ACCIDENT

Aircraft Type and Registration:	Learjet 45, D-CNIK
No & Type of Engines:	2 Honeywell TFE731-20 turbofan engines
Year of Manufacture:	2003
Date & Time (UTC):	17 March 2006 at 2029 hrs
Location:	London Gatwick Airport
Type of Flight:	Public Transport
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Fuselage and entry door plus damage to a parked motor vehicle
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	42 years
Commander's Flying Experience:	9,500 hours (of which 2,450 were on type) Last 90 days - 54 hours Last 28 days - 26 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was being prepared for departure to Paris. The commander was at the rear of the cabin and the co-pilot was on the flight deck. The right engine was running in order to provide electrical services and air conditioning for the cabin. The engine power was inadvertently increased to 70% N_1 and the aircraft moved forwards, unobserved by the co-pilot. Whilst moving forwards through the cabin, the commander fell from the open doorway. The outer part of the left wing struck a parked motor vehicle and the aircraft swung rapidly to the left, turning through 180º before coming to rest again against the side of the vehicle. The commander and a ramp handling agent were both struck by the aircraft and knocked to the ground. The commander was seriously injured.

History of the event

The aircraft had arrived at London Gatwick earlier in the day and was parked facing south on Stand 143 by the off-going crew. The nosewheel, which was chocked in front and behind with the aircraft's own chocks, was positioned on the yellow painted centreline of the stand. The weather conditions at the airport were dry and clear with a surface wind from 050º at 18 kt.

The flight crew were driven to the aircraft by a handling agent. The vehicle was parked in front of the left wing facing approximately north. The co-pilot went on board and set the park brake by pulling and turning the handle. He then climbed into his seat, selected all three batteries ON, the cockpit lights ON and started the right

engine. Once the engine was running he selected the air conditioning ON.

The co-pilot recalled that he had been seated half in his seat facing rearwards. After a few seconds he sensed that something was wrong and realised that the aircraft was moving. He climbed back fully into his seat so that he could apply the toe brakes, but the aircraft was now swinging round rapidly to the left and he was unable to act in time to stop it. He heard a crash as the aircraft came to rest against the side of the parked van. He pulled the thrust lever back to idle and a few seconds later shut down the engine.

Meanwhile the handling agent had brought the catering to the aircraft and the commander stowed it in the galley. The commander then went to the rear of the aircraft cabin to stow his baggage. While he was there, he noticed an increase in engine noise, he tried to call to the co-pilot but because of the air conditioning noise could not be heard. He moved forward up the cabin and as he came alongside the steps realised that the aircraft was moving. He was partially on the steps when he lost his balance and fell to the ground outside the aircraft.

After the aircraft came to rest the co-pilot could hear someone calling and so he looked back into the galley area; he was surprised to see that no one was there. He climbed out of the aircraft, over the van which was now partially blocking the doorway, and found the commander lying on the ground injured. The handling agent, who had also been knocked over by the aircraft, was back on his feet and together they assisted the commander towards the van. The handling agent telephoned airfield operations and asked them to contact the emergency services.

Accident sequence

The aircraft had been parked with the nose wheel aligned with the painted central guidance line for stand 143L on a heading of 169ºM. Alongside the aircraft was a Volkswagen 'Sharan' Multi-Purpose Vehicle (MPV) acting as a ground support vehicle (see Figure 1). The aircraft had moved forward and initially struck the left hand side of the MPV, and had then turned to the left around the rear of the ground support vehicle. It had then struck the right side of the MPV, coming to rest against the vehicle on a heading of 013ºM, approximately 8.6 m from the centre of the stand marking. The MPV had been pushed sideways in the final impact and moved approximately 0.6 m, forcing the left front tyre off its rim.

At some stage during the aircraft movement the commander had fallen to the ground outside the aircraft. The trailing edge of the nose landing gear door had been bent by impact with the commander and there was a faint mark on the concrete surface of the stand that had been made by his clothing. The mark followed an arc corresponding to the path of the nosewheel (see Figure 1) as he was dragged by the aircraft.

Personnel information

The commander was employed by the operator on an occasional basis as a freelance pilot. He had flown some 50 hours on their behalf over a period of 15 months prior to the accident. He held a Type Rating Examiner (TRE) qualification on the aircraft and had previously carried out some check flights on other pilots on behalf of the operator. He flew this aircraft type on behalf of several other operators and also flew another commercial aircraft type.

