دولة الامارات العربية المتحدة
الهيئة العامة للطيران المدني
UAE General Civil Aviation Authority

AIRCRAFT ACCIDENT 01/04

FINAL REPORT ON THE ACCIDENT INVOLVING KISH AIRLINES FOKKER F27 MK.050, IRANIAN REGISTERED AS EP-LCA ON APPROACH TO SHARJAH INTERNATIONAL AIRPORT, UNITED ARAB EMIRATES ON 10 FEBRUARY, 2004

OBJECTIVE

In accordance with Annex 13 to the Convention on International Civil Aviation, it is not the purpose of aircraft accident investigation to apportion blame or liability. The sole objective of the investigation and the Final Report is the prevention of accidents and incidents.

INTRODUCTION

SYNOPSIS

The aircraft involved was a Fokker F27 Mk.050, owned by the Kish Airlines, based at Ekbatan in the Islamic Republic of Iran. The Islamic Republic of Iran was the State of Registry and the State of the Operator. The Netherlands was the State of Design and the State of Manufacture. On this particular flight, IRK 7170, EP-LCA, was operating a scheduled passenger flight from Kish Island to Sharjah, UAE, and was approaching to land on runway 12 at Sharjah International Airport in good daylight visibility. The aircraft was observed to pitch down and suddenly turn to the left. The aircraft continued to descend and turn at high pitch and roll angles and impacted a sandy area within a residential area 2.6 nm from the runway threshold. Immediately a large explosion was seen. The aircraft was destroyed and there were 43 fatalities.

The cause of the accident was attributed to the movement of the propellers from the Flight Control Range to the Ground Control Range.

Four safety recommendations have been made. Unless otherwise indicated, recommendations in this report are addressed to the regulatory authorities of the State having responsibility for the matters with which the recommendation is concerned. It is for those Authorities to decide what action is taken.

ACCIDENT DETAILS

The accident details are as follows;

Registered Owner	:	Kish Airlines
Registered Operator	:	Kish Airlines
Aircraft type & model	:	Fokker F27 Mk.050
Nationality	:	Islamic Republic of Iran
Registration	:	EP-LCA
Place of Accident	:	2.6 nm final to Sharjah International Airport, United Arab Emirates Runway 12 Latitude : 25° 21.35’ N Longitude : 055° 28.63’ E
Date & Time	:	10 February 2004 1138 hours local UAE time 10 February, 2004 0738 hours UTC

Note: *Except where discussing DFDR, CVR and ATC times, all times in this report are local UAE time, which is Coordinated Universal Time (UTC) plus 4 hours.*

Persons on board	:	2 Flight crew
	:	2 Cabin crew
	:	2 Security personnel
	:	40 Passengers
Fatalities	:	43
Injuries	:	3 Serious

ORGANIZATION OF THE INVESTIGATION

The GCAA was notified within minutes of the accident and an Aircraft Accident Investigation Committee was established under a Ministerial Decree identifying the GCAA as the authority responsible for the conduct of the investigation. Notification to ICAO and applicable States was completed on the day of the accident. Officials from the following State of Operator/Registry, State of Design and individual States of Manufacturer of the aircraft, engine and propellers were granted Accredited Representation in accordance with ICAO Annex 13 and corresponding UAE Civil Aviation Regulations. Officials representing the Type Certificate holder of the aircraft manufacturer of engines and propellers also assisted in the investigation and were granted observer status.

State of Operator/Registry	-	Iranian Civil Aviation Organization (CAO)
State of Design/Manufacture (aircraft)	-	Dutch Transport Safety Board & Civil Aviation Authority
State of Manufacture (engine)	-	Canadian Transportation Safety Board
State of Manufacture (propeller)	-	UK Air Accidents Investigation Branch
State of Manufacture (skid control unit)	-	US National Transportation Safety Board

GCAA Investigators, assisted by experts from the Dutch Type Certificate holder Fokker Services B.V. and by technical and operational experts from the CAO, Kish Airlines and the engine manufacturer, Pratt & Whitney Canada, examined the site of the accident to secure material evidence. The wreckage was later removed to a secure site within Sharjah International Airport. The French Bureau Enquêtes-Accidents was requested to provide assistance with the flight recorder read-outs and analysis and this was conducted within a week of the accident. Representatives from the propeller manufacturer Dowty joined the investigators and work continued on the first findings of the recorders and on the aircraft components. The technical investigation was closely coordinated and controlled by the GCAA during the initial onsite investigation and the collection of technical information, DFDR/CVR readouts, as well as the examination of the components removed from the wreckage.

The first factual findings of the investigation were published in an ADREP Preliminary Report issued on 01 March, 2004.

FINAL REPORT

This Final Report was released on 21 April, 2005 by the GCAA under the authority of the GCAA Director General.

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7. Accident Photographs

ABBREVIATIONS USED IN THIS REPORT

agl	Above Ground Level
amsl	Above Mean Sea Level
ALT	Altitude
AOM	Aircraft Operating Manual (Kish Airlines)
ATC	Air Traffic Control
BEA	Bureau Enquêtes Accidents
CAA-NL	Civil Aviation Authority – The Netherlands
CAO	Civil Aviation Organization (Islamic Republic of Iran)
cm	centimetre(s)
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
DME	Distance Measuring Equipment
EEC	Electronic Engine Controller
EMI	Electromagnetic Interference
FF	Fuel Flow
ft	Feet
GCAA	General Civil Aviation Authority (UAE)
h	hour(s)
HDG	Heading (Magnetic)
hPa	Hectopascals
IAS	Indicated Air Speed
ICAO	International Civil Aviation Organization
kg	Kilogram(s)

km	Kilometre(s)
kt	Knots
lbs	pounds
LH	Left Hand
m	Metre(s)
M	Magnetic (heading)
MDA	Minimum Descent Altitude (for non precision approach)
MHz	Megahertz
min	Minute(s)
MLG	Main Landing Gear
mm	Millimetre(s)
mph	Miles per hour
Nh (NH)	High pressure rotor speed
nm	Nautical Mile(s)
NP	Propeller Speed
PCU	Propeller Control Unit
PEC	Propeller Electronic Control
PF	Pilot flying
PLA	Power lever angle
PLP	Propeller Low Pitch
PNF	Pilot not flying
QNH	Setting on altimeter sub scale to indicate altitude above mean sea level
QRH	Quick Reference Handbook (Kish Airlines)
RH	Right Hand

SCU	Skid Control Unit
sec	Second(s)
SHJ	Sharjah Aeronautical Designator
SOP	Standard Operating Procedure(s) (operator)
TAT	Total Air Temperature
TQ	Torque
UAE	United Arab Emirates
UTC	Coordinated Universal Time
VMC	Visual Meteorological Conditions
VOR	VHF Omni-directional Radio Range
V_{REF}	Threshold Speed

1. FACTUAL INFORMATION

1.1 History of the flight

1.1.1 The aircraft was operating as a scheduled flight from Kish Island, Iran to Sharjah, UAE with the Captain initially as the pilot flying (PF). The crew reported nothing unusual to ATC for the take-off at Kish Island and the aircraft operated to Sharjah on the 35 min flight without event. The accident occurred on approach to Sharjah runway 12. The aircraft was operated in a dedicated passenger configuration as flight IRK 7170 and the radio call-sign was “Kish Air 7170”.

1.1.2 At 1124 hours local time, the aircraft contacted Dubai Arrivals and was cleared from 9000 ft to 5000 ft and instructed to expect a VOR/DME approach to runway 12 at Sharjah International Airport. At 1129 hours the aircraft was further cleared to 2500 ft and cleared for the approach. The aircraft was under its own navigation and the daylight conditions were fine with excellent visibility. At 1135 hours the aircraft was instructed to contact Sharjah Tower and the pilot reported that the aircraft was established on the VOR final approach for runway 12. The Tower cleared IRK 7170 to land and advised that the wind was calm. This was acknowledged and there were no further radio transmissions from IRK 7170.

Another aircraft was positioned at the holding point of Sharjah runway 12 and the pilot was observing the progress of the Fokker F27 Mk.050 as he had been given a clearance to line up after this aircraft. The pilot stated that he saw the aircraft on what appeared to be a normal approach when it suddenly pitched down. It then commenced a steep left-hand spiral dive, which continued until impact with terrain. As far as he could recall, the aircraft impacted the ground approximately 10-15 seconds after the initial nose down movement in what he estimated to be a 60º nose down attitude. Impact was followed by a large volume of flame and smoke. Prior to impact, he stated that the aircraft appeared to be totally intact without any signs of fire. This was collaborated by the First Officer, who also witnessed the accident.

1.1.3 The crash alarm was activated immediately and rescue and fire trucks dispatched to the scene. The runway was closed and all inbound traffic diverted to regional aerodromes.

1.1.4 The aircraft impacted in a vacant sandy area within a residential area. The aircraft missed houses by about 60 m and crossed a bitumen road before coming to rest 50 m from the initial impact point. Local residents were able to assist with the rescue of those surviving passengers.

Place of Accident:	2.6 nm final to Sharjah International Airport, United Arab Emirates Runway 12 Latitude : 25° 21.35’ N Longitude : 055° 28.63’ E Elevation : 110 ft amsl

Date & Time : 10 February 2004 - 1138 hours local UAE time
10 February, 2004 - 0738 hours UTC

1.2 Injuries to persons

There were a total of 43 fatalities and 3 survivors. Initially there were four survivors although one later died in hospital. Due to the severity of the injuries and subsequent fire, only a third of the fatalities were able to be recognized without the need of DNA sampling. The crew consisted of a Captain, First Officer, Purser, Cabin Crew member and two security personnel

Injuries	Nationality	Crew	Passengers	Total in Aircraft	Others
Fatal	Iranian	6	11	17	0
	Indian	0	13	13	0
	Egyptian	0	3	3	0
	Algerian	0	2	2	0
	Filipino	0	1	1	0
	Bangladeshi	0	1	1	0
	Cameroonian	0	1	1	0
	Emirati (UAE)	0	1	1	0
	Nepalese	0	1	1	0
	Nigerian	0	1	1	0
	Sudanese	0	1	1	0
	Syrian	0	1	1	0
	Total	**6**	**37**	**43**	**0**
Serious	Iranian	0	1	1	0
	Egyptian	0	1	1	0
	Filipino	0	1	1	0
	Total	0	**3**	**3**	**0**
Minor		0	0	0	0
None		0	0	0	0
Total		**6**	**40**	**46**	**0**

1.3 Damage to aircraft

Most of the aircraft was completely destroyed on impact and the ensuing fire and only the tail section was relatively intact.

1.4 Other damage

Apart from a deep scrape in a bitumen road next to the wreckage there was no third party damage, nor any environmental damage.

1.5 Personnel information

1.5.1 General.

The required flight crew complement for the Fokker F27 Mk.050 was a Captain and First Officer. It was established that the Captain was occupying the left seat and was at the controls at the start of the events leading up to the accident. All crew members held the required licences, experience and training specific to their appointment.

1.5.2	Captain	:	Iranian National Male 48 years		
	Licence	:	Valid ATP Licence Fokker F27 Mk.050 command type rating		
	Medical Certificate	:	Class 1 valid until 21 February, 2004		
	Flying experience	:	Total all types	-	6440 hours
			Other Types flown	-	Fokker F27-500
				-	Fokker F28
				-	Military aircraft
			Total on Fokker F27 Mk.050	-	1516 hours
			Last 90 days on F27 Mk.050	-	207.27 hours
			Last 7 days on F27 Mk.050	-	28.40 hours
			Last 24 hours on F27 Mk.050	-	5.13 hours
	Duty Times	:	Last 7 days	-	47.54 hours
			Last 48 hours	-	13.48 hours
	Training	:	Fokker F27 Mk.050 initial	-	07 April 02
			Last Line Check	-	04 August 02
			Last Pilot Proficiency Check	-	04 October 03
1.5.3	First Officer	:	Iranian National Male aged 50 years		
	Licence	:	Valid ATP Licence Fokker F27 Mk.050 co-pilot type rating		
	Medical Certificate	:	Valid until 26 March, 2004		
	Flying experience	:	Total all types	-	3978 hours
			Other Types flown	-	Fokker F27-500
				-	Military aircraft
			Total on Fokker F27 Mk.050	-	517 hours
			Last 90 days on F27 Mk.050	-	132.29 hours
			Last 7 days on F27 Mk.050	-	18.00 hours
			Last 24 hours on F27 Mk.050	-	3.36 hours

Duty Times	:	Last 7 days	-	30.00 hours
		Last 48 hours	-	14.30 hours
Training	:	Fokker F27 Mk.050 initial	-	19 March 03
		Last Line Check	-	10 April 03
		Last Pilot Proficiency Check	-	03 October 03

1.5.4 Cabin Crew.

Documents were presented that indicated that the cabin crew member had conducted a formal cabin crew training course.

