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## Human factors analysis of EK407

A340-541 Tailstrike  
Melbourne, Victoria  
20 March 2009

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## The accident:

- Melbourne Airport, Victoria
- Friday 20 March 2009 22:30
- It is 3 hours since the sun set and there is no moon
- Airbus A340-542 operating as Emirates flight EK407 to Dubai, UAE, is taxied onto Runway 16 at Melbourne Airport
  - 257 passengers
  - 18 crew (4 flight crew and 14 cabin crew)

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- Crew notified of tailstrike from ECAM message and a call from ATC
- Crew decided to return to Melbourne and climbed aircraft to 7,000 ft, they could not pressurise due to the damage
- ATC provided radar vectors over Port Phillip Bay while crew jettisoned fuel
- While the crew prepared for landing they noticed that the weight used to perform the take-off performance calculations was 262.9 tonnes instead of the planned 362.9 tonnes
- PAN declared

- Report from engineers via ATC for crew to expect 'significant damage to the tail'
- Weight reduced to 280 tonnes for landing (above MLW)
- During approach to Runway 34, a report came to the flight crew of smoke in the rear cabin
- Safe approach and landing made
- Inspected by ARFF on runway and cleared to return to terminal

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## Damage to aircraft

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# Other damage



## Weight error formation

- Pre-flight, approximately 20 minutes before pushback
- First officer inadvertently entered a TOW of 262.9 tonnes into the EFB when performing the take-off performance calculation [Intended TOW was 362.9 tonnes]
- The resulting performance figures, including the erroneous TOW were transcribed onto the Flight Plan
- Captain and FO discussed peculiarity of the SID
- EFB passed to Captain to check the performance figures (done silently)
- Captain entered the performance figures into the FMGS

- At the same time the FO confirmed the departure clearance with ATC
- Captain crosschecked the data entered into the FMGS with the First Officer – TOW not part of this check
- Captain read aloud the green dot speed as 225 knots (FO responded 'checked')
- EFB handed back to FO and loadsheet confirmation procedure carried out
  - FO read TOW from FMGS as 361.9 tonnes
  - FO read 326.9 tonnes from flight plan, then immediately corrected it to 362.9 tonnes, TOW on flight plan changed
- FO read aloud green dot speed from FMGS as 265 knots (Captain paused then responded with 'yes')

## Take-off performance

- Planned as a reduced thrust takeoff
- Termed 'FLEX' takeoff on Airbus aircraft
- Flight crew monitor and react to take-off reference speeds ( $V_1$ ,  $V_R$ ,  $V_2$ )
- Performance calculations determine take-off reference speeds, flap configuration and an 'assumed' temperature
- Assumed (FLEX) temperature used to reduce thrust produced by engines
- Acceleration not monitored

## What went wrong?

- Erroneous performance figures resulted in:
  - Over-rotation and tailstrike (low  $V_R$  and flap setting)
  - Long take-off roll and runway overrun (low thrust setting)
- Erroneous TOW likely due to a transposition error (slip)
  - expectancy, inattentive blindness
- Erroneous take-off weight not detected
  - Non-adherence to standard operating procedures (distraction, attention and perceived usefulness)
  - Captain's check of EFB (aural distraction and task interruption)
  - FO read correct weight during loadsheet check
  - FO changed flight plan without investigation (missed opportunity)
  - Green dot speed check (2 occasions)

- Degraded take-off performance not detected
  - Acceleration not monitored
    - reference (minimum required) acceleration not provided
    - actual acceleration not presented to flight crew
  - Crew experienced a wide range of performance
    - In the previous 2 months, TOW varied from 150-370 tonnes
    - Speeds vary with weight, no ability to do a 'reasonableness check'
  - Dark night takeoff meant there were reduced visual cues

## Human Factors issues

- Interruption and distraction
  - number of distractors present during critical tasks
  - prospective memory following interruptions
  - management and training
- SOP design and usability
  - potential for perceived doubling up of checks
  - linear procedure/non-linear information flow
  - work-around to prevent doubling up (last minute changes)
- 'Reasonableness' check
  - mixed fleet flying, FLEX takeoff operations
- 'Checking' versus 'verifying'

## Communication

- Cabin crew seating
  - Crew member at door R2 was at door operator position
  - Crew member at L4C was supposed to be at R2A
- Crew briefing
  - Flight crew briefed purser
  - Purser briefed cabin crew
- Calls from cabin crew direct to flight crew
  - First to report problem at TO, second smoke during approach
- ARFF on tower frequency during approach – distraction for flight crew

## What worked well

- Captain's decision to go to TO/GA thrust during the takeoff
- Excellent CRM between flight crew when planning the return – good use of all four flight crew
  - discussed landing weight, 280 tonnes to allow several approaches
  - three independent calculations of landing weight using two ref's
- All crew had input and challenged decisions as required during the planning and approach to Melbourne
- Communication between flight and cabin crew

## Is that it?

- Is this a problem for this operator only?
  - Mar 1991      United States      DC-8
  - Aug 1999      Denmark            Boeing 767
  - Jun 2002      Germany            Airbus A330
  - Mar 2003      South Africa        Boeing 747
  - Mar 2003      New Zealand        Boeing 747
  - Oct 2003      Japan                Boeing 747
  - Jul 2004      France                Airbus A340
  - Oct 2004      Canada              Boeing 747 (7 fatalities)
  - Aug 2005      China                Airbus A340
  - Dec 2006      France                Boeing 747
  - Oct 2008      Jamaica              Airbus A330
  - Dec 2008      United Kingdom    Boeing 767
  - Dec 2009      United Kingdom    Airbus A340