The co-pilot had been employed by the operator for a period of 18 months. He had flown a total of 920 hours

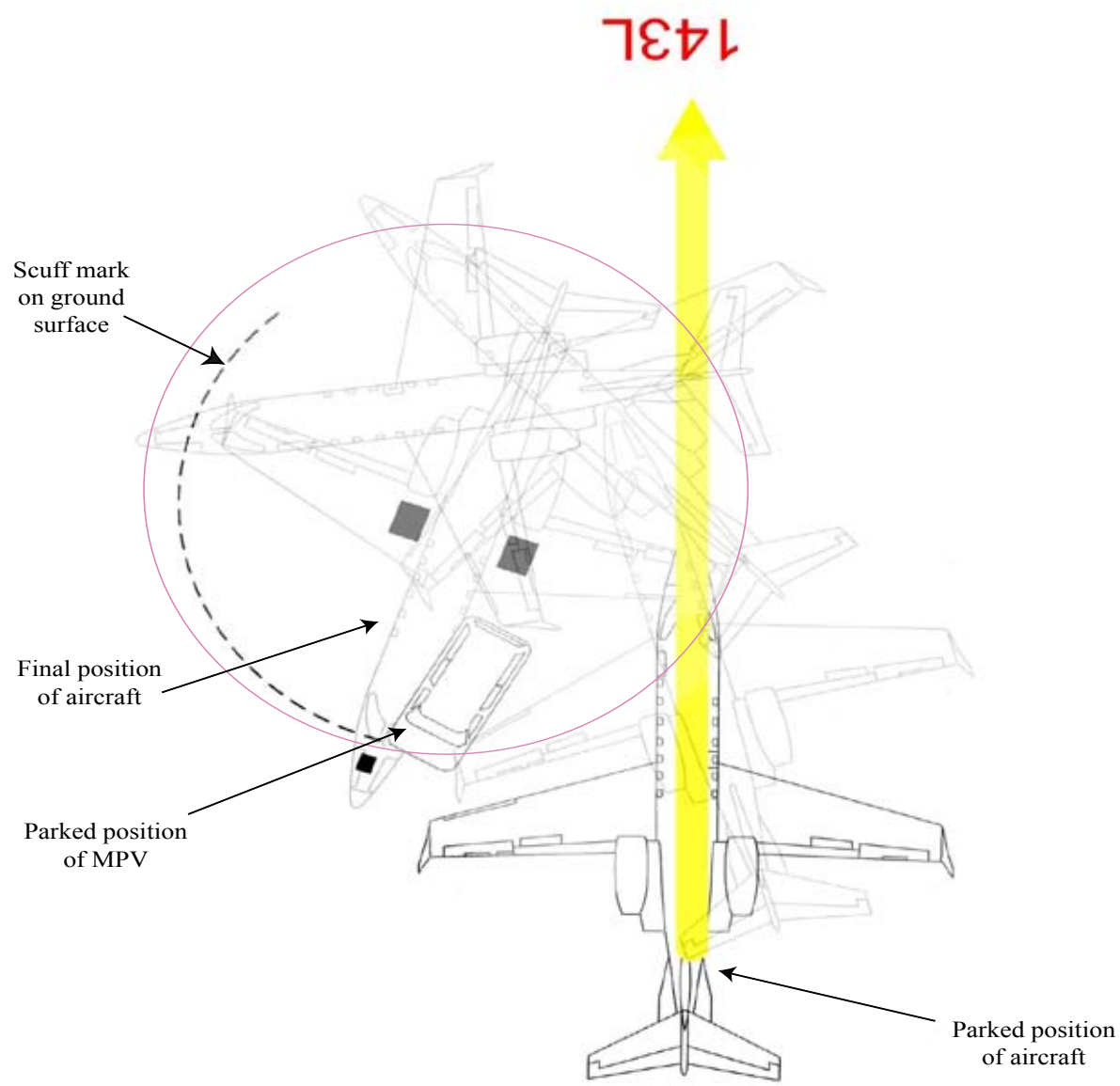

Figure 1

Location of aircraft and ground support vehicle

on the aircraft type. He had not flown any other type in the preceding 90 days. When the co-pilot started his employment with this operator, he was already qualified on the aircraft type.

Aircraft information

General

This type of aircraft is fitted with two engines mounted high on the rear fuselage. D-CNIK was not fitted with an APU, it is an item of optional equipment for the aircraft. A pair of small wooden chocks weighing approximately 1 kg each was carried aboard the aircraft.

