1 Findings:

1. The crew was qualified to operate the aircraft, was in compliance with regulated rest criteria, and was operating the aircraft in a competent and professional manner up to the time of the upset event.

2. The Air Data Heat (ADH) system was not operating normally, allowing ice to form in the pitot tube(s). Based upon the information provided it could not be conclusively determined how the ADH system malfunctioned, but there was no evidence that it was not activated by the crew as part of the pre-takeoff check list procedure.

3. The sensed/displayed calibrated airspeed began to decrease and diverge, initially resulting in an alert for a rudder limiter failure and then triggering an ATS and autopilot disconnect. This disconnect occurred while the aircraft was in a turn.

4. At the time of the initial upset, the airplane was being controlled using the automation and the crew was focused on avoiding adverse weather. When the crew took over from the automation, the only information they had of an abnormal aircraft condition was the rudder limiter alert which occurred a few seconds before the automation disengaged.

5. At the beginning of the upset, both pilots attempted to control the airplane, which exacerbated the overall controllability problems and could have led to the control column disconnect.

6. The crew was able to recover the airplane using basic airmanship skills, thus reinforcing the importance of maintaining these skills.

5.2 Safety Recommendation for consideration:

1. Emphasize to Part 121 Operators:
    a. Ensure training programs emphasize the critical importance of positive transfer of control of the aircraft from either pilot to the other.
    b. The importance of automation training and the need to ensure that use of automation does not degrade basic airmanship skills.
    c. Upset Recovery Training include not only maneuvers required to regain control, but effective CRM techniques to achieve the safest possible operation.