- ...and that is only a portion of the reported occurrences between 1989 and 2009 that shared multiple similarities with this accident! (AR-2009-052)
- And they continue to occur, irrespective of aircraft type, location, operator, EFB/paper calculation system
- Is “good airmanship” enough for detection of gross errors in take-off performance?
- Is enough being done about this?
  - At least 9 previous investigations with recommendations regarding monitoring of take-off performance
  - No commercial system currently available that can detect degraded take-off performance
  - No design standards or requirements by any NAA

## So what is being done?

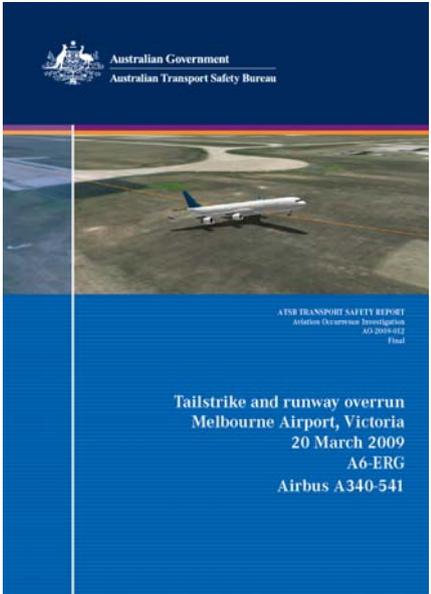
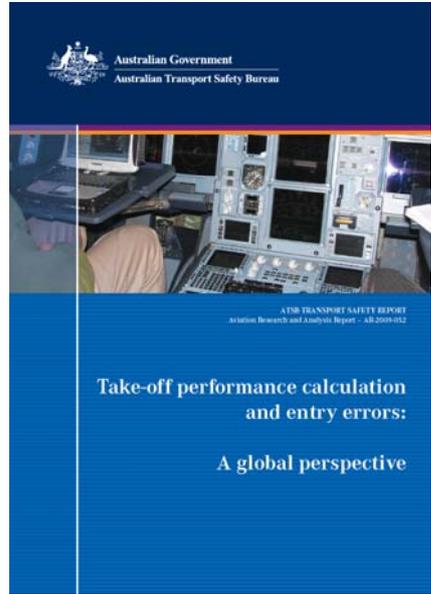
- The operator has improved its procedures and training to strengthen their defences.
- Airbus producing a system that will automatically check the reasonableness of the performance data entered into the FMGS



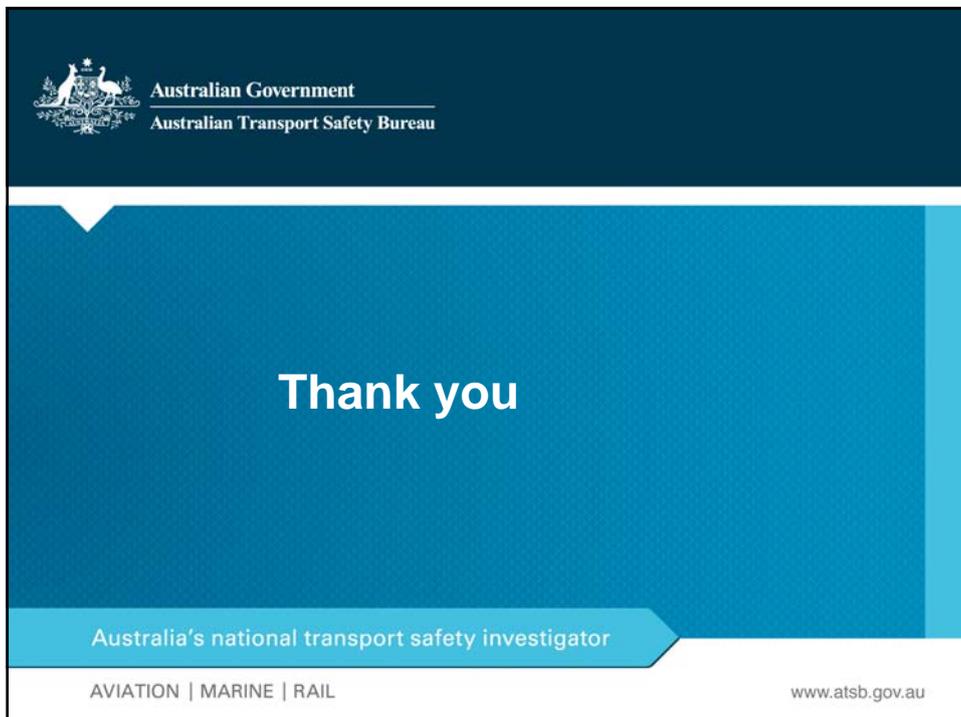
- Safety Advisory Notices to Flight Safety Foundation and International Air Transport Association to encourage development of guidance for flight crew on formation of appropriate mental models for weight and associated performance.

- The operator working with avionics manufacturer to develop a take-off performance monitoring system
- European Aviation Safety Agency (EASA) working with EUROCAE to develop a design standard for take-off performance monitoring systems and rulemaking to require such systems
- Recommendation to Federal Aviation Administration
- Airbus conducting feasibility study for potential future take-off performance monitoring system

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 <p>Australian Government Australian Transport Safety Bureau</p> <p>ATSB TRANSPORT SAFETY REPORT Aviation Occurrence Investigation AO 2009-012 Final</p> <p>Tailstrike and runway overrun Melbourne Airport, Victoria 20 March 2009 A6-ERG Airbus A340-541</p>	 <p>Australian Government Australian Transport Safety Bureau</p> <p>ATSB TRANSPORT SAFETY REPORT Aviation Research and Analysis Report - AR 2009-052</p> <p>Take-off performance calculation and entry errors: A global perspective</p>
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**Thank you**

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