Brake systems

The braking system on this type of aircraft comprises the normal brake system and the emergency/parking brake system. The normal brake system is controlled by a two channel brake control unit which controls

hydraulic pressure to the brake control valves under a combination of pilot brake pedal demand, anti-skid, locked wheel protection and touchdown protection. The main hydraulic system supplies a nominal system pressure of 3,000 psi to the normal braking system from two engine-driven pumps. An auxiliary DC motor-driven hydraulic pump provides pressure to the brake system if the engine driven pump supply is lost. A separate brake accumulator, fed by the auxiliary system provides hydraulic pressure to the emergency/parking brake system.

The emergency/parking brakes are applied by pulling upwards the emergency/parking brake handle located on the centre pedestal. The handle is connected via a lever and a cable to the emergency/parking control valve, which opens to allow hydraulic pressure from the emergency/parking brake accumulator to the emergency/parking brake shuttle valves. Turning the emergency/parking brake handle through 90º when the handle is fully extended from the pedestal holds the emergency/parking control valve open to maintain the hydraulic pressure to the brakes for parking.

The emergency/parking brake control valve internal switch signals the data acquisition system that the valve has been opened and displays a white PARK BRAKE ON annunciation on the engine instrument and crew alert system (EICAS) display. The emergency/parking brake accumulator hydraulic pressure is also displayed on the EICAS. The pressure is displayed in amber at less than 2,600 psi or more than 3,600 psi and a BRK ACUM PRESS warning is displayed.

The auxiliary DC motor-driven pump is automatically switched on when the landing gear is transitioning UP or DOWN, or selected manually using the push button AUX HYD switch. Operation of this pump recharges the emergency/parking brake hydraulic accumulator which provides reserve hydraulic pressure at 3,000 psi. The accumulator is designed to provide at least six emergency brake applications or to maintain parking brake pressure for approximately 48 hours.

The procedure in the Airplane Flight Manual (AFM) required the accumulator to be charged by activating the AUX HYD pump before applying the park brake. The emergency/parking brake system pressure cannot be charged by the engine driven pumps. However, if the park brake handle is set to ON when there is sufficient residual pressure in the system, the brakes will be applied. When applied with full system pressure available, the brakes are capable of holding the aircraft in position at high power settings.

Nose wheel steering system

The nosewheel steering system is used to steer the aircraft during takeoff, landing and taxiing. The nosewheel steering computer senses pilot rudder pedal demand, via differential transformers, and operates an electrical steering actuator to turn the nosewheel. Steering is only available when the aircraft is on the ground and only functions if the nose steering push switch, located on the forward instrument panel, is armed. The system is normally armed after start and before the aircraft is taxied.

Engine control system

Each engine is controlled by its own Digital Electronic Engine Control (DEEC) computer. This is normally left switched to the ON position, although there are two other modes of use, MANUAL and OFF.

Flight Recorders

The aircraft was equipped with a solid state Flight Data Recorder (FDR) capable of recording and retaining data

for a minimum duration of 25 hours and a solid state Cockpit Voice Recorder (CVR) capable of recording 120 minutes of communication and ambient noise from the cockpit environment. Both recorders were removed from the aircraft and subsequently downloaded at the AAIB's replay facility. The accident data was successfully recovered from both the FDR and CVR.

Both recorders were electrically powered when battery power was applied and remained powered for 64 minutes after the accident. The FDR was capable of recording a total of 139 parameters, which included the position of both engine thrust levers and the N_1 shaft speeds from both engines.

Recorded Data

Figure 1 provides the salient parameters of the accident. The No 2 engine thrust lever was set to about 19º[1] and shortly afterwards the No 2 engine N_1 shaft speed started to increase. As the engine was started there was a short conversation on the flight deck that lasted about six seconds. As the aircraft's avionics systems powered up the magnetic heading parameter became active, indicating that the aircraft was on a magnetic heading of 169º. The number two engine N_1 shaft speed continued to increase until it settled at idle thrust, which was about 21% N_1. Some 10 seconds later the bleed air was heard to be selected ON.