1.6 Aircraft information

1.6.1 General Information

Certification of Registration	:	Registered in Iran as EP-LCA
Certificate of Airworthiness	:	Issued 03 March, 2003 and valid
Registered Owner	:	Kish Airlines
Registered Operator	:	Kish Airlines
Aircraft Manufacturer	:	Fokker Aircraft BV (Netherlands)
Type	:	Fokker F27 Mk.050
Serial No.	:	20273 manufactured in 1993
Total airframe hours	:	20466 hours
Total cycles	:	19845 cycles

1.6.2 Maintenance Details.

Maintenance performed in accordance with the manufacturer's Maintenance Schedule for Fokker F27 Mk.050.

Date of last inspection	:	"A" Check conducted 24 December, 2003
Next maintenance review	:	20600 hours or 31 April, 2004

1.6.3 Technical Considerations.

The aircraft maintenance documents indicated that the aircraft had no deferred defects since the last daily inspection on 10 February, 2004. The Aircraft Technical Flight Log indicated that the aircraft was serviceable at the initial departure aerodrome of Kish Island. There was full compliance with Airworthiness Directives and Service Bulletins.

1.6.4 Engine Details

	Left	Right
Manufacturer	Pratt & Whitney	Pratt & Whitney
Type	PW-125B	PW-125B
Serial No.	124197	125068
Operating hours	11,196	24790
Cycles	8383	21437

There were no recorded defects for the flight or unscheduled maintenance since installation on 22 January, 2004.

1.6.5 Propeller details

	Left	Right
Manufacturer	Dowty Propellers	Dowty Propellers
Date of manufacture	13 January, 1988	12 August, 1992
Type	R352/6-123-F/1	R352/6-123-F/2
Serial No.	DRG/9401/87	DAP/0044
Operating hours	25868 hours	17161 hours
Time Since Last Overhaul	5730 hours	2380 hours

There were no recorded defects or unscheduled maintenance since overhaul and the aircraft technical logbooks indicated that there had been no scheduled or unscheduled maintenance conducted on the aircraft propeller components since the commencement of operations with Kish Airlines in March, 2002.

1.6.6 Skid Control Unit

The operation of an unmodified Skid Control Unit was determined to have a bearing on this accident. There was a known undesirable condition during the landing gear lowering sequence, whereby the secondary stop protection solenoid was energized through the Skid Control Unit and the subsequent loss of protection could allow the power lever movement into a ground control range in flight if the power levers were moved through the mechanical stop. This component is fully described at paragraph 1.16. There were no entries in any of the aircraft log books regarding the servicing or replacement of this component.

1.6.7 Operational details

A review of operational documentation indicated that the crew had all information for flight planning available prior to departure and there were no abnormalities found. The Kish Airline's Weight and Balance Manifest was a combined load sheet and weight and balance sheet and reflected the actual load of the aircraft. The details for this flight from Kish Island to Sharjah were;

Dry Operating Weight	-	13515 kg
Traffic Load	-	2980 kg
Zero Fuel Weight	-	16495 kg
Fuel	-	2000 kg (Jet A1)
Take-off Weight	-	18495 kg (Max 20820 kg)
Calculated % TO MAC	-	34.9
Estimated trip fuel	-	500 kg
Estimated Landing Weight	-	17995 kg (Max 19730 kg)
Estimated % LDG MAC	-	34.7
Average Passenger Weights	-	71.5
Cabin baggage	-	120
Cargo	-	0

1.7 Meteorological information

1.7.1 General.

There was a general forecast of a weakening high pressure gradient covering the area with no low level instability expected. The actual weather at the time of the accident was fine with bright sunlight, slightly hazy with light and variable winds. Investigators at the scene reported clear skies and light variable winds with conditions as stated in the meteorological reports. Photographs taken from 2 km away and shortly after the accident occurred show the smoke rising almost vertically without wind effect.

1.7.2 Weather Conditions.

1.7.2.1 Sharjah Weather Report (Forecast). The forecast issued for the period 0000 to 2400 hours on 10 February, 2004 was 140/04 kt; CAVOK; BECMG 320/13 kt.

1.7.2.2 Sharjah Weather Report (Actual). The weather conditions recorded at 0730 UTC (8 minutes before the accident) and at 0746 hours UTC (8 minutes after the accident), were the same as recorded on the Airfield Terminal Information Service (ATIS). There were no reports of turbulence prior to the accident and helicopter crews operating into the accident site reporting smooth flying conditions.

		0730 hours UTC		0746 hours UTC
Wind	:	Variable 3 kt (variable 300-100°)	:	360/05 kt
Visibility	:	> 10000 m	:	>10000 m
Cloud	:	nil	:	nil
Temperature	:	23° C; Dewpoint 09° C	:	24° C; Dewpoint 07° C
QNH	:	1022 hPa	:	1022 hPa
Warnings	:	Nil	:	Nil

1.8 Aids to navigation

1.8.1 Navigation Aids.

The navigation aids at Sharjah are VOR/DME for runway 12 as well as an ILS for runway 30. They conform to, and are in compliance with, Annex 10, Volume 1, Radio Navigation Aids. The runway 12 VOR/DME was operating on 112.30 MHz and there was no known unserviceability or abnormality prior to the accident. A functional check was conducted shortly after the accident, which confirmed normal operation.

1.8.2 Approach Chart

From the CVR, the Captain was heard to instruct the First officer to set 410 ft for the MDA, (published as 500 ft) and a final approach track of 118° M (published as 117° M). No approach charts were found in the wreckage. All Sharjah approach charts were reviewed and apart from a reference of 410 (ft/min) in the Descent Gradient column, there were no references to these incorrect figures in the Jeppesen chart or the UAE AIP for VOR/DME runway 12. (Refer to Appendix 1).

1.8.3 Radar Plot.

The radar returns from Kish Air 7170 plot were recorded from the radar head at Dubai every 5 seconds from 10 nm. As a normal procedure to verify the aircraft's altitude corresponds to that observed on radar, an altitude check was requested by Dubai Approach when IRK 7170 was indicated as cruising at 9000 ft, just prior to descent. This altitude was confirmed by the aircraft. The radar plot, together with superimposed same time ATC communications, was available to the Investigation Team. The returns from the aircraft indicated that the aircraft intercepted the VOR/DME approach for runway 12 near position SAMAK (13 DME on the final approach track) at 2500 ft and when cleared for the approach at 8 nm DME descended to 900 ft at approximately 1500 ft/min remaining above the approach chart profile at a ground speed of 200 ± 2kt. Approaching 1000 ft and after 4 DME the rate of descent reduced, the ground speed reduced sharply by 30 kt in 20 seconds and shortly after the returns became erratic with a "NMC" (No Mode Charlie on the altitude encoding) followed by an indication of 100 ft altitude. The indications from the last three plot returns were:

Time (UTC)	**Lat/Long**	**Bearing/distance from SHJ VOR**	**Mode C (alt)**	**Groundspeed (kt)**	**Radar track (° M)**
07 h 38 min 15s	N 25° 21' 24.9" S 055° 28' 09.5"	298/3.23 nm	900 ft	187	118
07 h 38 min 20s	N 25° 21' 11.7" S 055° 28' 13.3"	295/3.06 nm	NMC	177	No record
07 h 38 min 25s	N 25° 21' 19.2" S 055° 28' 32.6"	300/2.87 nm	100 ft	168	No record

1.9 Communications

All transmissions to the aircraft, as well as inter-agency telephone conversations, made by UAE ATC were clear, in the English language, and recorded. Transcripts were made of all communications involving IRK 7170 and the initial emergency response. There were no transmissions made by IRK 7170 indicating a problem and all conversation was given in a clear and unhurried manner. It was determined that the First officer made the communications to ATC from IRK 7170, except for all transmissions to Sharjah Tower. During all transmissions, no aircraft warning noises were heard. There was no transmission made on the recorded distress frequency of 121.5 MHz.

For arrivals into Sharjah, the Emirates Area Control Centre control and vector the aircraft until the aircraft approaches the Dubai airspace and the responsibility for arrival is transferred to Dubai Approach Control. For VOR/DME operations at Sharjah, Dubai Approach Control vector the aircraft towards the inbound VOR radial in accordance with Local Air Traffic Services Instructions and then transfer control to Sharjah Tower.

The UTC timing on the tapes was determined to be correct UTC time. (Refer to Appendix 2 for transcript). As all instructions issued by ATC were correctly acknowledged, radio communications between ATC and IRK 7170 were not considered a factor in this accident.

1.10 Aerodrome information

1.10.1 Aerodrome

Sharjah International Airport is a UAE international airport with full facilities. Runway 12 is aligned at 121° M and dimensions are 4060 m x 45 m with a Landing Distance Available of 3850 m. The approach to runway 12 is over a sparsely populated residential area with sandy vacate areas approximately 100 ft amsl.

1.10.2 Air Traffic Control

At the time of the accident the control tower was manned by correctly licensed and validated personnel.

1.10.3 Fire Services

Sharjah Airport Fire Services are categorised as Rescue and Fire Fighting (RFF) Category 9. The RFF facility was determined to be operating to RFF Category 9 at the time of the accident.

1.11 Flight recorders

1.11.1 Recovery

The Cockpit Voice Recorder, a Fairchild Model A100A, S/N 62252, and the Digital Flight Data Recorder (DFDR), a Fairchild Model F800, S/N 05023 were retrieved from the relatively undamaged tail section of the aircraft in very good condition. They remained under GCAA control and were presented to the Bureau Enquetes Accidents (BEA) in Le Bourget, France on 16 February, 2004 for extraction of the DFDR data and CVR transcription. The opening of the recorders and downloading of the data were witnessed by members of the GCAA Investigation Team. Both the DFDR and CVR timings were adjusted to UTC time.

1.11.2 Cockpit Voice Recorder

1.11.2.1 General. A satisfactory replay was obtained, which covered the conversations between crewmembers in Farsi and English, communications with Tehran, Dubai and Sharjah ATC in English and general cockpit sounds. The 32 minute duration recording was a good quality recording on 4 separate tracks (area microphone; Captain radio; First Officer radio and timing track). The replay commenced as the aircraft was climbing to 9000 ft after departure from Kish Island and ended within seconds of impact. Throughout the recording the crew is heard to conduct the approach briefing and pre-descent checklist in accordance with SOPs. The calculated threshold speed (V_{REF}) was stated as 100 kt, the company final approach speed ($V_{REF\ +10}$) was stated as 110 kt and the final figure for the company approach speed corrected for headwind was stated as 115 kt. At no time does the crew make any reference to an unserviceability or abnormality. A full transcript was made commencing from the time the aircraft intercepted the final approach track until after the recording stopped at impact. (Refer to Appendix 3 for full transcript).

1.11.2.2 Approach Anomalies

The Captain instructs the First officer to set 410 ft for the MDA, and not 500 feet as published on the Jeppesen chart and UAE AIP for VOR/DME runway 12. The Captain also instructed the First officer to set a final approach track of 118° M, and not the published track of 117° M.

1.11.2.3 Human Factors

From the CVR, the Captain is heard to hand over control of the aircraft to the First Officer during the descent to 2500 ft and to tell the First Officer that this will be the First Officer's flight. The First Officer is not expecting this and he does not accept this willingly as he is not confident of his ability to conduct the VOR/DME approach into Sharjah. The First Officer is heard to say that he doesn't have the same experience as the Captain to conduct this approach and the Captain insists. The Captain, in an attempt to boost the First Officer's confidence, is heard to encourage him and continued to assist him during the conduct of the approach. This generates some discussion and the First Officer continues to fly with the Captain giving advice on inbound track capture and approach profile. There is an inconsistency with this exchange as the First Officer had over 4000 flight hours, of which 600 hours were on the F27 Mk.050 aircraft and he had another 2400 hours as pilot in command on large turbo-prop aircraft (C-130). It was difficult for the Investigation Committee to understand why this pilot believed he didn't have the necessary experience to conduct a simple straight-in non precision approach in day VMC conditions. However, from the DFDR and radar plot, the First Officer positioned the aircraft above the normal approach profile, at a high airspeed and not configured for landing. At the time the Captain takes over control, the aircraft is at least 50 kt over the normal final approach speed, above a normal approach profile of 3° glide slope, and less than 3 nm from the threshold. This may be indicative that the First Officer did not know the SOP approach speed and configuration.

