TRANSPORT ACCIDENT INVESTIGATION COMMISSION
TE KOMIHANA TIROTIRO AITUA WAKA

AIRCRAFT ACCIDENT REPORT

No. 89-088

Cessna A188-B

ZK-CSC

Omahuta State Forest
38 km SE of Kaitaia

30 October 1989

Transport Accident Investigation Commission
Wellington · New Zealand

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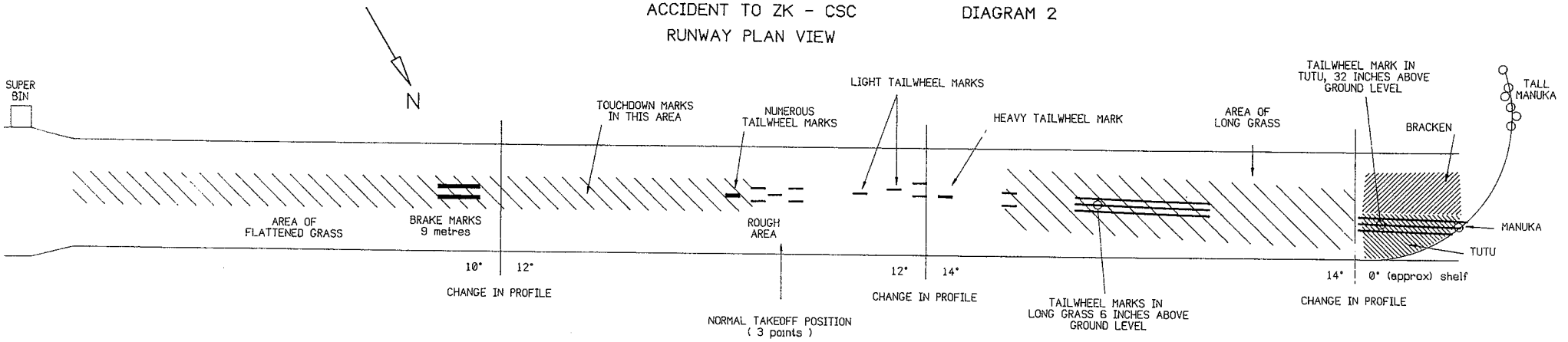
Aircraft Type, Serial Number and Registration:	Cessna A188-B, 188-0202 ZK-CSC
Number and Type of Engines:	One Continental IO-520-D
Year of Manufacture:	1966
Date and Time:	30 October 1989, 1715 hours NZDT
Location:	Omahuta State Forest 38 km SE of Kaitaia Latitude: 35°13.5'S Longitude: 173°35.9'E
Type of Flight:	Aerial Work, Topdressing
Persons on Board:	Crew: 1
Injuries:	Crew: 1 Serious
Nature of Damage:	Aircraft destroyed
Pilot in Command's Licence:	Commercial Pilot Licence – Aeroplane and Commercial Pilot Licence – Helicopter
Pilot in Command's Age:	48 years
Pilot in Command's Total Flying Experience:	12,480 hours (approximately 1800 on type)
Information Sources:	Office of Air Accident Investigation field investigation
Investigator in Charge:	Mr D V Zotov