The No 2 engine thrust lever remained at the idle thrust position until about 17 seconds later when it was quickly advanced to about 80º, some 12º before it would have entered the MCR[2] position. Just prior to and also coincident with the movement of the No 2 engine thrust lever, a series of clicks was heard on the flight deck, but the exact origin of those noises could not be determined. The No 2 engine N_1 shaft speed started to increase from idle thrust until about eight seconds later it had reached 59%, at which time the aircraft began to move forwards. The N_1 speed increased until it reached 72%, at about which time the aircraft then started to accelerate rapidly forwards and turn to the left. About five seconds later the No 2 engine thrust lever was quickly moved to the idle position and the N_1 shaft speed started to reduce. Almost coincident with the No 2 thrust lever moving to idle, a noise was recorded that was similar to brakes being applied. About one second later the aircraft stopped turning. The aircraft had turned onto a magnetic heading of 013º having turned through 154º in 6 seconds.

About seven seconds after the aircraft had stopped turning, the No 2 engine thrust lever was closed and the engine was shutdown. Both recorders continued recording for about 64 minutes before electrical power was removed.

When the No 2 thrust lever was set to the idle position, the number one engine thrust lever was slightly advanced to about six degrees and a sequence of three chimes was recorded.

DEEC data

Data is stored in the DEEC and can be accessed by the operator to obtain engine operational and fault information. Within the stored data file there is a restricted area accessible by the engine manufacturer for the purpose of accident investigation. A data download of the DEEC was carried out for the investigation. The data obtained from the DEEC did not provide any useful additional information to that obtained from the FDR.