The CVR indicated that the Captain took over control of the aircraft and intended to hand over control again to the First Officer once the aircraft was on the correct profile for landing. The flap lever and landing gear selector are heard on the CVR to be moved when above their respective Aircraft Flight Manual limiting speeds. When compared with the DFDR data, the landing gear was determined to be selected down at approximately 185 kt (limiting speed of 170 kt). This was calculated to be 14 sec before there was an audible increase in propeller noise.

1.11.2.4 Final Approach and Landing.

The First Officer discusses the limiting altitudes and DME distances to be observed. On reaching the 4 nm point from the DME the First Officer is heard to disconnect the autopilot and shortly afterwards call for “Flap 10” then “landing gear down”. The Captain then states that he has control. A few seconds later the propeller(s) RPM noise is heard increasing.

1.11.2.5 Spectrum Analysis

A spectrum analysis was conducted on the CVR area mike from 07 hr 38 min 10-12 s to determine if any sound on the CVR could be identified as the power levers moving into the ground control range. The spectrum analysis was based on the work carried out by the BEA during the investigation into the accident involving Luxair as well as further trials using the same aircraft type.(refer to Appendix 4). The target sounds heard were compared with a reference noise, and when analysed, presented several similarities in their shape, cadence and frequencies. The conclusion was the identification on the target noise as the movement of the ground range selector and then movement of the power levers. A further sound was heard similar to the movement of the power levers to a forward position

1.11.2.6 Combined CVR Comments and Spectrum Analysis

The following relevant comments and sounds are heard shortly after the autopilot is disconnected approaching 900 ft amsl (approximately 800 ft agl), 4 DME, at 185 kt in a clean configuration. The results of the additional spectrum analysis are included in italics

UTC Time		**Comment**
07 h 37 min 54 sec	-	Flap 10 command from First Officer (PF)
57 sec	-	click similar to flap lever hitting detent
58 sec	-	Landing gear down command from First Officer
-		Click similar to landing gear lever hitting stop
	-	Wind noise similar to landing gear and door movement
38 min 01 sec	-	Click similar to flap lever hitting detent
03 sec	-	“With Me” as Captain takes over (PF)
05 sec	-	“I will make it” response from First Officer
06 sec	-	Triple chime commences (flap to 25° without landing gear)

07 sec - "I will give it back to you" from Captain
08 sec - "Okay" from First Officer
10 sec - Triple chime stops (when landing gear down)
11.3 sec - sound consistent with lifting of ground range selectors
12 sec - Increase in propeller noise
12 sec - "Why! (or woe betide us)" from Captain
12.6 sec - sound consistent with release of ground range selectors
14.1 sec - sound consistent with movement of power levers (forward)
15 sec - "Push it forward" (possibly power levers)
16 sec - "Can't raise it" (possibly nose attitude)

1.11.3 Digital Flight Data Recorder

1.11.3.1 General. A satisfactory extraction of the data was obtained but it was determined that there were no parameters for the landing gear, flying controls (aileron, elevator, rudder), power levers and lateral acceleration.

1.11.3.2 Approach & Event. The DFDR indicated that the aircraft had intercepted the final approach track for the VOR/DME runway 12 and descended from 2500 ft to 900 ft at an average airspeed of 195 kt, an average rate of descent of approximately 1000 ft/min and in a clean configuration. For the purposes of this report, event is defined as the movement of propellers into the ground control range.

UTC Time **Comment**

07 h 37 min 48 sec - Autopilot disconnected
51 sec - Torque reduction (LH 5%; RH 0%)
57 sec - Flap angle moves from 0° at 186 kt at 960 ft amsl
38 min 06 sec - Then from Flap 10° at 183 kt at 950 ft amsl
10 sec - Reaches Flap 25° at 162 kt at 1000 ft amsl
38 min 11 sec - Commencement of event
11-13 sec - Low pitch lights on indicating both propellers move below a nominal 10° blade angle
- Both propeller RPM increase,
- commencement of gradual pitch down to 27°
- commencement of gradual bank to left of 35°
Both engines reduce slightly below 74.01% NH (which is the flight idle setting)
Reduction in fuel flow
15 sec - Sudden increase in
- LH fuel flow
- LH Engine torque
- LH Inter-turbine temperature (ITT)

21 sec - reduction in pitch and roll angles
26 sec - Roll angle 12° to left

- Pitch 17° nose down
- commencement of increase in pitch and roll angles

29.5 sec
- Recording stops
- Heading 062° M
- Speed 113 kt
- Roll angle 47°
- Pitch 17° nose down

1.11.3.3 Low Pitch (LO PITCH) indications

The DFDR parameter for the low propeller pitch lights indicate that the left propeller entered the ground control range about 1 sec prior to the right propeller, yet the propeller RPM parameters indicated that both propellers moved simultaneously into the ground control range. This discrepancy of the low pitch lights could be explained by the parameter sampling rate, which is 1 per sec. It is conceivable that the time difference was only a fraction of a second but the low pitch light of the right propeller was recorded in the next sample. (Refer also to paragraph 1.16.2.7)

1.11.3.4 Engine/propeller relationship. The engine, aircraft and propeller manufacturers were in agreement that propeller behaviour in a ground control range during flight was unpredictable. However, from analysis of the DFDR data, there was a general consensus as to the propeller behaviour. The analysis estimations are summarized in the following table and reference should be made to paragraph 1.16 for further explanation and description.

1.11.3.5 Initial Power Lever Position. There is no DFDR parameter to indicate the position of the power levers. At time 07 h 37 min 51 sec, there is a power reduction, which equates to the power levers being at the flight idle detent even though there is a slight residual torque on the left engine. At the time of the event at 07 h 38 min 11 sec the DFDR indicated a reduction in fuel flow for both engines. At 07 h 38 min 12 sec the DFDR indicated a reduction in both engine high pressure rotor speed (Nh) below that calculated for flight idle. The command for a reduction in fuel flow can only be made by a power lever thus confirming both power levers were moved to a position below flight idle.

1.11.3.6 DFDR Summary. The following table indicates the DFDR engine and propeller data with the propeller pitch change event commencing at 07 h 38 min 11 sec.

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TIME	TAT	IAS	ALT	HDG	TQ LH	TQ RH	NP LH	NP RH	PLP LH	PLP RH	NH LH	NH RH	FF LH	FF RH
hh:mm:ss	deg C	kts	ft	deg	%	%	%	%	disc	disc	%	%	lbs/hr	lbs/hr
7:38:01	23,8	183	951	116	3,6	0,0	85,3	85,2	0	0	76,1	77,0	275	245
7:38:02	23,8	179	954	116	3,6	0,0	85,3	85,1	0	0	75,8	76,8	268	245
7:38:03	23,8	178	954	116	3,6	0,0	85,3	85,1	0	0	75,9	76,8	275	250
7:38:04	23,8	173	960	115	3,6	0,0	85,3	85,1	0	0	75,8	76,8	268	250
7:38:05	23,8	169	973	116	3,6	0,0	85,1	85,0	0	0	75,9	76,8	274	245
7:38:06	23,3	168	990	116	4,5	0,0	85,3	85,1	0	0	76,5	76,6	281	239
7:38:07	23,3	164	990	116	3,9	0,0	85,2	85,1	0	0	77,2	76,3	303	239
7:38:08	23,3	161	995	116	3,5	0,0	85,2	85,1	0	0	77,0	76,2	291	240
7:38:09	23,2	156	1004	116	2,1	0,0	85,2	85,1	0	0	75,8	76,2	262	245
7:38:10	23,8	153	1004	115	2,9	0,0	85,2	85,1	0	0	75,2	76,5	256	227
7:38:11	**23,8**	**153**	**1008**	**115**	**0,0**	**0,0**	**86,1**	**85,3**	**1**	**0**	**74,5**	**75,2**	**250**	**187**
7:38:12	23,3	146	1006	115	1,3	0,0	94,5	94,2	1	1	72,9	73,4	209	187
7:38:13	23,8	139	974	113	4,5	0,0	89,7	99,0	1	1	72,3	73,6	202	338
7:38:14	23,3	135	950	113	6,8	0,0	86,1	101,3	1	1	78,6	78,0	401	245
7:38:15	23,3	135	923	114	13,6	0,0	85,9	102,0	1	1	81,2	77,7	375	397
7:38:16	23,2	132	884	112	44,5	0,2	88,9	105,5	1	1	87,5	82,6	583	413
7:38:17	22,7	127	824	107	82,6	0,0	88,4	106,5	1	1	93,4	81,8	914	338
7:38:18	22,7	127	764	103	98,8	0,0	86,1	106,5	1	1	96,0	81,1	1141	374
7:38:19	22,7	124	692	100	35,0	0,0	75,1	104,5	1	1	90,6	80,5	1071	221
7:38:20	22,7	123	621	94	23,7	0,0	67,3	100,8	1	1	83,1	76,8	338	233
7:38:21	22,7	130	543	87	6,8	0,0	76,4	98,3	1	1	82,7	75,5	410	239
7:38:22	22,7	129	454	82	4,0	0,0	87,8	97,3	1	1	79,8	75,2	287	250
7:38:23	22,7	131	355	78	5,5	0,0	87,5	97,2	1	1	77,9	75,4	250	250
7:38:24	23,3	130	264	74	3,4	0,0	85,2	97,0	1	1	76,4	75,9	234	368
7:38:25	23,8	128	182	71	12,8	1,9	87,4	101,8	1	1	79,2	82,0	293	560
7:38:26	23,8	124	106	67	39,0	0,0	88,9	106,1	1	1	87,2	85,1	573	354
7:38:27	23,3	122	38	61	56,8	0,0	87,1	106,8	1	1	90,4	83,1	750	362
7:38:28	23,3	116	4975	53	69,0	2,8	85,9	106,8	1	1	92,1	83,1	867	391

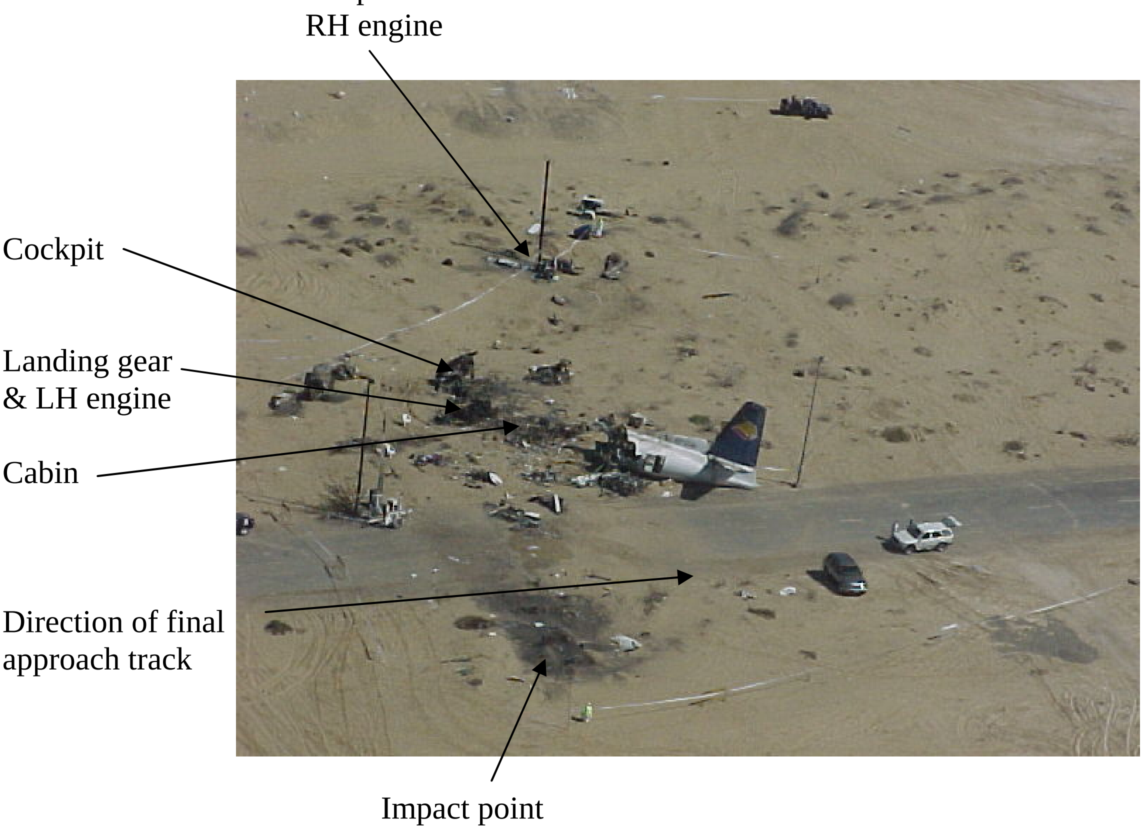
Flight Data Recorder information for propeller/engine (Commencement of event in red)

1.11.3.7 Human Factors. From the DFDR data, the flap and landing gear is selected above their respective limiting speed. Flap 10 is selected at 186 kt (limiting speed of 180 kt); Flap 25 is selected at 183 kt (limiting speed of 160 kt), and the landing gear is selected at approximately 185 kt (limiting speed of 170 kt). The approach is non standard as the speed is 60 kt fast and the aircraft is not configured with flap 10, landing gear down as required in the Kish Airlines AOM Volume 2.