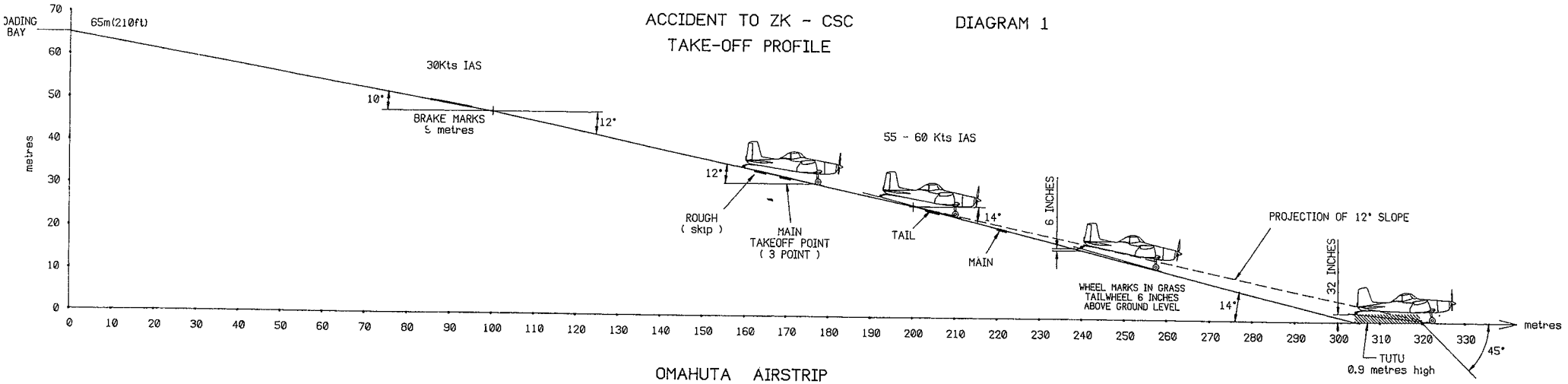
ACCIDENT TO ZK - CSC
RUNWAY PLAN VIEW

DIAGRAM 2



ACCIDENT TO ZK - CSC
TAKE-OFF PROFILE

DIAGRAM 1



OMAHUTA AIRSTRIP

1. NARRATIVE

1.1 The aircraft was spreading granulated fertilizer on properties adjacent to the Omahuta State Forest; the airstrip was situated on a ridge within the forest, some 300 feet higher, at an elevation of 1050 feet amsl at its top end. The 300 m long airstrip, which faced north-west, had three distinct sections of 100 m each, progressively increasing in downslope from 10° to 12° and then to 14°; there was a small flat shelf at the bottom and after that the hillside sloped down at about 45° to the valley floor. (See Diagram 1).

1.2 The surface of the airstrip was a mixture of cocksfoot and rye grass; although the grass was long, the large wheels of the A188 had rolled it down easily and it had provided no significant impediment. The take-off and landing path, which extended over about two thirds of the airstrip, had been rolled flat by the aircraft. The bottom third of the airstrip was covered in much lusher grass, about 800 mm high and the aircraft had not operated from it.

1.3 At the very end of the strip was a bank of dense shrubs, about 900 mm high and extending some 20 m beyond the strip; to the left side of this was a bank of bracken of similar height and to the left of that were manuka trees 4 to 5 m high. A single manuka, some 40 mm in diameter, had been on the extended centreline beyond the shrubs and bracken.

1.4 Twelve to fifteen tons of the twentyfive ton contract had been sown. The first loads had been 1400 pounds (636 kg) and these had been progressively increased by 100 pound (45 kg) stages. About 6 flights prior to the accident flight, the load had been increased to 1700 pounds (773 kg).

1.5 The weather was clear and there had been a moderate north-westerly breeze blowing up the airstrip. However, the loader driver had noticed the wind had decreased and that there had been a period of calm, after which the wind had picked up again. He did not notice the wind at the time of the accident or afterwards.

1.6 When the airstrip was visited at the same time of the evening in similar meteorological conditions, there was a steady 10 knot north-westerly breeze at the top of the airstrip but at the bottom of the strip the wind was fluctuating between five knots and calm.

1.7 An agricultural pilot who was experienced in operations from this airstrip advised that such fluctuations, together with a general reduction in wind strength towards evening, were typical of conditions on this strip and indeed of many others around Northland. They should not have caused a problem provided a due margin had been left to allow for them.

