DC-8-62F, 9G-MKH

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Aircraft Type and Registration:	DC-8-62F, 9G-MKH
No & Type of Engines:	4 Pratt & Whitney JT3D-7 turbofan engines
Year of Manufacture:	1971
Date & Time (UTC):	20 July 1999 at 1104 hrs
Location:	Manston, Kent International Airport
Type of Flight:	Public Transport (Cargo)
Persons on Board:	Crew - 3 - Others - 5
Injuries:	Crew - None - Others - 1 Serious, 4 Minor
Nature of Damage:	Deformation of fuselage structure adjoining nose gear bay; nose gear doors, and nose gear components; minor damage to fuselage skins adjoining cargo and forward entrance door
Commander's Licence:	Airline Transport Pilot·s Licence
Commander's Age:	N/A
Commander's Flying Experience:	N/A
Information Source:	AAIB Field Investigation

Introduction

The aircraft operator routinely operatedDC-8 cargo flights into Manston. Because of space restrictions on the stand,the normal practice with the DC-8 was for the aircraft to position on thetaxiway after landing and for a tug to manoeuvre the aircraft thereafter, theaircraft being finally pushed back onto the parking area. On the day of theaccident, the aircraft had landed normally and had positioned as usual on thetaxiway where it was met by the tug. A DC-8 nose landing gear ground lock pin,carried for the purpose on the tug, was then installed and the aircraft wastowed without incident before being pushed back onto the stand. The noselanding gear pin was then removed by the tug crew, the tow bar disconnectedfrom the nose leg, and the torque link reconnected. The tug then departed andunloading of the cargo began.

The ground staff involved in the unloadingoperations were assisted by the loadmaster from the inbound crew, and also by asecond loadmaster who was scheduled to position with the aircraft

toLuxembourg, upon departure from Manston. The latter supervised and alsoassisted with the movement of palletised cargo from within the cargo space onthe main deck to the L1 cargo door on the forward left side; the former sat inthe forward vestibule area completing his paperwork. The operator maintained asmall ground engineering organisation at Manston, to carry out turn-aroundchecks on company aircraft, and to undertake routine line maintenance asrequired. During the turn-around period in question, there was a total of fourground engineers working on the aircraft whilst it was being unloaded. Thesecomprised: two airframe/engine licensed engineers whose tasks included routinechecks of the hydraulic fluid reservoir and checks on the No 3 engine constantspeed drive (CSD), which had been the subject of an entry in the Technical Log;a supervisor; and an avionics engineer who was making an unscheduled change toa global positioning system (GPS) unit on the flight deck.

Sequence of events

The inbound flight crew vacated the aircraftin due course, and the outbound crew boarded. The flight engineer immediatelypositioned himself at his station on the flight deck and thereafter, throughoutthe relevant period, was occupied almost exclusively with the re-fuelling ofthe aircraft and balancing of the fuel load. The first officer (FO) was unableto occupy his seat upon boarding because it was occupied by the avionicsengineer, who was busy changing the GPS unit which was situated on the rightside of the pedestal, abutting the main instrument panel and immediatelybeneath the landing gear selector lever. On seeing this, the commander left theflight deck so as to keep out of the way of the avionics engineer, and the FOchecked the Jeppeson library for the same reason. The problem with the GPS, asit had been diagnosed originally, required a replacement memory card but thecard which had been supplied for the purpose was for a different model of GPSunit, and was not compatible. It had been decided, therefore, to change thewhole GPS box for a type which was compatible with the replacement card, thetwo types of unit being comparable in all other respects. The avionics engineerreported that having pulled the circuit breaker powering the GPS system, heprepared to remove the GPS unit but was prevented from doing so by the positionof the landing gear selector lever. He had changed GPS units previously onDC-8-50 series aircraft without such a problem. However, the landing gear leveron the DC-8-60 is significantly longer than on the -50 series, and in the DOWNposition the end of the lever physically prevented the GPS unit from beinglifted clear of its housing.

The hydraulic systems were unpressurised atthis time, and the avionics engineer decided that he would have to raise thelanding gear lever out of the DOWN position sufficiently to allow the GPS unitto be lifted clear. Before doing so, however, he left the flight deck andinserted ground lock pins into all three landing gears, using the aircraft setof pins. He then returned to the flight deck where he pulled the gear lever outof the DOWN detent and, lifting it just sufficiently to provide the necessaryclearance, removed and replaced the GPS box. So far as he could recall, he thenreturned the landing gear lever to the DOWN position, in its detent, beforeresetting the associated circuit breaker and checking the operation of the GPSunit. He then left the flight deck, retrieved the pins from the landing gears,and returned them to the their stowage on the aircraft before moving to theback of the flight deck, where he stood waiting. Meanwhile, the commander andFO had re-entered the flight deck and resumed their seats. Neither pilotrecalled the position of the landing gear lever at this time, although the FOdid recall seeing that the GPS unit was lit; thereafter, his attention wasfocused on the overhead radio panel, which was of a different configuration toother aircraft in the fleet. The flight engineer had remained at his stationthroughout, occupied with his re-fuelling tasks.