Footnotes

1 Idle thrust setting is between 9º and 23º thrust lever angle.

2 MCR (maximum cruise thrust), which is the first de-tented position and is between 91.5º and 96.9º thrust lever angle.

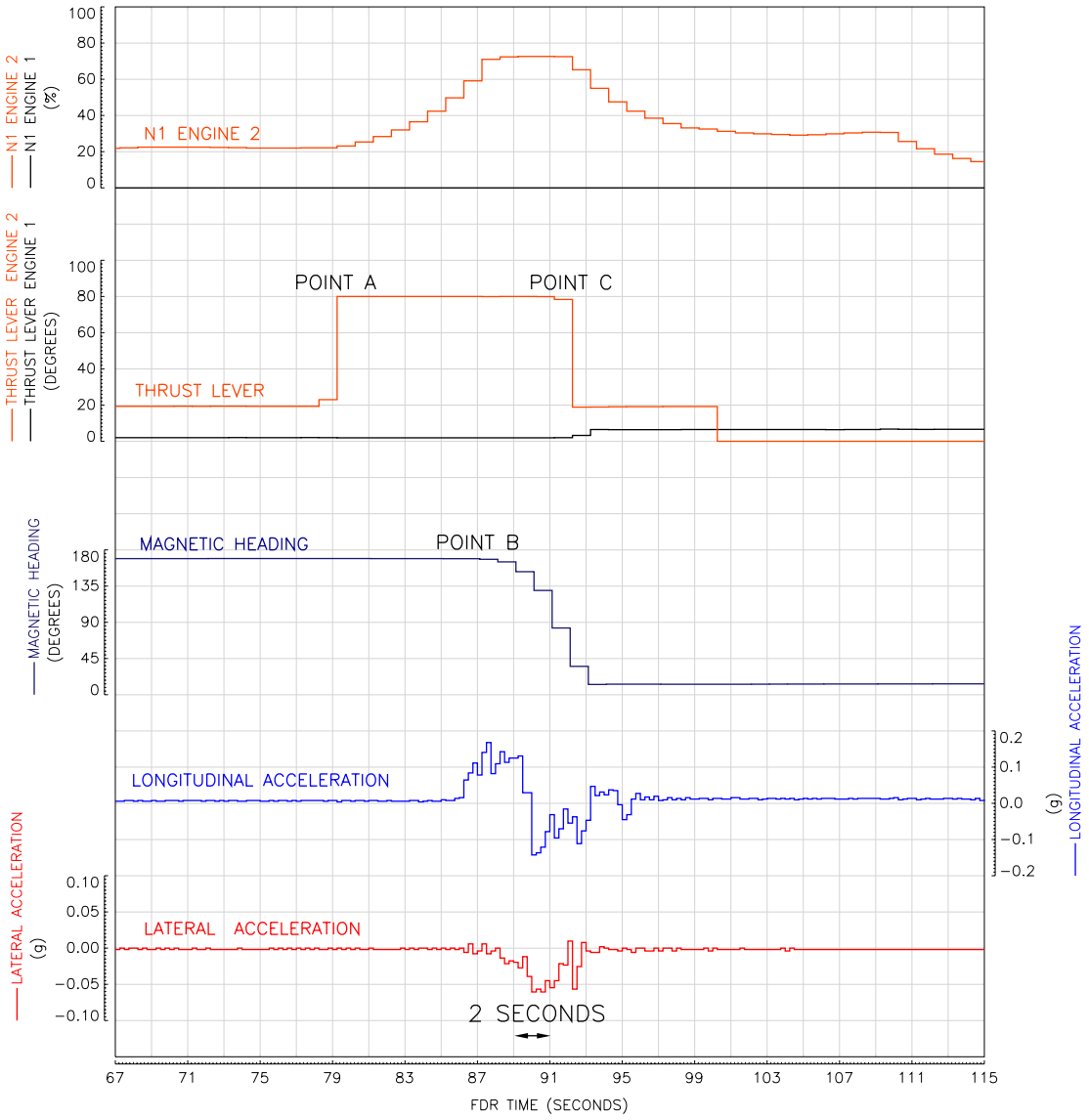

Figure 2

Selected data from FDR and CVR

Wreckage and impact information

The aircraft suffered impact damage to the left side of the fuselage between the passenger entry door and the leading edge of the left wing. There was some scuffing to the left wing leading edges and the trailing edge of the left nose landing gear door had been bent inwards. The MPV had suffered impact damage to both its left and right sides, the front windscreen was cracked and the left front tyre had been pushed off its wheel rim.

When the aircraft was examined after the incident it was noted that the right engine DEEC was selected to the OFF position. However, the FDR readout confirmed that the DEEC was on during the incident.

Tests and research

Following the accident, in the presence of the operator, aircraft battery power was applied. The EICAS indicated that the emergency/parking brake accumulator pressure was 1,440 psi. This was sufficient to hold the aircraft

on a dry level surface against ground idle power. The system was then depleted by multiple applications of the parking brake and the accumulator recharged by means of the auxiliary hydraulic pump. Engine ground runs were performed to test the effect of turning off the DEEC with the engine running. The table below shows the results. At around 30% N_1 on one engine, the aircraft would start to move on a dry, level surface with the brakes off.

DEEC Position	N_1 % RPM
ON	22.8
MANUAL	28.7
OFF	30.4

Table 1

Effect of DEEC selection on engine N_1 at idle

Organisational and management information

Operation of the flight

The intended flight was being operated in accordance with the requirements of JAR-OPS. The operator provided a Flight Operations Manual (FOM) for their flight crews. The FOM contained procedures derived from the AFM, some of which were abbreviated, together with specific company operating procedures. The FOM was intended to be used in conjunction with the AFM. The FOM included a requirement for a pilot to be seated during flight but this requirement did not specifically apply to pre-flight operations.

Checklists

The aircraft was equipped with the operator's own checklist card. The cockpit preparation and before start checklists from the card are reproduced below at Figure 3. The operator's checklist card allocates responses to CM1 (commander), CM2 (co-pilot) or B (both pilots) but the operator considers this does not necessarily represent the designation of the task. If only one pilot is on the flight deck, that pilot has to read the checklist and action all the items. The PARKING BRAKE/HYD response was allocated to CM1.

The aircraft manufacturer provides full checklists in the AFM; there are no abbreviated versions provided. In the AFM both the *'Exterior Pre-Flight'* and the *'Before Starting Engines'* checklists require that the parking brake be set. The *'Before Starting Engines'* checklist also requires the crew members to be in their seats with their seatbelts fastened before engine start. The manufacturer did not provide - and the operator did not have - a checklist specifically for engine start for ground service use.

Cockpit Checklist		
Outside Check	Completed	CM1
Seats, Belts, Harnesses	Secure/Adjust	B
Oxy Masks & Smoke	Checked	B
Circuit Breakers	Set	B
Gear Handle	DN	CM1
Audio Panels	Set	B
DU & REVERSION Panels	NORM	B
ELEV DISC & ROLL DISC	Stowed	CM1
Electrical System	EMER&BATT	CM1
Crew Lights	Set	B
Rudder Panels	Adjust	B
SYSTEM TEST Panel	Test	CM1
RUD BOOST	ON	CM1
PAX OXY/PRESSURIZATION	Checked	CM2
Standby ATT Indicator	Uncaged	CM2
Cockpit Checklist compl.		