1.8 The aircraft had been refuelled since it arrived at Omahuta airstrip, but there was no record of the quantity put in to the aircraft nor of the number of loads flown since refuelling. However, the pilot believed that the tank was about one third full at the time of the accident, based on the fuel gauge which he considered fairly accurate. This would have been about ten imperial gallons (approximately 45 litres), sufficient for about 20 minutes flying with a small reserve.

1.9 About halfway down the rolled take-off path there were a pair of marks 9 m long where both of the mainwheels had been braked heavily. (See Diagram 2). The marks were similar for each wheel, centred on the rolled area, straight along it and made while the aircraft was going downhill. The spacing was consistent with the aircraft being laden. The marks did not appear to have been rolled over after they were made.

1.10 At the take-off end of the rolled path were marks from the mainwheels and tailwheel showing where a rough spot had caused the aircraft to skip; it had skipped 7 to 10 m and touched heavily in a three-point attitude before finally becoming airborne. This take-off pattern appeared to have happened on a number of occasions.

1.11 A further 15 m down the strip (close to the point where the slope changed from 12° to 14°) there was a tailwheel mark 500 mm long; a further 10 m down, on a slightly different alignment, was a 1 m long tailwheel mark followed by mainwheel marks. Five metres further on (just after the start of the 14° slope) on yet a different alignment was a 3 m long tailwheel mark, heavier than the previous ones, followed by mainwheel marks. 15 m further on, on the same alignment as the last marks, mainwheel and tailwheel marks in the lush grass area extended 28 m. These tailwheel marks were about 150 mm above ground level.

1.12 These final wheel marks were aligned with wheelmarks through the bank of shrubs. The mainwheels had touched on the flat at the very end of the airstrip and continued at that level, breaking through stems which were about 7 mm thick, tough and densely spaced. The tailwheel mark was about 820 mm above ground level. To the left of these wheelmarks the bracken had been shaved off at an angle corresponding to the dihedral angle of the left wing and at the far end of the wheelmarks a single broken stump of manuka projected above the shrubbery.

1.13 The aircraft was seen by a witness from a farm directly on the extended centreline of the airstrip, some 300 feet below and 1 km to the north-west. On previous flights the aircraft had appeared to her to descend in a straight line after becoming airborne, before turning away down the valley to the sowing area. When the accident occurred the flight looked normal until the aircraft pitched up to the extent that she could see it in plan view from below, slid backwards and then pitched steeply nose down before disappearing. She described the aircraft noise during this period as "rumbling".

1.14 The pilot believed that, rather than tailsliding, the aircraft had flick-rolled to an inverted attitude before its nose pitched towards the ground.

1.15 A trail of light tree debris extended some 50 m to the impact point, i.e. the aircraft started brushing the treetops halfway down the slope. Close to the accident site, breaks in the trees showed that the descent path was westerly, at 60° to the horizontal, while propeller slashes suggested that the aircraft's attitude may have been near the vertical. Debris from propeller strikes was thrown sideways to a distance of 5 m.

1.16 The aircraft struck the ground at the edge of a bank which was at 80° to the horizontal, ploughed down the soft ground, pivoted round when it came

to the flat at the bottom of the bank and slid backwards into a grove of pongas. Apart from the right wingtip and a short length of the leading edge of the right wing, which had been removed by trees just before the aircraft struck the ground, all parts of the aircraft were present at impact. The brunt of the impact was taken by the wings and forward fuselage. The cockpit area was essentially intact.

1.17 The hopper was still loaded and there was no sign of dumping, either at the strip or at the site. The hopper lever was closed and the flap lever was at 2 notches (10°) which was the take-off setting normally used by the pilot. The electric fuel pump switch was on "HIGH" but the pilot believed he must have knocked it to that position during the impact sequence; the normal position was "OFF" for take-off. There was no blood or skin on this switch or on the adjacent structure.