1.11.3.8 Previous Flight. A check was conducted on the DFDR data from the previous landing conducted by this aircraft to ensure that there was no abnormality with the propeller ground/flight mode for the take-off and landing. The data indicated normal operations and discounted any power lever/engine control rigging possibilities.

1.12 Wreckage and impact information

1.12.1 There was a single crater found in a flat sandy area on the opposite side of the road to where the majority of the wreckage was found. The scorched sand crater indicated an impact explosion but no impact information such as aircraft attitude or heading could be determined. As the wreckage of the cockpit, fuselage and tail section was located within 30m of the initial impact crater, it could be determined that the aircraft had a low horizontal velocity at the time of impact. There was evidence of scraping across the road in the direction of where the burnt out cabin was located indicating that the momentum of the aircraft on impact was towards 050° M. The severed tail section was aligned 330° M. whilst the burnt out fuselage wreckage indicated that the aircraft came to rest on a heading of 340° M. No aircraft components were found outside this small debris field.



1.12.2 Landing Gear.

The landing gear was recovered from the main fuselage area and it could be determined that it was down and locked at the time of impact.

1.12.3 Flaps.

The flap jacks were all recovered and it was established that Flap 25° was set.

1.12.4 Cockpit.

Parts of the instrument panel were found but all cockpit instruments were totally destroyed. From one section of the centre console, it was clearly established that the landing gear lever was in the down position. Part of the power lever quadrant was recovered with the left power lever almost full forward and the right power lever about mid travel. The ground idle stop mechanism was burnt out and the position could not be established.

1.12.5 Engines.

The left engine was severely burnt as it was in the main wreckage whilst the right engine was thrown 50m clear on impact. Both of the power turbines were observed to be undamaged. Both the left and right hand engines displayed circumferential deformation to the compressor low pressure impellers characteristic of the gas generators being powered at the time of impact. There was no evidence of any release of internal engine components, nor evidence of bird ingestion, on any engine.

1.12.6 Propellers.

All propeller blades had sheared at the hubs on impact and were recovered from various sections of the debris field. Being of composite construction no impact information could be determined. The hubs were recovered as well as the applicable beta tubes, Propeller Control Units, Propeller Electronic Controllers, overspeed governors, but only one feathering pump could be found.

1.12.7 Skid Control Unit

The Skid Control Unit was found in a severely burnt condition.

1.12.8 Cabin Baggage and Freight

The recovered cabin baggage reflected that stated on the weight and balance manifest.

1.12.9 Weapon

A loaded 0.38 inch pistol, of Spanish make, serial number 13707 was found in the wreckage. Kish Airlines advised that a Sky Marshall was authorized to carry this weapon with 36 bullets. Forensic testing confirmed that the weapon was one issued to the Sky Marshall and had not been fired.

1.13 Medical and pathological information

1.13.1 Investigation of the flight crewmembers' medical history confirmed that they met the CAO and ICAO Annex 1 medical standards for the licences held. Both pilots had a limitation for the wearing of glasses whilst exercising the licence privileges. There were no indications of any disorder that could have had a bearing on this accident.

1.13.2 The results of the pathological and toxicological examinations detected no carbon monoxide, drugs or alcohol in either pilot's system.

1.13.3 There was no evidence that physiological factors or incapacitation affected the performance of flight crew members.

1.14 Fire

1.14.1 From the scorching of the impact crater, adjacent power line and road, and further substantiation by witnesses, there was a large explosion on impact. The fire immediately engulfed the remains of the cockpit section. The fire spread to the main cabin area, totally destroyed it.

1.14.2 The rescue and fire fighting vehicles were not at the scene for almost 25 min after the accident. The access to the site by the rescue and police services was hampered by the number of private vehicles and people crowded into the restricted residential area. The fire was extinguished about 30 minutes after the accident but the wreckage continued to smoulder for a further hour.

1.15 Survival aspects

There were four survivors initially found in the fuselage section however one died on the way to hospital. A witness, who was on the scene very quickly, stated that the main fuselage was still intact when he arrived and he could hear people inside requesting help. Attempts were made to gain access to these passengers through the front door but it would not move as it appeared to be crushed and fire prevented access to the cabin through open sections of the fuselage. The fire intensified very quickly forcing rescuers away and it quickly engulfed that section of the fuselage. A photograph taken approximately 10 minutes after the accident showed the cabin totally engulfed. There may have been more survivors if immediate access to the cabin had been achievable. The survivors could not remember any details of their seating position although it was most likely that they were seated in the middle section of the main cabin behind the wing.

1.16 Tests and research

1.16.1 General.

The DFDR determined that both propellers entered a ground control mode as the propeller low pitch light illuminated. The Investigation Committee conducted the following research into the propeller(s) system and associated components.

1.16.2 Propeller

1.16.2.1 Description. The engine drives a variable-pitch, constant speed propeller. The pitch ranges from feathered, through zero pitch to full reverse. The propeller pitch angle varies in flight from +15° to approximately +45°. Propeller pitch is controlled by balancing oil pressure provided by a high pressure pump driven by the propeller gear box, against the coarse pitch seeking force provided by counterweights attached to the blade roots. Should the oil pressure fail, such as after an engine failure, the counterweights assist the propeller blade angle to auto-coarsen to +55°, which is a low drag windmilling condition. Automatic or manual feathering would achieve a blade angle of +82.5°. The propeller pitch angle in the ground control range varies on the ground from +15° to -17°. Please refer to the Dowty Propeller report at Appendix 6 for a more detailed explanation of the propeller system, normal operation and analysis. Illustration 1 below indicates the power lever angle (PLA) and propeller pitch angle relationship.

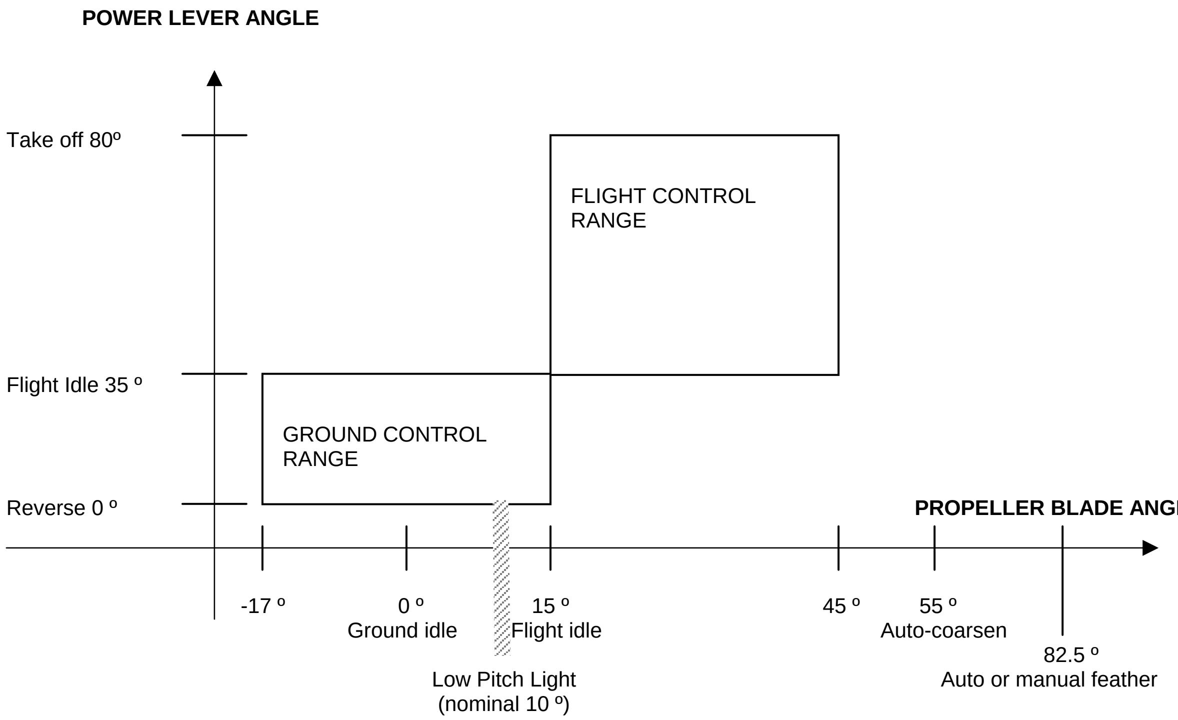


ILLUSTRATION 1

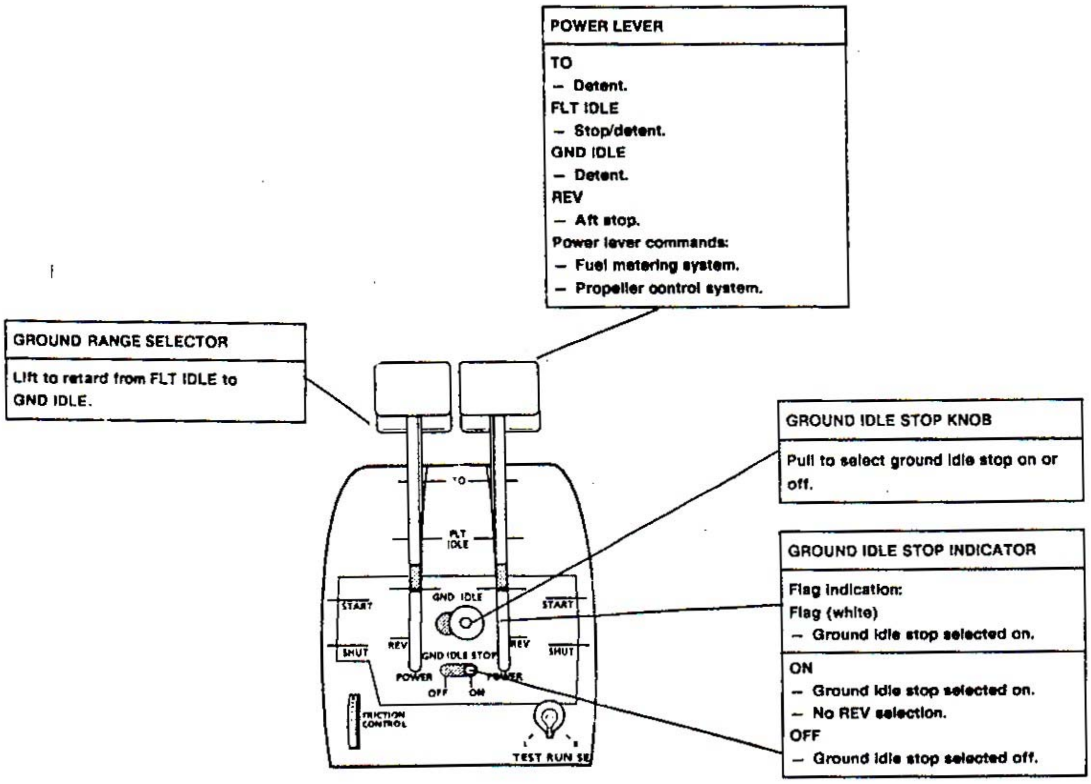


ILLUSTRATION 2

1.16.2.2 Control Ranges. There are two control ranges.

(a) Flight Control Range. When the power levers are positioned at, or above, the flight idle detent, constant speed control is regulated automatically. This range is used for take-off and all phases of flight until landing. The Propeller Electronic Controller unit (PEC) controls propeller speed by varying the blade angle and propeller synchronizing is automatic.

(b) Ground Control Range. On the ground, when the power levers are positioned at the ground idle detent, propeller pitch is directly controlled by the power lever position. The transition from constant speed control as described in paragraph (a) and direct propeller pitch control occurs when the power lever is positioned about half way the range between the ground idle detent and the flight idle detent. Below the ground idle detent position propeller pitch moves to reverse. The ground control range is also referred to the beta range as propeller pitch is controlled directly by varying high oil pressure through a beta tube to achieve the desired blade angle according to the power lever position. The ground control range is used for propeller braking effect such as for varying taxi speed and deceleration after landing.