Before Start Checklist		
PARKING BRAKE/HYD	Set & Checked	CM1
Cabin Door	Closed	CM2
NO SMOKING BELTS	ON	CM1
Passenger Briefing	Completed	CM2
ANTI-ICE	OFF	CM1
EICAS	Checked	CM1
FUEL QTY & BAL	Checked	CM1
VOLTS	Checked	CM1
BCN / NAV	ON	CM1
Before Start Checklist compl.		

Figure 3

Cockpit Preparation and Before Start checklists

Analysis

The evidence derived from the recorded data was that the aircraft had moved on the stand as a result of a forward movement of the right (No 2) engine thrust lever which led to a corresponding increase in the right engine power. The chocks were pushed out of the way as the aircraft moved forward. The left wing contacted the parked vehicle and the aircraft started to pivot around it to the left. The direction and rate of turn thereafter was affected by a number of factors which were additive: the restraint on the left wing, the high power on the right engine and the absence of nose wheel steering which allowed the nosewheel to caster freely. The wind which was strong and gusty would also have acted in the direction of the turn.

On his arrival at the aircraft the co-pilot had checked that chocks were in place; they were positioned at the nosewheel. The chocks used were those carried with the aircraft; they were made of wood and of relatively light weight. These chocks could easily be pushed aside were any force applied and would not have been sufficient to hold the aircraft against any significant power. The fact that the chocks were in position may have given the co-pilot a false impression that the aircraft was secure against movement.

This particular model of the Learjet 45 did not have an APU which meant that in order to supply air to the cabin and to regulate the temperature, an engine needed to be running. It was normal practice, therefore, to start the right engine to supply bleed air to the cabin whilst preparing for a flight.

The co-pilot reported that his first action on boarding the aircraft was to put on the park brake. The park brake position is not one of the parameters recorded on the FDR so whether or not the action was carried out could not be definitely determined. For the aircraft to have moved, there were three possibilities. Firstly, the park brake was not effective because the handle was never set; secondly the handle was set but there was insufficient pressure in the accumulator to apply the brakes at the wheels; and thirdly, the brakes could have been applied but overcome by the additional thrust when the thrust lever was advanced. It was not possible to determine which of these occurred but it was noted that unless the correct procedure was used to set the brake then it was possible to set the handle without actually applying the brakes. The procedure in the AFM required the accumulator to be charged by activating the AUX HYD pump before applying the park brake. However this action was not carried out and the co-pilot seemed to be unaware that it was a required procedure. Nevertheless, if sufficient residual pressure had been retained in the system, the brakes would have been applied.

The co-pilot stated that he had been in his seat to start the engine. There were a number of activities that may have distracted him and caused him to move from his seated position afterwards. There was no specific requirement in the Operations Manual which required a pilot to be seated at the controls while an engine was running. It seems likely that as he moved around, he inadvertently moved the right thrust lever forward, either directly through physical contact or indirectly through snagging with clothing or equipment. At first he did not notice that the aircraft was moving and when he did, he was not in a position from where he could immediately apply the brakes. The movement cues could have been reduced by the lack of external visual cues in the dark and, if his attention was focused elsewhere, he would not necessarily have noticed the movement.

In an aircraft such as this, where it is necessary to run an engine to supply ground services, it may be that there is insufficient awareness amongst flight crew of the associated hazards. It is also possible that ground personnel working around the aircraft are less aware and therefore less cautious than when engines are started for flight. It is likely that a general practice had developed within the operation whereby one engine was started as a routine without reference to a checklist procedure. If the co-pilot's actions were not in accordance with the general practice then this should have become apparent during his training.

The operator's checklist did not specifically require the co-pilot to set the park brake. Although the AFM did provide a procedure to set the park brake, it was part of the *'Before Starting Engines'* checklist. This checklist was lengthy and not necessarily appropriate for starting one engine just to supply ground services as in this case. Failure to use a checklist in such circumstances is made more likely by the absence of an appropriate abbreviated procedure. Conversely, when the engines are started for the purpose of flight, more formal attention would probably be given to the required procedures and awareness levels would be raised.

Safety action

In order to be certain that the park brake is properly applied and functional, it is essential to follow the correct procedure. An additional checklist designed specifically for starting an engine for ground operation could facilitate this procedure. Since this accident, the operator has stated that it intends to redesign its Learjet 45 checklist card to include a procedure for the ground operation of one engine.