1.18 The inertia reel unit was unlocked but had locked during the impact and the pilot's harness remained intact. However, the seat frame came off its rails during the impact sequence and the pilot's weight may have been taken by his legs: one of the cast aluminium rudder pedals had fractured. The pilot's face struck the rolled metal coaming which had absorbed the shock by deforming. He suffered fractured ribs which may have been associated with the harness going slack during the impact sequence.

1.19 His helmet had received a diagonal blow on the rear. When rescuers arrived the pilot was sitting on the edge of the doorway but had been unable to go further because of his knee injuries. The pilot's recollection of events before the accident was somewhat affected by his injuries.

1.20 Rescuers noted some smell of Avgas but not much; the fuel tank itself was ruptured and the plastic bag which surrounded it contained a small quantity of Avgas. This bag was intended to contain fuel leaks and green staining showed that it had contained an appreciable quantity at some time before the accident. On the pilot's instructions the electrical master switch was turned "OFF".

1.21 The engineers who maintained the aircraft advised that cracking of the fuel tanks was a recurring problem with A188 aircraft when operating from rough strips. Extensive weld repairs had been made to ZK-CSC's tank six months before the accident.

1.22 The fuel filter was clean. The unions to the fuel distribution manifold had been sheared off in the accident. There was some fuel in the line between the mechanical pump and the fuel control unit although the union to this line had been sheared off at the pump.

1.23 The propeller was still attached to the engine and showed little damage. The blades were in the fine pitch position. When the nose struck the bank, one propeller blade cut into the bank a few inches, stopped, and as the aircraft slid down the bank it acted like a bulldozer blade. There were no indications of power at impact and the small scatter of pieces chopped from trees by the propeller were consistent with it windmilling rather than being driven. The pilot believed that he did not close the throttle at any stage.

1.24 Powdery debris was found under the mechanical fuel pump relief valve, such that the pump would not function. When this contamination was cleared, the pump functioned normally.

1.25 The engine stopped rotating at the beginning of the ground slide, prior to the major disruption of the engine bay when the unions were sheared, so the contamination was probably present prior to the accident. Such contamination was not uncommon, since the aircraft was operating in a dust-laden environment. The aircraft information manual stated:

> "In the event of an engine-driven fuel pump failure during take-off, immediately [place] the auxiliary fuel pump switch in the HI position until the airplane is well clear of obstacles. . . The ON position will then provide sufficient fuel flow to maintain engine operation while manoeuvring for a landing."

1.26 No other deficiencies were found in the engine or related systems.

1.27 The absence of power at or prior to impact could be explained in terms of the extreme attitudes adopted by the aircraft after take-off, which would have resulted in the partial fuel load unporting and causing the engine to cut. This might have caused the "rumbling" heard by the witness; alternatively (given that sound would have taken about 3 seconds to reach her) it may have been that the sound of the aircraft crashing through the scrub arrived contemporaneously with the manoeuvres she observed. No control discontinuity was found and all of the airframe damage was impact related.

1.28 The pitch-up after the aircraft cleared the scrub was explicable in that full up elevator would have been required to prevent the drag on the wheels from pitching the aircraft on its nose: immediately the drag ceased, the aircraft would have pitched up abruptly. Whether the aircraft then performed a hammer stall, as the witness thought, or a flick roll, as the pilot recollected, or some combination of the two, was academic: in any event, the pilot found the aircraft pointing straight down, at low speed, with insufficient height for recovery.

1.29 The position of the electric fuel pump switch could have been due to a knock by the pilot's hand during the impact sequence, though the absence of blood or skin in the vicinity tended to argue against that possibility. Alternatively, the pilot may have switched it on instinctively when the engine cut out. A third possibility was that the fuel pressure may have fluctuated or the engine may have faltered during the take-off run, prompting the pilot to select the electric pump "ON". The pilot could not recall any problem with the engine.

