SAFETY ISSUE ANALYSIS

BOEING 737
UNCOMMANDED ROLLS

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Safety Analysis Branch
Office of Accident Investigation
September 1995

PILOTS' REPORTED ROLLS COMPARED TO FDR-MEASURED ROLL

THE TABLE BELOW SHOWS PILOTS TYPICALLY OVERSTATE THE DEGREE OF ROLL IN AN EVENT. THIS IS SUPPORTED BY FINDINGS FROM A RECENT U.K. STUDY OF WAKE VORTEX REPORTS.*

EVENT	ROLL REPORTED BY CREW	ROLL RECORDED BY FDR
06/26/95 USAir (DCA)	30 & 45	18 & 14
07/18/95 USAir (ORL)	25	20
07/25/95 USAir (MEM)	12	0
07/25/95 USAir (RIC)	30	24
07/25/95 CONTINENTAL (MEX)	--	--
08/05/95 USAir (CHT)	30	19
08/10/95 USAir (MSY)	30	0
08/30/95 CONTNTL (CLE)	30 & 30	3, 9 & 9

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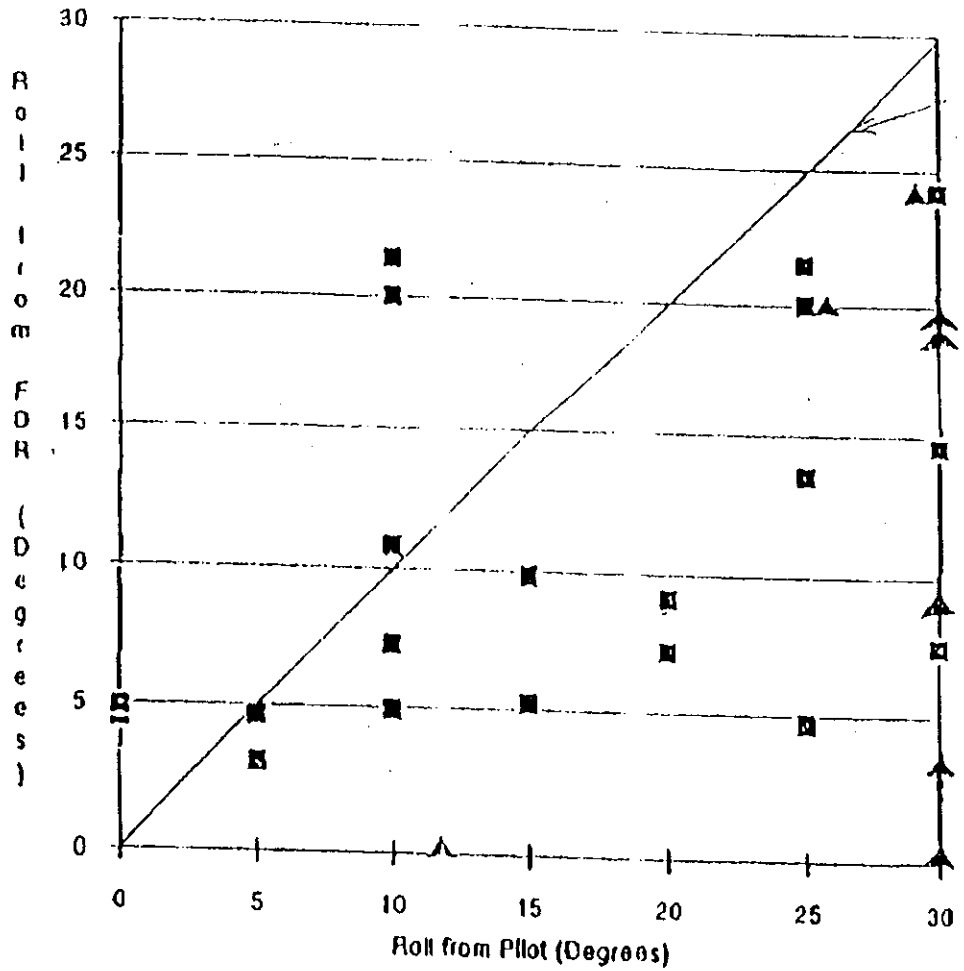
THE U.K. STUDY OF WAKE VORTEX UPSETS CONCLUDED IN PART THAT THE PILOT-PERCEIVED ROLL IS NOT CONSISTENT WITH THE ROLL ANGLE MEASURED BY THE DFDR. A FEW PILOT REPORTS WERE FOUND TO BE VERY CLOSE TO THE MEASURED ROLL, BUT OTHER PILOT REPORTS VARIED BY AS MUCH AS 20 DEGREES FROM DFDR MEASURED ROLLS. "THE SMALLER DIFFERENCES BETWEEN PERCEIVED AND ACTUAL ROLL COULD POSSIBLY BE EXPLAINED BY THE FACT THAT PILOTS TEND TO SPECIFY ROLL ANGLE TO THE NEAREST 5 DEGREES. HOWEVER THE REASONS FOR THE VERY LARGE DISCREPANCIES AND LACK OF CONSISTENCY ARE NOT FULLY UNDERSTOOD.