Shortly after the flight crew had re-entered the flight deck, the groundengineering supervisor boarded the aircraft having been asked by the engineerservicing the hydraulics reservoir to restore hydraulic power, so that theassociated main landing gear door could be closed. (The reservoir was locatedwithin the main wheel well and the gear door had to be lowered, using a servicepanel control valve, to gain access.) Upon entering the flight deck thesupervisor announced his intention, saying *OK to put the hydraulics on?,* or words to that effect. Although the pilots each recalled mention having beenmade of hydraulics, neither gave explicit permission for hydraulic power tobe brought on line; however, the request was not refused. (The flight engineerwas still occupied with re-fuelling at this time, and did not recall anymention of hydraulics.) The supervisor then selected the auxiliary(electrically powered) hydraulic pump to ON using the switch on the flightengineers overhead panel. Some 20 to 30 seconds later, the nose landing gearretracted and the nose dropped violently to the ground. The commanderimmediately looked across and saw that thelanding gear lever was in the UP position. He therefore moved it back to theDOWN position, and instructions were given to put the ground lock pins in themain landing gears.

Injuries sustained

The sudden dropping of the nose onto theground resulted in those standing on the flight deck (ie the avionics engineerand the supervisor) being thrown violently off their feet. A scream was alsoheard from the main deck, and the avionics engineer immediately moved back toinvestigate. However, having reached the vestibule area, he was suddenlyovertaken with extreme back and neck pain, and found himself unable tocontinue. The scream had emanated from the loadmaster who had been involved inmoving the palletised loads into the L1 doorway, and who had been standingbetween the pallet being moved and the forward cabin bulkhead when the noselanding gear had collapsed. When the nose had suddenly dropped, he foundhimself against the bulkhead with the pallet, which weighed approximately 2tonnes), sliding towards him. With his back against the bulkhead, he hadbrought one knee up in front of him in an effort to brace himself against theapproaching pallet, however the pallet drove his knee back, dislocating hisknee.

He was subsequently taken to hospital wherehe underwent an operation to re-locate his hip. He then spent four weeks intraction, followed by six weeks physiotherapy. The avionics engineer was alsohospitalised for three days, having suffered bruising of his lower spine andwhiplash injuries to his upper spine. The supervisor attended hospital as anoutpatient, for assessment of whiplash type injuries. In addition, two groundstaff engaged in unloading operations also suffered minor injuries. One of themhad been ahead of the pallet, and was pushed forward through the L1 door intothe forward vestibule, suffering bruising to his knee. The other, who had beenpositioned aft of the pallet and was pushing it forward while holding onto itsnetting, suffered a fractured thumb as the pallet suddenly moved forward. Theengineer working on the No 3 engine had just stooped beneath the forwardfuselage, and was making his way back across the apron when the nose fell tothe ground.

Damage to the aircraft

The aircraft sustained major structuraldamage in the vicinity of the nose wheel bay, and to the nose gear doors. Inaddition, a pivot housing which formed part of the weight-on-wheel sensingmechanism on the nose landing gear had fractured, and the fuselage skinssuffered minor damage in several areas caused by contact with ground equipmentas the aircraft shifted.

Technical investigation

The nose landing gear retracts forward andconsequently, in the event of a retraction on the ground, there would be minimalloading on the retraction actuator even with the weight of the aircraft restingon the gear, due to the ability of the nose wheels to roll freely forward.Retraction of the nose landing gear would therefore have been expected if, withno ground lock pin installed, the system was selected to UP with the hydraulicsystem pressurised. (The main landing gears retract sideways, and consequentlythey would not be likely to retract, due to the lateral resistance from tyrefriction.) A typical delay period before an unpressurised system reaches aworking pressure, after switching on the auxiliary pump, is of the order of 20to 30 seconds. In this accident the landing gear ground lock pins had beenremoved and the nose landing gear retracted some 20 to 30 seconds after theauxiliary hydraulic pump had been energised. Immediately afterwards, thelanding gear lever was observed in the UP position. The evidence thereforeindicated that the nose landing gear had been retracted by the retractionsystem, as a result of the selector lever having been in the UP position.