1.30 There had been at least two other take-offs, prior to that on which the accident occurred, when the aircraft had sunk after take-off until the tailwheel struck the ground causing the aircraft to porpoise. A pilot with experience on A188 aircraft advised that when this occurred the reduced angle of attack which resulted from the tailwheel springing the rear end of the aircraft up resulted in a significant transfer of load to the main wheels, with perceptible deceleration. It was at least possible that the reducing headwind, combined with the higher load with which the aircraft operated for the last six flights, may have resulted in a progressive deterioration in take-off performance so that the porpoising occurred further and further down the runway, and the margin over the shrubbery at the end of the strip became less and less, until on the accident flight, the margin was non existent.

1.31 However, this did not explain the heavy brake marks made by both wheels, half way down the normal take-off roll. These brake-marks, indicating firm application of brake for about half a second, could only be explained in

terms of a decision to abandon the take-off, followed by a decision to continue. They could not be explained by a need for directional control as only one brake would have been applied in that case; besides, full rudder authority would have been available at that stage.

1.32 The pilot had no recollection of making the brake application; the brake marks were fresh and did not appear to have been rolled over subsequently. Both of these facts argued that the marks had been made on the take-off roll leading to the accident flight.

1.33 After about 85 m of the take-off roll, the pilot applied the brakes heavily for about half a second. The only conceivable explanation for this was a perceived problem with the take-off: since the load was not jettisoned the problem must have appeared to be transient, e.g. an rpm surge, as opposed to a continuing fault, producing vibration or perceptible power loss. It was estimated that the braking added about 30 m to the take-off run required.

1.34 The aircraft presumably was jolted into the air by the rough spot which, on previous flights, had caused it to skip a few metres before finally bouncing into the air, about 170 m down the 300 m strip. Main and tailwheel marks at the usual take-off point showed that the aircraft had usually become airborne in the 3-point attitude and there was no reason to suppose this take-off was any different.

1.35 On at least two previous take-offs, the aircraft had sunk subsequently until the tailwheel touched the ground and pitched the aircraft forward onto the mainwheels before it finally became airborne. That happened on the accident flight, but 10 m to 20 m further down the strip and the tailwheel strike was heavier. At that time the aircraft was beyond the point where the angle of the strip increased by 2°, to 14°.

1.36 The aircraft was just able to become airborne with an angle of attack of about 12°. Had it remained airborne its trajectory would have been on or above the projected slope (which was also 12°) and diagram 1 shows that this would have just about cleared the shrubs at the end of the strip. However, when the tailwheel struck the ground beyond the point at which the slope changed, the angle of attack was reduced as the tailwheel rebounded into the air. The aircraft therefore sank, and the mainwheels touched the ground.

1.37 Had the aircraft again been rotated to the three-point attitude, its initial trajectory would have been parallel to the steeper slope, until it was sufficiently clear of the ground that it could be rotated to its original climbing attitude. The clearance margin at the end of the strip would therefore have been reduced.

1.38 However, the pilot held the aircraft with the tailwheel 150 mm off the ground, presumably to avoid the tailwheel being again pitched into the air, and the aircraft became airborne in this attitude. The reduced angle of attack required an increase of airspeed of 7%, compared to that required in the 3-point attitude, just to fly parallel to the strip. The aircraft ran for 28 m before it again became airborne, with 35 m to go to the end of the strip.

1.39 When it touched down again at the end of the strip, the mainwheels were forced up, relative to the tailwheel, by the level shelf. However, the drag of the shrubbery on the mainwheels prevented the tail from being lowered sufficiently for the aircraft to get airborne: the deck angle was about 6° with

reference to the shelf. The drag on the wheels would probably have decelerated the aircraft.

1.40 The previous marks where the aircraft porpoised after becoming airborne indicated that only two thirds of the length of the strip was used and thus there may have appeared to be an adequate safety margin. When the aircraft porpoised a few metres further on, beyond the point at which the slope changed, it was doubtful if the aircraft could have cleared the scrub at the end of the strip unless the load had been jettisoned so there had, in reality, been little safety margin previously. From the point at which the wheel marks in the long grass ceased, the aircraft would have had to achieve a change of flightpath of 10° upwards to clear the scrub beyond the end of the strip, whereas if the aircraft had maintained the slope of the strip from before the 200 m point, it would just have cleared the scrub with no change of flightpath.