1.16.2.3 Flight Protection. For a Fokker F27 Mk.050 in flight, should both propellers move into a ground control range, the resultant drag would affect the lift over the wings and tail plane and the aerodynamic lift/weight and thrust/drag moments would be altered. There may be an asymmetric condition to further affect the controllability of the aircraft and the responsiveness of the engine may be affected by the propeller behaviour. The use of the ground control range in flight is considered by the Certification Authority (CAA-NL) to be a catastrophic event and as such, the effects on the aircraft controllability, propeller behaviour, and engine responsiveness have not been explored by the manufacturers. However, it is accepted that this condition would be extremely dangerous. Therefore, for the Fokker F27 Mk.050, the power levers are prevented from moving into the ground control range in flight by;

(a) Mechanical flight idle stop (primary stop). To select ground control range after landing, the power levers must be in the flight idle position. The Ground Range Selector, which is fixed to the power levers, must be then physically lifted by a pilot to remove the mechanical stop so that the power lever can be moved backwards. This mechanism is designed to require a positive action by a pilot and cannot be accidentally moved. Refer to Illustration 3.

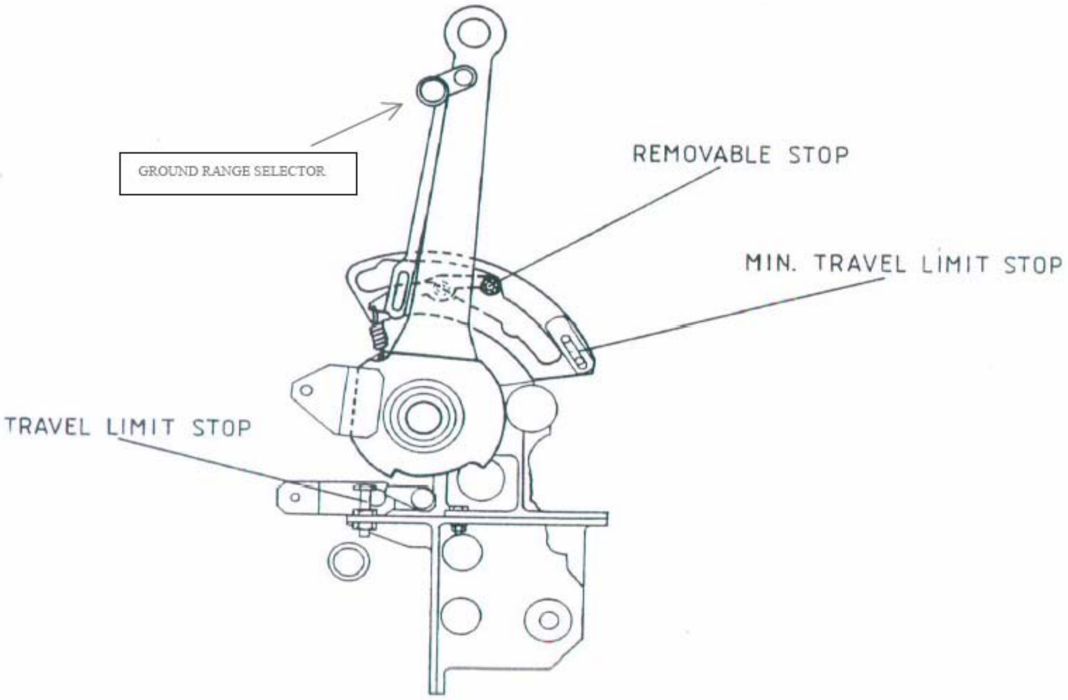


ILLUSTRATION 3

(b) Electrical flight idle solenoid (secondary stop). Although not a requirement at the time the Fokker F27 Mk.050 was type certificated, there is an electrical flight idle solenoid (secondary stop) for each propeller located on each engine. Once energized the solenoid removes a flight idle lock lever. Each solenoid is powered through one Skid Control Unit and/or the Ground/Flight switches (refer paragraph 1.16.5 and Illustration 5). The solenoid prevents the corresponding power lever from moving from the flight idle position into a ground control range. Refer to Illustration 4.

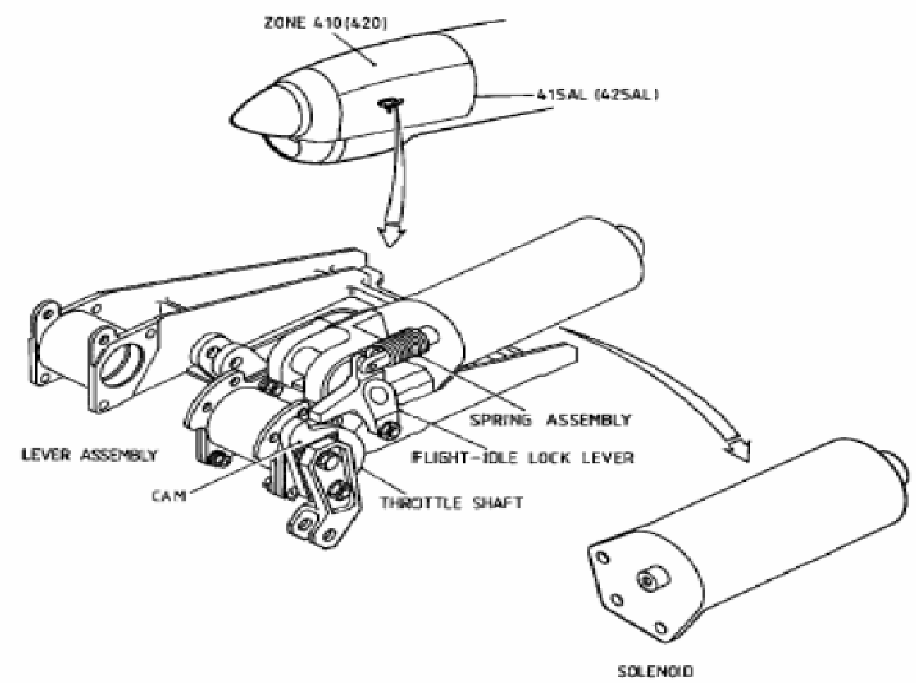


ILLUSTRATION 4

1.16.2.4 Loss of Protection in Flight

The electrical flight idle solenoid is designed as a back up safety feature to provide protection in case the primary protection fails or is removed by the pilot. Other than the reasons listed below, the aircraft manufacturer determined that there could be no system failure, or a combination of system failures, which could simultaneously overcome both electrical stops and place both propellers into the ground control range whilst airborne. The only known reasons for this secondary stop being deactivated in flight are as follows and except for (e) below, the loss of protection is limited to a period of 16 sec.

(a) Lowering of the undercarriage when both up-lock switches are de-energized within approximately 40 micro sec of each other and only with a Skid Control Unit Part Number (6004125); or

(b) EMI disturbance signals to either Skid Control Unit Part Numbers 6004125 or 6004125-1, or an unmodified aircraft (SBF50-32-035)

(c) Use of the anti-skid test function to either Skid Control Unit Part Numbers 6004125 or 6004125-1; or

(d) Cycling of the TOW switch (enables towing of the aircraft) to Skid Control Unit Part Numbers 6004125; or

(e) Failure of one of the Ground/Flight switches to the Ground mode.

For this accident, the aircraft manufacturer indicated that (b) above; the likelihood of EMI on both wheel speed signals exactly at the same time was most unlikely and that (c) and (d) above could be discounted as the data provided by the flight recorders indicated that these switches were not activated and there was no evidence of an associated system failure. The reference to “aircraft manufacturer” means Fokker Aircraft B.V or Fokker Services B.V (refer also to paragraph 1.17.4).

1.16.2.5 Propeller Precaution

To ensure that pilots are aware of the danger of attempting to move a propeller into the ground control range in flight, the Fokker F27 Mk.050 Aircraft Operating Manual, Chapter 2, page 2.06.01 states:

PROPELLER OPERATING LIMITS

WARNING: DO NOT ATTEMPT TO SELECT GROUND IDLE IN FLIGHT. IN CASE OF FAILURE OF THE FLIGHT IDLE STOP, THIS WOULD LEAD TO LOSS OF CONTROL FROM WHICH RECOVERY MAY NOT BE POSSIBLE.

1.16.2.6 Ground Idle Stop Knob. A selectable Ground Idle Stop knob is installed at the pedestal to prevent selection of the power levers to the reverse position during a rejected take-off. This knob moves a mechanical lock so that the power levers cannot be moved from the ground idle detent towards reverse. Kish Airlines had issued a written instruction that the Ground Idle Stop knob was to be left in the “ON” position at all times for all flights. There was no reference heard on the CVR during the approach checklist indicating the position of the Ground Idle Stop knob. The positioning of this knob was not considered relevant as it had no effect on the resultant propeller behaviour.

1.16.2.7 Low Propeller Pitch Light. Should the power lever be brought into a ground control range, a blue light (LO PITCH) illuminates at a nominal figure of +10° propeller pitch angle and this is a recorded parameter on the DFDR. From the DFDR, both propellers low pitch lights illuminated and remained on until impact. As the right propeller was just in a flight control range on impact, further research was conducted on the tolerances of a low pitch light switch to determine how this could occur. The propeller manufacturer indicated the setting of the light switch could be within the range of 10° - 13.5° and that once the switch was set, there would be virtually no change to this range. The conclusion therefore was that the right propeller blade angle was moving within the ground control range towards the flight control range at impact and the next recording of the DFDR low pitch light parameter, which is every second, most likely would have indicated a change to the light off position.

1.16.3 Propeller Technical Analysis

1.16.3.1 General. The propeller components such as the propellers, hubs, beta tubes, pitch control units, feathering pumps and propeller electronic controllers were sent to the manufacturer Dowty Propellers of Gloucester, United Kingdom for further analysis under the direct supervision of the GCAA Investigation Team. The research involved the propeller pitch settings on impact and any obvious malfunctions. Although the two propeller electronic controllers included a memory chip, it was established that any faults recorded, which could have indicated a propeller system fault, would activate a warning light on the pilot master panel in the cockpit. No single warning chime was heard on the CVR and there was no discussion by either pilot regarding any system faults. In addition, the propeller electronic controllers are only effective when the power levers are in the flight control range (above flight idle).

1.16.3.2 Relationship between Power Lever and Beta Tube Movement

Propeller pitch is linked mechanically to the position of the beta tubes in the PCU. When a power lever is moved to flight idle on approach for landing, the PCU hydro-electrical control system normally pressurises the fine pitch oil way to drive the beta tubes forward towards finer pitch. This is in order to maintain propeller RPM when the airspeed is low. The propeller is then being operated in beta control. The beta tubes and propeller stop moving toward fine when the propeller pitch reaches 15° because, below this point, the porting in the beta sleeve in the PCU cuts off fine pitch oil from the propeller and allows the coarse pitch-seeking counterweight forces to hold pitch at 15°. This is a key feature of the propeller system design and specifically addresses safety aspects as required by the certifying authorities.

In order for propeller pitch to fall below 15^o and into the ground control range, only the power lever can determine the beta sleeve position through the PCU. Therefore the Ground Range Selector, which is fixed to the power levers, must be physically lifted by a pilot to remove the mechanical stop so that the PCU could position the beta tubes accordingly. Should there be a disconnect in the linkage between the beta sleeve and the power lever, a spring in the PCU would move the beta sleeve back to a 19.4° position, so preventing access to the ground control range.

1.16.3.3 Findings. The propeller manufacturer concluded that the propeller system was capable of correct operation up to the point of impact. Only a power lever movement could have caused the propeller pitch to move into the ground control range. The left hand propeller was determined to have impacted the ground at a blade angle of approximately -18°, which equates to the full reverse position and the right hand propeller was found to have impacted the ground at a blade angle of approximately +15°, which is just in the flight control range. The accuracy of these positions was considered as ±2°. Refer to Appendix 6 for the report from Dowty Propellers.

1.16.4 Propeller Behaviour

1.16.4.1 DFDR Analysis. The following propeller behaviour and power lever positions are based on the DFDR data and is summarised in the following table and accompanying notes.