The design of the landing gear and relatedsystems on the DC-8-60 is such that the action of pulling the landing gearlever back to disengage it from the DOWN detent will change the state of a setof microswitches in the gear indicator light circuit, causing the three geardown-and-locked green lights to extinguish, and the single gear in transitred light to illuminate; no warning horn should sound. Both the green and redlanding gear lights are positioned close by the landing gear lever. If,therefore, the gear lever had been out of position, and this had not beennoticed by any of those on board, it is conceivable that an abnormal gearindication would have also gone unnoticed.

Consideration was given as to whether itwould have been possible for the landing gear lever to have moved from thefully DOWN position to the UP position as a result of jarring when the nosedropped to the ground. Such a scenario presented several problems, however, notleast of which was the fact that the lever would have had to overcome not onlythe positive-lock detent at the DOWN position (which required a deliberateoutward pull on the lever to clear the detent), but it would then have had tobypass a mechanical baulk which stops the lever moving out of the DOWN positionwhenever the aircraft is on the ground and the weight-on-wheels sensor is inground mode. The weight-on-wheels system used a mechanical cable, mounted onthe gear itself, which moved in response to oleo extension and activated amechanical baulk at the landing gear lever quadrant. This baulk could bebypassed only by depressing a large button adjacent to the gear lever. Part ofthe weight-on-wheels cable mechanism had fractured, but detailed investigationrevealed that all of the associated damage had been caused by contact with thenose landing gear doors as the fuselage under-side had struck the ground, iethe damage had occurred after the retraction process had begun. Consequently,the damage to the cable system could not have compromised the effectiveness ofthe baulk prior to the reaction process being initiated. Furthermore, the baulkmechanism at the gear selector quadrant was spring loaded into thebaulk-engaged position, and relied on cable tension to remove the baulk;consequently, any failure of the cable/lever mechanism would have caused thesystem to revert to the baulk-engaged state. Tests carried out on the actualbaulk engagement mechanism showed that it was wholly effective in blockingmovement of the landing gear selector lever.

It was established by testing in situ thatthe retraction system control valves, which were operated by the landing gearselector via a system of cables and pulleys, were correctly rigged with notendency for hydraulic fluid to be ported to the UP lines prematurely. It wasalso established that the lever had to be moved almost fully upward, beyond thecheck detent (a detent position just below the UP position, where both UP andDOWN circuits are vented to system return) before the UP line of the noselanding gear was pressurised. Consequently, for movement of the lever to havecaused the retraction, it would have been necessary not only for it to havemoved out of the

positive lock detent at DOWN, but then to have breached theground mode baulk, and finally to have moved upward through the check detentposition virtually into the fully UP position. On the evidence, therefore,it did not appear possible for the lever to have moved by itself from the fullyDOWN position to the almost fully UP position.

Investigation into the amount of clearanceneeded to lift the GPS box out of its housing in the pedestal showed that inorder to gain sufficient clearance, it was necessary for the landing gearselector lever to be raised well beyond the ground mode baulk, almost as far asthe check detent. The avionics engineer did not recall depressing the baulkrelease button when he moved the lever, but he agreed that the lever must havemoved beyond the baulk position in order for him to have been able to changethe GPS unit. Anecdotal evidence suggested that quite large changes of nose legoleo extension can take place during cargo loading and unloading operations,caused by changes in aircraft centre of gravity as the cargo is moved. It wouldappear possible, therefore, that the nose landing gear weight-on-wheel systemcould make transient changes of state, between ground and air mode, at suchtimes. It would also appear possible that such a change might have occurredwhilst the avionics engineer was working on the GPS. If this had been the case,and if the moment when the avionics engineer had lifted the landing gear leverhappened to coincide with a period when the system had reverted briefly to theair mode, then the baulk would have been withdrawn already, and consequentlythere would have been no impediment to his moving the lever sufficiently toallow him to remove the GPS box, without any need for him to first depress thebaulk release button.

Experimentation after the accident with thelanding gear selector lever in different positions in its gate showed that oncethe lever had been lifted sufficiently to allow removal of the GPS box, itwould occasionally start to creep upward, imperceptibly at first beforeaccelerating rapidly and jumping into the check detent position. This detentdid not provide a positive stop to the lever, and it was therefore possible toconceive of a situation where, if the lever was moving rapidly enough into thecheck detent, it might over-run the detent and reach a position on the far sidewhere hydraulic fluid was directed to the gear-up lines. In short, it appearedpossible for the lever, having first been raised sufficiently to permit removalof the GPS box, to have moved subsequently, without further intervention, intoa position which would have resulted in a retraction of the nose landing gearwhen the hydraulic system became pressurised.