* WAKE VORTEX REPORTING PROGRAMME; ANALYSIS OF INCIDENTS REPORTED BETWEEN JANUARY AND DECEMBER 1992. (PROJECT EU0804)

Comparison of Pilo. FDR Roll Angle

▲ = US DATA

■ = UK DATA



NOTE: POINTS BELOW THE LINE SHOW THE FREQUENCY BY WHICH PILOTS OVERSTATED ROLLS AND THE DISTANCE FROM DATA POINTS TO THE LINE SHOW THE DEGREE OF OVERSTATEMENT. POINTS ABOVE THE LINE SHOW THE OPPOSITE.

PILOT DIFFICULTY SENSING ROLL AND DEGREE OF ROLL

THE FOLLOWING ILLUSTRATION COMPARES THE ROLL SEQUENCE AS REPORTED BY THE CREW VERSUS THE ROLL SEQUENCE AS MEASURED BY THE FDR IN THE MOST RECENTLY REPORTED EVENT (AUGUST 30, 1995). THE ILLUSTRATION SHOWS BOTH CREW MEMBERS NOT ONLY OVER STATED THE DEGREE OF ROLL SIGNIFICANTLY, BUT EACH CREW MEMBER FAILED TO SENSE AN ENTIRE ROLL IN THE SEQUENCE.

CREW REPORT	FDR DATA
1. ROLL 30 LEFT	1. ROLL 3 LEFT
2. ROLL LEVEL	2. ROLL LEVEL
3. ROLL 30 RIGHT	3. ROLL 9 RIGHT
4. ROLL LEVEL	4. ROLL 9 LEFT
	5. ROLL LEVEL

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FLIGHT SIMULATION OF AILERON PROBLEMS

- IN RESPONSE TO NTSB RECOMMENDATION A-94-64, BOEING AND FAA CONDUCTED A SIMULATOR TEST OF A B737-500 TO DETERMINE 737 CONTROLLABILITY UNDER A WORST CASE "STUCK" AILERON

  SCENARIO

  BROKEN AILERON CABLE

  FULL "UP" AILERON;

  10-KNOT CROSSWIND AT 90 DEGREES TO LANDING RUNWAY

  FLAPS AT 5, 15 AND 30 DEGREES

- IN ALL SCENARIOS, THE AIRCRAFT WAS CONTROLLABLE WITH A MAXIMUM OF 40-DEGREE CONTROL WHEEL MOVEMENT (107 DEGREES OF WHEEL MOVEMENT AVAILABLE)

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- AIRCRAFT WAS NEVER CLOSE TO CONTROL LIMITS

SUMMARY

- UNDER WORST CASE CONDITIONS IN A SIMULATOR, WITH AN AILERON "STUCK" IN FULL "UP" POSITION, THE AIRCRAFT WAS CONTROLLABLE.

- IN EVERY INFLIGHT EVENT, THE FLIGHT CREW CONTROLLED THE AIRCRAFT AND MADE A SUCCESSFUL LANDING WHILE NEVER BEING IN DANGER OF LOSING CONTROL