Time reference	Engine related crew actions	Left hand powerplant		Right hand powerplant	
		Propeller pitch	Engine power	Propeller pitch	Engine power
7:38:10		+23 degrees	Idle	+23 degrees	Idle
7:38:11	Power levers pulled back into the ground range [1]	Between +3 and –2 degrees [2]	Idle	Between +7 and +3 degrees [3]	Idle
7:38:12		Moving to reverse	Idle	No change	Idle
7:38:13	Power levers slammed to the take-off position [4]	Moving to reverse	98 SHP	No change	Idle
7:38:14		Moving to reverse	144 SHP	No change	Idle
7:38:15		Moving to reverse	287 SHP	No change	Idle
7:38:16		Moving to reverse	973 SHP	No change	Slight increase in Nh, fuel flow limited by propeller overspeed governor.
7:38:17		Moving to reverse	1793 SHP	No change	Fuel flow limited by propeller overspeed governor.
7:38:18		-17 degrees	2090 SHP (max CRZ is 2030)	No change	Fuel flow limited by propeller overspeed governor.
7:38:19	Power levers pulled back to flight idle	No change	646 SHP	No change	Idle
7:38:20		Moving out of reverse [5]	391 SHP	No change	Idle
7:38:21		Moving out of reverse	128 SHP	No change	Idle
7:38:22		No change	86 SHP	No change	Idle
7:38:23		No change	118 SHP	No change	Idle
7:38:24	Power levers pushed forward.	Moving to reverse	71 SHP	No change	Idle
7:38:25		Moving to reverse	274 SHP	No change	Slight increase in Nh
7:38:26		Moving to reverse	853 SHP	No change	Slight increase in Nh, fuel flow limited by propeller overspeed governor.
7:38:27		Moving to reverse	1215 SHP	No change	Fuel flow limited by propeller

					overspeed governor.
7:38:28		Moving to reverse	1456 SHP	Increasing [6]	Fuel flow limited by propeller overspeed governor.

Notes:

[1] The propeller low pitch signals on the DFDR data indicates that both power levers were moved into the ground range. The exact position to where they were moved cannot be determined, but it can be narrowed down as follows:

- The highest position is the point where full beta control is established. Beta control should start when the power levers are retarded to a position approximately halfway between flight and ground idle.

- The lowest position is ground idle because the SOP of Kish Air requires the ground idle stop to be ON during all phases of flight and no comments or noises were identified on the CVR tape that could suggest that the stop was selected to the OFF position.

[2] The propeller blade angles associated with the power lever positions specified in [1] are +7 degrees (nominal) for the beta entry point and –2 degrees (nominal) for ground idle. Since the left hand propeller subsequently moved to the reverse position when the power lever was returned to the flight range, it can be concluded that the initial propeller pitch was at or below the self pitch change neutral point (where the sum of the aerodynamic, centrifugal and counterweight blade twisting moments is zero) when coarse pitch oil pressure was lost, which is estimated to be approximately +3 degrees for a propeller speed of 90 percent and an indicated airspeed of 140 knots, but not lower than –2 degrees.

[3] The right hand propeller moved eventually to the minimum flight idle position and must therefore have been at or above the self pitch change neutral point, which is estimated to be approximately +3 degrees for a propeller speed of 100 percent and an indicated airspeed of 140 knots, but not higher than +7 degrees.

[4] The variations in high pressure rotor speed (Nh) on both engines show that the crew continued to operate both power levers synchronously after beta entry (see figure 1). The excursions on the right hand engine are however much smaller due to interference from the propeller overspeed governor. The power increase on the left hand engine between 7:38:13 and 7:38:18 indicates that the power levers were placed in the take-off position.

[5] The increase in propeller speed at 7:38:20 and 7:38:21, while engine power is still declining, indicates that the propeller is partly coming out of the full reverse position. This only happens during the period that the left hand propeller speed is below the selected constant speed setting (i.e. 85 percent).

[6] The pitch angle of the right hand propeller may have increased during the final second(s) because the (coarse) self pitch changing moment became higher due to the reduction in forward speed.

1.16.4.2 Research-Movement Into Ground Control Range. Should a power lever be moved into the ground control range whilst airborne and the secondary stop did not function, it was possible for the propeller to quickly achieve a blade angle corresponding to the power lever position. The DFDR data and CVR spectrum analysis determined that the power levers were positioned into the ground control range. All manufacturers agreed that propeller behaviour within the ground control range in flight was unpredictable.

1.16.4.3 Research-Movement Back Into Flight Control Range.

All manufacturers agreed that propeller behaviour from the ground control range to the flight control range was unpredictable due to many variable factors. The following additional information is provided to explain those factors.

(a) Control modes.

The Fokker F27 Mk.050 propeller control system has two basic control modes:

(1) Beta control for ground handling with a fixed relationship between power lever position and propeller blade angle. This control mode is active in the range from full reverse up to halfway between ground and flight idle. Propeller pitch is controlled in both directions (i.e. coarse and fine) by means of oil pressure.

(2) Constant speed control for in-flight operation. This control mode is active above the beta range. Propeller pitch is changed in coarse direction by means of counterweights on the propeller blades and controlled in fine direction by means of modulated oil pressure. Fine pitch selections are limited in the constant speed range by a minimum blade angle set by the power lever position. This minimum blade angle will be reached in-flight only with a flight idle selection at very low forward speeds.

Either control mode can be selected by placing the power lever above or below the halfway position between ground and flight idle.

(b) Counterweight forces.

The blade twisting moments created by the propeller counterweights are not constant but diminish with a reduction in blade angle, to become zero at flat pitch. In reverse pitch the counterweights provide a blade twisting moment in the opposite direction, i.e. fine/reverse seeking. Forward speed of the aircraft will introduce an additional (aerodynamic) blade twisting moment that drives the blades to fine/reverse pitch. At the normal in-flight blade angles, these aerodynamic blade twisting moments are insignificant.

(c) Loss of propeller pitch control

A rapid power lever movement from beta range into the constant speed range may result in a propeller hang-up due to the fact that coarse pitch oil pressure is lost before the blades had attained a pitch angle where the counterweights provide sufficient blade twisting moment to coarsen the blades. The probability that the propeller blades will not coarsen into the normal flight range will increase with forward speed due to the additional aerodynamic blade twisting moments.

(d) Rate of Power Lever Movement

Both the CVR and DFDR evidence suggest that the power levers were moved back into the flight control range shortly after the event occurred. Whilst it is not known just how far and how fast the levers were positioned, it is considered most likely the First Officer moved them fully forward quickly 2 sec after the initiation of the event under the instruction of the Captain and existing situation. Both the aircraft and propeller manufacturers indicated that the chances for the propeller to regain the flight control range are improved, but not guaranteed, if the power levers are slowly moved forward and the initial power lever position was not below the ground idle position.

(e) Summary

Due to the unpredictable propeller behaviour, movement of the power lever from within the ground control range to the flight control range would have little initial effect on the movement of the propeller pitch towards the flight control range.

1.16.5 Skid Control Unit (SCU)

1.16.5.1 General. The SCU was designed to give optimum brake operation for all runway conditions by using wheel speed sensors in each main landing gear axle. However in addition the SCU consists of components, which energize the flight idle stop solenoids, and when energized, remove the secondary stop protection. (refer to paragraph 1.16.5.2 below for the SCU/solenoid relationship). As it was ascertained that the electrical flight idle solenoids did not prevent the power levers from moving into the ground control range, further research was conducted on the SCU. An analysis of the SCU was carried out by the manufacturer, Aircraft Braking System Corporation (ABSC) of Ohio, USA. It was ascertained from their investigation that this unit was the original unmodified version (part number 6004125) but no analysis of its operating performance could be determined due to the severe fire damage.

1.16.5.2 SCU/Solenoid Relationship. The flight idle stop solenoids are energized by the Ground Control Relay, which in turn is activated by either the;

(a) RH GND/FLT switch; OR

(b) LH GND/FLT switch; OR

(c) Wheel speed > 20 mph from RH inboard AND outboard wheel; OR

(d) Wheel speed > 20 mph from LH inboard AND outboard wheel.

The latter two wheel speed signals are obtained from the Skid Control Unit. The Skid Control Unit is basically designed to provide optimum brake operation for all runway conditions. One of the basic inputs for this is the wheel speed of the different MLG wheels, sensed by the wheel speed sensors in each wheel axle. Hence, by using the wheel speed discretes from the Skid Control Unit, the Skid Control Unit forms a part of the system to control the Flight Idle Stop solenoids. The following Illustration 5 shows the relationship between the SCU and an electrical flight idle solenoid.

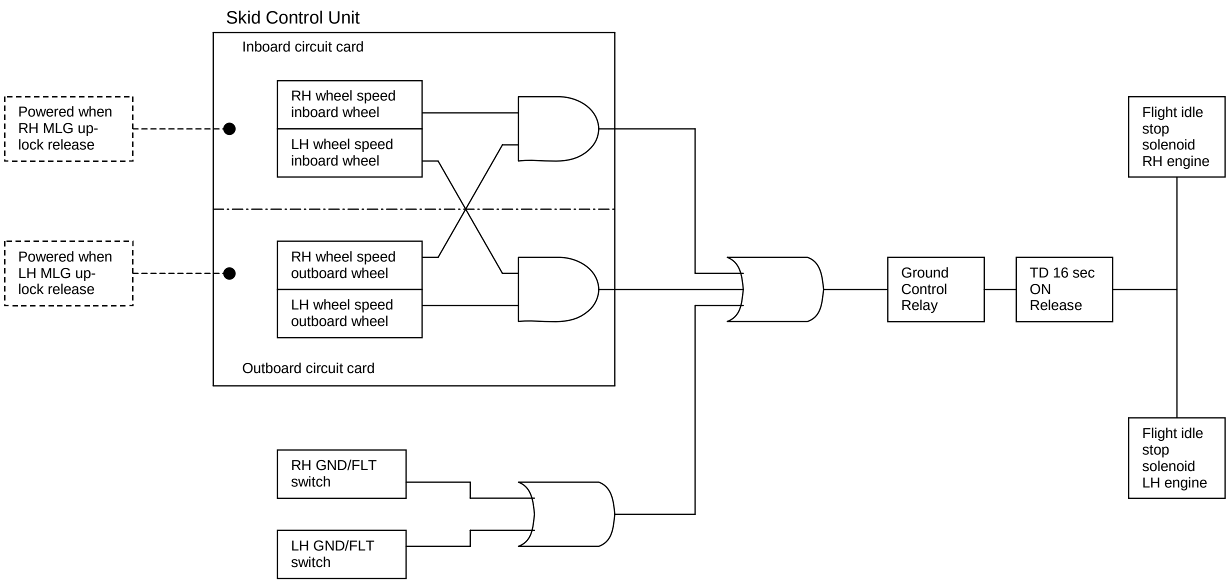


ILLUSTRATION 5

1.16.5.3 Undesired System Behaviour. The Skid Control Unit contains two channels which are electrically powered separately. The inboard card is powered when the RH MLG comes out of the up lock position and the outboard card when the LH MLG comes out of the up lock position.

In 1992 it became apparent that during power up the wheel speed discrete >20 MPH was activated for about 20 milliseconds. When the inboard and outboard wheel speed discretes overlap each other for a short duration the Ground Control Relay is activated (ref diagram) and subsequently the Flight Idle Stop solenoids are energized for 16 seconds (the 16 second delay has been introduced to prevent on/off switching in case of bouncing during the landing). In view of the short duration of the power up pulses it can be concluded that this only occurs when both MLG-up lock switches are activated at almost the same moment. To solve this phenomenon ABSC issued ABSC SB Fo50-32-04.

Subsequent to loss of braking reports it also appeared that EMI on the wheel speed wiring or on the Skid Control Unit test switch wiring could cause wheel speed signals as well. Subsequently Fokker Services issued SBF50-32-035 which improves the Skid Control Unit grounding and thus the EMI susceptibility. Furthermore, activating the anti skid test button in the cockpit, recommended by the Aircraft Operating Manual to check the anti-skid system in flight after a lightening strike with landing gear down, would also cause temporary activation of the >20MPH wheel speed discretes. To rectify all known abnormalities, ABSC issued SB 6004125-32-01(includes ABSC SB Fo50-32-04 modification) which was covered by Fokker Services SBF50-32-038 (which asks also for accomplishment of SBF50-32-035).

Provided there was an inboard and outboard wheel speed discretes overlap, a possibility therefore existed on Fokker F27 Mk.050 aircraft with a Skid Control Unit Part Number 6004125 for the propeller(s) to be placed in a ground control mode should the power levers be deliberately or inadvertently brought over the mechanical primary stop whilst the Flight Idle Stop solenoids are energised.

1.16.5.4 Skid Control Unit Modification. To initially resolve this undesired system behaviour, ABSC SB Fo50-32-04 was issued. Once this first modification (Part Number 6004125-1), as notified by ABSC SB Fo50-32-04, was incorporated the aircraft manufacturer stated that there was no possibility of inadvertent energizing of the solenoid (unless EMI or use of the anti-skid test switch). ABSC then issued SB 6004125-32-01, which resolved the EMI and test switch anomalies.