Human factors issues

The investigation identified a lack ofcoordination between the various personnel working on the aircraft during theturn-around, and a commensurate failure to fully supervise or control thevarious activities taking place.

The engineering ground staff were nominallyunder the supervision of the ground crew supervisor. However, whilst the latterwas aware of the routine activities being carried out by the airframe andengine technicians, he had not himself tasked the avionics engineer withcarrying out the GPS change. This tasking had been carried out indirectlythrough one of the engine/airframe technicians who, in the absence of thesupervisor, had telephoned the companys technical control departmentearlier that morning from the hotel where he and the rest of the ground staffwere temporarily residing, to ascertain whether there were any particularinstructions for the Manston team. He, in turn, had then passed on the GPStasking to the avionics engineer. (It is possibly significant that thecompanys Manston engineering base had been established for only a short timebefore this accident, and was staffed by personnel originally based at Stanstedand living in temporary hotel accommodation at Manston. The supervisor usuallyalso stayed at this hotel, but on

the morning in question had been travellingdown from his home near Stansted, where he had spent the night; consequently,he was not directly involved in tasking the avionics engineer).

The supervisor reached Manston in good timefor the arrival of this aircraft, and he was aware of the routine turn-aroundtasks being carried out by his engineers on the aircraft. In principle, theavionics engineer also came under his supervision; however, whilst thesupervisor was aware that this engineer was working on the GPS unit, he did notknow that this involved removal and replacement of the GPS box or, moreimportantly, that it would require the landing gear lever to be moved. Indeed,none of the other ground engineers or the flight crew were aware that thelanding gear lever was to be moved. The implications of pressurising thehydraulic system were therefore not apparent to the supervisor, the groundengineer who had asked this of him, or the flight crew.

The accident occurred at a time when theaircraft was partly under the control of the flight crew (with the flightengineer actively controlling re-fuelling operations from the flight deck) andpartly under the control of the ground supervisor. It was also being worked onindependently by other ground staff engaged in offloading the cargo. Arguably,therefore, lines of demarcation and control were blurred. Although thesupervisor sought permission from the flight crew to pressurise the hydraulicsystem, it was apparent that his request took the form of an open statement tothe effect that he was proposing to carry out this action, effectively relyingupon a countermand from any crew member who might object, rather than a requestper se. The flight crew evidently presumed that the supervisor knew what he wasdoing, and being unaware themselves that the gear lever had been moved shortlybefore, said nothing to prevent him from pressurising the system. Had thesupervisor, or any member of the flight crew, been aware of the true situationthen it is most unlikely that the system would have been pressurised withoutchecks being made first to ensure that it was safe to do so.

So far as the avionics engineer wasconcerned, his tasking had been carried out in an informal manner and he had noworksheet or written procedure to follow. Not having removed a GPS unit from aDC-8-60 aircraft before, he did not anticipate having to move the landing gearlever out of the DOWN position, and found himself having to improvise. It isoften the case that, in practice, avionics engineers work independently oftheir airframe/engine colleagues and it is possible that this cultural separationmay have contributed to the avionics engineers failure to involve thesupervisor, or indeed any of the other engineers, even though he was disturbingsystems outside his normal area of responsibility or expertise. The fact thatthe flight crew had previously entered the flight deck only to leave it again,albeit with the best of intentions to allow him to replace the GPS unit, mayalso have been a factor by possibly indirectly putting pressure on him tofinish his task without undue delay. Under such conditions, he is less likelyto have sought advice or the involvement of the supervisor, or from one of theairframe/engine technicians; or to have sought more formal guidance on thecorrect procedure to follow.

Safety action

These aspects were drawn to the attention ofthe Operator at an early stage of the AAIB investigation, and the company alsocarried out its own independent internal investigation. The companysubsequently reported that it had taken the following actions in the light ofthis accident:

Steps were taken toclarify and explain the terms of reference of the engineering supervisor, andthe responsibilities of all individuals engaged on turn-around duties.

A Quality Notice wasraised to address the problem caused by the need to move the landing gearselector lever when changing a GPS box on DC-8-60 series aircraft

The implications ofmodifications will in future be subject to scrutiny by a ModificationsCommittee.

A Quality Notice wasraised addressing the procedures to be adopted for checking the correctpositions of aircraft controls and indications prior to the application ofhydraulic power.

The procedures coveringcontrol of the GPS Data Card system were reviewed by the Operations Departmentand, with the involvement of the Technical Records Supervisor, were revised. ANotice to Crew on this subject was raised.