1.41 However, the difference in take-off runs would have appeared negligible to the pilot in terms of distance gone. In terms of attitude, the pilot remarked that during the accident take-off he could see the scrub, but should not have been able to. The apparent similarity to previous successful take-offs, until it was too late to take action, may explain why the load was not jettisoned. (At 70 knots, for example, the 85 m from the mainwheels touching in the porpoise would have taken $2^1/_2$ seconds so the time available for a decision was very short).

1.42 The essence of the accident was that there was no margin for unforseen circumstances and the application of the brakes, for whatever reason, made a successful take-off impossible without jettisoning at least part of the load.

1.43 The shallow ground angle of the A188 limited the extent to which it could be rotated on take-off and this was further limited on any airstrip the down slope of which increased along the take-off roll. The effect was to depress the initial trajectory to a greater extent than, for example, an FU24, which could be rotated to its normal climb more rapidly.

1.44 The pilot's practice was to raise the tailwheel about 150 mm above the ground during the take-off run. The Cessna aircraft company recommended that the pilot should. . .

> ". . . LIFT TAILWHEEL and assume level flight attitude for best acceleration"

for both normal and short field take-offs. This was endorsed by a pilot with 6000 hours experience on A188s. He also considered it essential that the aircraft was placed in a level flight attitude so that it could not get airborne prematurely from bumps or gusts. If the aircraft got airborne prematurely it tended to "squash" badly, due to the high-speed wing section (compared to other agricultural aeroplanes). During this process it could consume a lot of runway length without any significant acceleration. He considered that if there was any doubt as to the adequacy of the runway length, it was better to hold the aircraft down while speed built up, rather than try to fly it off early.

1.45 Other A188 pilots reported difficulty in taking off from airstrips with similar profiles to Omahuta airstrip. One had touched down on the end of the strip, in similar circumstances, but there were no obstructions and he was able to fly away safely.

2. FINDINGS

2.1 The pilot was properly qualified to conduct the flight.

2.2 The aircraft was properly maintained.

2.3 The aircraft load had been adjusted to the conditions of the day, as was normal in agricultural operations.

2.4 An engine malfunction during the take-off roll may have caused the pilot to apply the brakes momentarily, then select the electric fuel pump on.

2.5 After the aircraft became airborne, its tailwheel touched the ground and pitched the nose down.

2.6 The combination of nose-down pitch and steepening runway depressed the take-off trajectory and the mainwheels entered dense shrubbery at the end of the runway.

2.7 When the wheels cleared the shrubbery, the aircraft pitched steeply nose up, stalled and dived into the forest.

2.8 The aircraft's fall was broken by trees and steeply sloping terrain and the deceleration forces were moderate.

2.9 The cockpit area remained occupiable but the pilot's seat broke from its rails. This allowed his harness to go slack and he struck parts of the aircraft structure.

2.10 The accident was probably caused by the pilot believing that the safety margins were greater than those which existed. In consequence, his application of brakes in response to a transient engine problem and the temporary reduction in engine power caused the aircraft to encounter shrubbery at the end of the strip, after which the pilot lost control. Contributory factors were a type of aircraft unsuited to operations from airstrips the slope of which increased in the direction of take-off, and the use of a less than optimum take-off technique.

3. SAFETY RECOMMENDATIONS

3.1 As a result of the investigation of this accident, the following recommendations were made to the Director of Civil Aviation Safety:

That the direction of operation of dump levers on agricultural aircraft be standardised, and

That improvements be made to the seats of A188 aircraft to reduce the potential for them to come off their rails during an accident.

12 June 1992

M F DUNPHY
Chief Commissioner