1.16.6 Previous Accidents/Incidents Involving Fokker F27 Mk.050.

A similar accident had occurred to a Luxair Fokker F27 Mk.050, LX-LGB on 06 November, 2002. In that accident the Final Report from the Ministry of Transport of the Grand-Duchy of Luxembourg stated that the pilot brought the power levers over the mechanical stop and that the electrical solenoid stop did not prevent the propellers from entering the ground control range. This resulted in a drag situation from which recovery was not achieved. It was determined during that investigation that the event occurred within 16 sec of the landing gear being lowered and an unmodified SCU (Part Number 6004125) was fitted. From comparison of the engine/propeller plots of the DFDR data, the similarities between the recorded propeller and engine parameters are evident.

1.16.7 Performance.

From the aircraft load sheet, fuel documents and existing meteorological data, it was calculated that the threshold speed (V_{REF}) at a Flap 25 setting should have been 99 knots giving a company recommended final approach speed (V_{REF} +10 kt) of 109 kt.

1.16.8 Standard Operating Procedures (SOPs).

The Kish Airlines AOM, Volume 2, on non precision approach procedures indicated an initial approach speed of 160 kt, reducing to 130 kt before the final approach fix. The aircraft was 190 kt at less than 3 nm from the threshold, and the DFDR had determined that the flap and landing gear limits had been exceeded contrary to the Aircraft Flight Manual and SOPs. The use of incorrect MDA and final approach track figures indicate that the crew briefing may have not been made using the current Jeppesen approach charts and contrary to the SOPs.

1.16.9 Other Technical Tests.

1.16.9.1 Enhanced CVR Testing. During the accident investigation of the Luxair Fokker F27 Mk.050, LX-LGB, noise spectrum analysis testing was conducted by the BEA and a comparison made with another Fokker F27 Mk.050 aircraft. The BEA was requested by the Accident Investigation Committee to conduct a similar enhancement test of the area mike sounds using data already gathered from this previous accident. The testing involved the area mike sounds recorded on the CVR at the time corresponding to when the propellers changed from the flight control mode to the ground control mode on the DFDR. During these tests, it was positively determined that a sound similar to the lifting of the Ground Range Selector was identified confirming that a pilot had brought the power levers over the mechanical stop into a ground control range position. A second test determined that it was unlikely that the ground idle stop knob was used.

1.16.9.2 Simulator Trials.

Trials were conducted in a Fokker F27 Mk.050 simulator, certified to JAR STD 1A level C standards. The use of the simulator was not intended to verify data, but merely to obtain a greater understanding of the aircraft systems and its operation. The simulator session was conducted using the same aircraft weight and meteorological conditions as IRK 7170. The following trials were conducted by a pilot member of the Committee;

(a) Familiarization of the Fokker F27 Mk.050 instruments and systems. This permitted the team members to relate technical issues and system components with handling characteristics.

(b) Effect of flap and landing gear extension. There were considerable elevator control forces experienced when lowering flap initially to 10° and then to 25° at a speed slightly above the limiting speeds. In addition it was noted that a triple chime sounded when 25° was selected and finished when the landing gear was down and locked.

(c) Effects of propeller drag. This exercise was not able to be accomplished as there was no malfunction available to simulate a ground control mode in the air.

(d) Whilst in flight, the power levers could not be physically moved into the ground control range. In addition, the Ground Range Selector could not be accidentally lifted.

(e) There were no obvious ergonomic design abnormalities noted regarding power lever movement, detents and indicators.

1.16.9.3 Airflow Disruption

On the CVR the Captain was heard to infer that he couldn't raise the aircraft nose ("can't raise it"). In addition the DFDR indicated a 28° nose down pitch attitude shortly after the event. Whilst no trials had been conducted during the certification process, it was reasonable to assume that if both propellers went into a ground control mode in flight, there would be a decrease of lift of unknown magnitude over the wing directly behind the propellers and a large part of the tail plane and elevator would be in turbulent low speed airflow. In addition there would be aerodynamic moments associated with lift/drag and thrust/weight coupling so that the end result would be that the aircraft pitched down and pitch control could not be regained.

1.16.10 Previous Use of Ground Control Range In Flight.

1.16.10.1 Intentional. The propeller manufacturer stated that a slight movement between the mechanical lock and the electrical lock was provided by design. Provided that the solenoid operated correctly, this movement could result in additional propeller drag and could vary from aircraft to aircraft. The aircraft manufacturer investigated this further and determined that, at a high approach speed, the additional drag would be negligible. From discussions with technical personnel during the investigation, there were hearsay reports that pilots had deliberately raised the Ground Range Selector in flight on non specific turbo-propeller types and moved the power levers from the mechanical flight idle stop to the electrical flight idle stop to take advantage of the additional propeller drag. The use of this prohibited technique was to slow the aircraft down during a high speed approach. The accuracy of these hearsay reports could not be established and remains as hearsay. The reason for the use of the ground control range in the previous Fokker F27 Mk.050 accident involving Luxair was not determined. (refer to paragraph 1.16.6)

1.16.10.2 Unintentional. In a Fokker F27 Mk.050 Service Letter 137 to operators, the manufacturer stated that it had been reported that unintentional movement of the power levers by the handling pilot from the mechanical flight idle stop to the electrical flight idle stop had occurred in flight during turbulent weather conditions.

1.17 Organizational and management information

1.17.1 Operator

1.17.1.1 The Kish Airline organization was adequate in all audited areas and all management personnel were experienced and well qualified. There were adequate management policies and demonstrated financial viability.

1.17.1.2 Crew Resource Management Training (CRM). The operator had a formal and documented CRM course, which was approved by the CAO. Whilst the crew had conducted the operator's CRM course, the comments heard on the CVR from the crew indicated that during the approach phase of this flight, co-ordination and co-operation between crewmembers was not indicative of CRM principles.

1.17.1.3 Training. The Captain was a line Captain and not a Training Captain and there was no evidence that he had any instructional experience or training qualifications. Both pilot's initial training was conducted in accordance with CAO requirements. The initial ground school was conducted by Kish Airlines using an approved syllabus and the flight training was conducted in Stockholm, Sweden using a Fokker 27 Mk.050 simulator, which was certified to JAR STD 1A standards. The instruction given was by a CAO approved instructor and all recurrent checks were given every six months by CAO designated check airmen. The recurrent training included approved Line Operational Flight Training in the simulator and there were no adverse findings in either pilot's training reports. From the documentation it was noticed that both flight crew members had conducted flights from Kish Island to Sharjah on a regular basis. For a pilot to deliberately move the power levers back into the ground control range presupposes that the pilot had used this technique before or had been told about this technique from another pilot who had possibly used it. Kish Airline's management pilots were interviewed on this subject and none knew of any previous instances or general discussion having taken place on this subject. There was no restriction on landings by First Officers.

1.17.1.4 Operational Documentation. A review was conducted of the documentation and communication aspects. All manuals and documentation sighted by the investigation team were in good order and met the CAO requirements. All correspondence relating to the SCU from the State of Manufacture and the manufacturer was received by the operator. In respect to the All Operators Message AOF 50.022 warning from the manufacturer, it was received in the first instance by the Engineering Director of Kish Airlines. It was then copied to the Flight Operations Director, who created a Crew Information File (CIF No. 8), which required all crew members to be aware of primary protection and emphasized the importance of ensuring that the ground range selector levers are never lifted in flight. It was ascertained that the Captain of this aircraft had signed this CIF, having indicated that he had read it. The operator had received the Airworthiness Directive BLA Nr 2003-091 from the State of Manufacture. The operator stated that they fully intended to comply with this Airworthiness Directive before the time limit of 01 May, 2004 but the SCU was unmodified on the Fokker 27 Mk.050 fleet at the time of the accident.

1.17.1.5 Maintenance Documents. All maintenance documents indicated that the maintenance had been conducted in accordance with the CAO approved maintenance schedule. There had been no maintenance on the propellers or the SCU since the purchase of the aircraft in 2002. All documents were found to be in order.

1.17.2 Regulatory Authority

In respect to regulatory oversight all documentation was in order and there was a demonstrated and adequate regulatory oversight in continuing airworthiness and flight operations by the CAO.

1.17.3 Skid Control Unit Manufacturer

Aircraft Braking Systems Corporation (ABSC) issued the following relevant publications regarding the SCU.

- 01 August, 1992 - Service Bulletin Fo50-32-4 advising of a possible Skid Control Unit abnormality

- 29 June, 1994 - Service Bulletin Fo50-32-4, Revision 1 advising of modification of the SCU to part number 6004125-1 status to overcome abnormality identified above.

- 07 May, 2003 - Service Bulletin Fo50-6004125-32-01 advising of modification of the SCU to part number 6004125-2 status due to recognized electromagnetic interference.

1.17.4 Aircraft Manufacturer

Fokker Aircraft B.V was the original certificate holder of this aircraft and the aircraft was certificated to JAR 25. When this company went into bankruptcy in 1996, Fokker Services B.V took over the administration of the certificate and administration of airworthiness matters. The reference to "aircraft manufacturer" means Fokker Aircraft B.V before bankruptcy and Fokker Services B.V since that time. Prior to the Luxair accident, the aircraft manufacturer, issued the following publications regarding the solenoid secondary stop issue.

- 20 December, 1994 - Service Letter 137 informing all operators of the SCU abnormalities and the availability of a modification.

As a result of the Luxair accident, the aircraft manufacturer issued the following publications regarding the solenoid secondary stop issue;

- 14 November 2002 - All Operators Message AOF 50.022 for all operators of Fokker 27 Mk.050 aircraft, to recall the characteristics of the security systems of the propellers.

- 08 May 2003 - All Operators Message AOF 50.028 announcing the publication of:

    1. ABSC SB Fo50-6004125-32-01 notifying operators of the availability of the modification 2 to the SCU (part number 6004125-2 status), which was issued on 07 May, 2003.

    2. Fokker SBF50-32-038, which recommended incorporation of modification 2 to the SCU (part number 6004125-2 status).

and stipulated that, with these modifications incorporated, abnormal braking, loss of braking at low speeds as well as unintended energizing of the flight idle stop solenoids were considered to be adequately covered.

- 08 May 2003 - Manual Change Notification/Maintenance Documentation MCNM-F50-045) incorporating the modifications to perform on the SCU.

1.17.5 Investigation Commission of Luxair Accident

Prior to the release of the Final Report into the Luxair accident, which occurred on 06 November, 2002, the Luxembourg Investigation Commission issued the following recommendations:

(a) Safety recommendation N°1, dated 15 November 2002:

"In order to avoid the failure of the Flight Idle Stop security, the Investigation Commission recommends that the opportunity should be evaluated to render the modification of the Antiskid Control Box (SCU) stated in the Service Bulletin be mandatory for all Fokker 50 aircraft.

Furthermore and without waiting for this modification, the Investigation Commission recommends that the crewmembers should be informed about the potential functioning of the system as mentioned above and about the content of Fokker message to all operators AOF50.022 dated 14 November 2002."

(b) Safety recommendation N°2 dated 28 November 2002, recommended the publication of an airworthiness directive stipulating that:

(i) Service Bulletin N° Fo50-32-4-revision 1 from ABSC; and

(ii) Service Bulletin N° SBF50-32-035 from Fokker Services B.V.

be made mandatory for all Luxembourg registered Fokker F27 Mk.050 aircraft.

(c) Safety recommendation N°3, dated 23 January 2003, stipulated that:

"In order to improve the functioning of the secondary safety Flight Idle Stop, the investigation commission recommends, that the announced publication of Service Bulletin Fo50-32-7 be speeded up and that its application be made mandatory for all Fokker F27 Mk.050 type aircraft."

(d) Safety recommendation N°4 dated 09 May, 2003 was made, recommending the publication of an airworthiness directive stipulating that:

(i) Service bulletin N° Fo50-6004125-32-01 from ABSC; and

(ii) Service bulletin N° F50-32-038 from Fokker Services B.V.,

be made mandatory for all Luxembourg registered Fokker 27 Mk.050 aircraft.

1.17.6 State of Design/Manufacturer

The Civil Aviation Authority of The Netherlands is the State of Design/Manufacturer and the aircraft was certified to JAR 25. Aircraft certification requirements stipulated that the selection of the ground control range may only be possible by a positive, distinct and separate action by the pilot. The provided mechanical stop to be removed by the pilot using the Ground Range Selector satisfied this requirement. The primary and the secondary stop system of the Fokker 27 Mk.050 was certified against JAR 25.1155 (change 9), which at that time, did not require additional protection such as a secondary stop. However, the aircraft manufacturer included a secondary stop on the Fokker 27 Mk.050 aircraft as an additional safety measure. JAR 25.1155 has since introduced an additional "means to prevent both inadvertent or intentional selection or activation of propeller pitch setting below the flight regime" for new aircraft certification.

On 31 July 2003, the CAA-NL issued an Airworthiness Directive BLA Nr 2003-091, rendering service bulletin N° F50-32-038 from Fokker Services B.V to be mandatory. (refer to Appendix 8) The compliance date for unmodified SCUs (part number 6004125) was 01 May, 2004 and 01 November, 2004 for the modified version (part number 6004125-1). Even though the Airworthiness Directive was issued as a direct result of the findings from the Luxair accident, the Investigation Committee noted that the emphasis of the Airworthiness Directive was directed toward a possibility of a brake failure problem and not to the propeller control problem as found to have caused the Luxair accident.

1.18 Additional information

Kish Airline's personnel, who had met the pilots involved in this accident after their first flight on the day of the accident, had indicated that they were in good spirits. There were no known or noticeable problems with either crew member and they had flown together on numerous occasions including flights to Sharjah. The CAO Medical Examiner interviewed family and friends and there were no known social or medical problems affecting either crew member.

1.19 Useful or effective investigation techniques

1.19.1 BEA

The use of the BEA facilities for the extraction of the data from the Flight Recorders was most effective. In addition, the use of the noise spectrum analysis equipment and comparison with another Fokker F27 Mk.050 aircraft positively determined that the ground range selectors were lifted and the power levers were moved from the flight idle position into the ground control range.

1.19.2 Dowty Propellers

The use of the Dowty Propeller laboratory facilities and metallurgic expertise was most effective in determining the blade angles on impact and an understanding of the propeller behaviour during the event.

1.19.3 ABSC

The laboratory analysis of the SCU was considered most useful as it confirmed the unmodified status of the component.

1.19.4 Pratt &Whitney Canada

The analysis confirmed the engines were functioning normally before the event and assisted the Committee in understanding the engine/propeller relationship once the power levers had entered the ground control range.

1.19.5 Simulator.

CAE Flight Training of Maastricht provided the investigation team with a full flight Fokker F27 Mk.050 simulator. The simulator provided effective techniques for determining indicative control forces, warning sounds and instrument indications as well as an understanding of the normal propeller behaviour.

1.19.6 Evidence and information regarding this flight would have been enhanced had a crash-protected image recorder been installed

2. ANALYSIS

2.1 General

2.1.1 Methodology

The following analysis was compiled from the factual information of Part 1. For the purposes of this analysis, the GCAA Aircraft Accident Investigation Committee used the methodology researched and developed by Professor James Reason of the University of Manchester. The Reason accident causation model is an industry standard, and has been recommended by ICAO for use in investigating the role of management policies and procedures in aircraft accidents and incidents. The methodology is amplified by italics.

2.1.2 Non Cause-related Factors

2.1.2.1 There were no weather, Air Traffic Control, communication or navigation aid considerations, which contributed to this accident.

2.1.2.2 The aircraft was correctly certified and maintained in accordance with the manufacturer's requirements. From the aircraft documentation and interviews with maintenance personnel the aircraft was considered fully serviceable for the second flight of that day.

2.2 Flight Operations

2.2.1 Departure

The crew were experienced and qualified to conduct the flight. The aircraft was observed to taxi, take-off and depart Kish Island normally.

2.2.2 Enroute

During the cruise and just prior to descent, the Captain was heard on the CVR to unexpectedly hand over control of the aircraft to the First Officer prior to the approach to Sharjah. The First Officer did not accept this willingly and stated that he was not confident of his ability to conduct a VOR/DME approach into Sharjah. This statement was not consistent with his previous experience and could indicate either a cultural or professional issue. The Captain insisted the First Officer fly the aircraft and was heard to encourage and instruct him during the approach.

This was identified as a local factor, which can affect the occurrence of active failures. Local factors are task, situational or environmental factors which affect task performance and the occurrence of errors or violations. This local factor was considered to have had a direct influence on the performance of both of the flight crew during the conduct of the flight.

2.2.3 Approach

The First Officer positioned the aircraft to be established on the final approach with the auto-pilot on and descended whilst remaining slightly above the approach profile. The visibility was good, there was no known turbulence, and the crew should have had the runway in sight throughout the approach. The initial speed for the approach was at least 50 kt high at approximately 190 kt with no flap and no landing gear. From the SOPs, the aircraft should have been configured with landing gear down and flap 10° during the approach and stabilized at 130 kt prior to the MDA. Approaching the MDA at flight idle setting, the auto-pilot was disengaged and the First Officer called for Flap 10 at 186 kt (limiting speed of 180 kt) and Flap 25 was selected by the Captain (uncalled for) at 183 kt (limiting speed of 160 kt), and the landing gear was called for and selected at approximately 185 kt (limiting speed of 170 kt). The Captain then took control of the aircraft and shortly afterwards the ground range selectors were heard by CVR spectrum analysis to be lifted and the power levers moved from the flight idle stop into the ground control range.

These were identified as active failures, which are errors and violations and have an immediate adverse effect. Active failures are or may result in unsafe acts, which most generally involve the actions of operational personnel. Such failures can be divided into two distinct groups; errors and violations. Errors involve attentional slips or memory lapses, and mistakes. Violations involve deliberate deviations from a regulated practice or prescribed procedure.

2.3 Event

2.3.1 Commencement of Event (07 h 38 min 11 sec)

During the course of the investigation, it was determined that the possibility of a system failure, or a combination of system failures, which could occur in flight simultaneously and place both propellers into the ground control range was extremely improbable. From the analysis of the technical factual information, it was determined that propeller pitch was linked mechanically to the position of the beta tubes in the PCU and had a fail safe mechanism within the PCU. Therefore, the propellers can only move into the ground control range if the power levers are physically moved rearward beyond the flight idle detent. This movement was also confirmed at the time of the event by;

(a) the high pressure rotor speed (Nh) momentarily reducing below the flight idle setting of 74.01%; and

(b) a corresponding decrease in fuel flow below that already indicated for flight idle. This decrease could only have been commanded by the rearward movement of the power levers; and

(c) the CVR spectrum analysis

2.3.2 Aircraft Pitch Down.

On selection of the power levers into the ground control range, the propeller pitch changes resulted in decrease of lift over the wing and turbulent low speed airflow over the tail plane and elevator. Coupled with other aerodynamic moments associated with lift/drag and thrust/weight coupling, the aircraft pitched down and remained in a nose low attitude. The aircraft then commenced a roll to the left most likely due to the asymmetric drag effects of the different propeller pitch angles.

2.3.3 Propeller Behaviour.

The left propeller then went to full reverse whilst the right propeller remained in positive pitch within the ground control range. The propeller behaviour could not be accurately ascertained and the relevant manufacturers agreed that propeller behaviour would be unpredictable once the ground control range was entered in flight.

2.3.4 Initial Power Lever Position. At time 07 h 38 min 11-12 sec both power levers moved into the ground control range for less than 2 sec. The propeller system was designed to move very quickly to the corresponding position of the power levers on the ground and this is most likely what happened on this occasion in-flight. It could not be accurately determined where the power levers were initially placed but it can be concluded that the corresponding initial propeller pitch of the left propeller was at or below the self pitch change neutral point which is estimated to be approximately +3 degrees and that the right propeller was at or above the neutral point of +3 degrees. The corresponding power lever position is much closer to the ground idle stop than the flight idle stop.

2.3.5 Effect of Moving Power Levers Forward. At 07 h 38 min 13 sec, both the CVR and analysis estimations verified that the power levers were moved to the take-off position. Whilst in flight, should a power lever be quickly positioned fully forward from the ground control range, the movement of the propeller pitch angle back into the flight control range would depend upon the oil pressure available to the propeller pitch control, the aerodynamic blade twisting moment, counterweight forces as well as inherent seal and system frictions. It can only be assumed that differences in these factors allowed the right propeller to gradually move towards the flight control range and for the left propeller to move to full reverse.

2.4 Technical

2.4.1 Maintenance Status

The aircraft documentation indicated that all required maintenance had been conducted in accordance with the CAO approved maintenance schedule. There were no deferred defects and there had been no maintenance on the propellers or the Skid Control Unit since the operator purchased the aircraft in 2002.

2.4.2 Serviceability

From the DFDR, all engine parameters indicated that they were continuing to operate at normal power without unusual vibrations or power fluctuations. The parameters of the DFDR were sufficient to determine from the data that all recorded aircraft systems were working normally without any technical fault or malfunction being evident during the approach. There were no warnings associated with instruments or systems and the CVR made no reference to any problem.

2.4.3 Lack of Propeller Secondary Stop Protection

Lack of propeller secondary stop protection was found to be caused by inadvertent energizing of the flight idle stop solenoids. Whilst no evidence of electromagnetic interference was researched, the flight idle stop solenoid protection was not available for both propellers at the time of the event and it was determined that the energizing of the flight idle stop solenoids occurred 14 sec into the known 16 sec window after lowering the landing gear. The likelihood of EMI affecting both solenoid stops simultaneously was considered remote by the aircraft manufacturer. It was therefore concluded that the source of the inadvertent energizing of the flight idle stop solenoids was a known anomaly within the SCU which was initiated by the lowering of the landing gear.

2.4.4 Skid Control Unit

The original unmodified version of the SCU was known as early as 1992 of there being a remote possibility that the solenoid secondary stop may be unavailable for a period of 16 sec after the landing gear was lowered. A modified version became available in 1994. After receiving subsequent reports about loss of braking, investigation by the aircraft manufacturer determined that the SCU was susceptible to EMI therefore a second modification was made available in 2003. The EMI related problem only resulted in temporary loss of braking and there were no known reports about EMI affecting the flight idle solenoids. Therefore the rectification of this problem had a lower priority. The investigation team inquired about the perceived lack of priority given by the aircraft manufacturer and certifying authorities to the rectification of the solenoid secondary stop problem prior to the Luxair accident. The response was that the risk potential was considered extremely remote as it firstly required a pilot to conduct a prohibited action and for the main landing gear up-lock switches to be activated at almost the same moment. There were also additional adequate and satisfactory modifications, safeguards and warnings in place. In addition, the aircraft certification basis did not require this additional protection.

This was identified as a latent failure, the implications of which were not immediately apparent and lay dormant for a considerable time.

2.5 Human factors

2.5.1 Movement of Power Levers into Ground Control Range. The propellers can only move into the ground control range if the power levers are physically moved past the primary stop by a pilot. The reason for the movement of the power levers into the ground control range could not be determined but there was nothing in the CVR comments or other evidence to suggest that this action was deliberate. The following factors were considered;

(a) Previous Occurrences. One reported occurrence involving an action by a pilot was the previously discussed Luxair accident. Another reported occurrence involved turbulent weather conditions. From the CVR and actual weather conditions observed at the time of the accident, turbulence was determined not to be a factor.

(b) Inadvertent Movement. There were two hypotheses considered.

(1) It was possible that a pilot was aware of the possibility to move the power levers over the mechanical stop to the electrical stop on the Fokker F27 Mk.050 aircraft. The pilot, in an attempt to slow the aircraft quickly, may have reverted to a conditioned response from previous experience(s) on this aircraft or another previously flown turbo-propeller aircraft type. This hypothesis was not supported by the evidence but in the opinion of the Accident Investigation Committee could not be discounted.

(2) From the comments on the CVR at 07 h 38 min 03 sec, it could be assumed that the Captain took over control of the aircraft and was the pilot flying at the time of the event. However, as the First Officer was questioning the Captain’s take over, a possibility existed for the First Officer to still have his left hand on the power levers. Should the Captain attempt to place his hand on the power levers whilst the First Officer still had his hand on them, it could be a possibility for the Captain’s fingers to actually grasp the ground control selectors in the mistaken belief that he held the power levers. Any attempt by the Captain to move the power levers rearwards to a perceived flight idle position may have resulted in the inadvertent lifting of the ground control selectors and rearward movement. This hypothesis was also not supported by the evidence as the CVR indicated the First Officer appeared to relinquish control at 07 h 38 min 08 sec, which was approximately 3 sec before the event. However, in the opinion of the Accident Investigation Committee, it could not be discounted.

2.5.2 The defences against this risk included notification by the aircraft manufacturer to all operators and regulatory authorities of the problem, and the introduction of an Airworthiness Directive. In addition, Kish Airlines notified all pilots in writing of the danger associated with the use of the ground control range in flight and each pilot, including the crew of EP-LCA, signed as having read the content.

2.6 Summary

The certification of the Fokker F27 Mk.050 aircraft provided adequate and appropriate defences under normal operating procedures. However, once Standard Operating Procedures were not complied with, the level of defences in place proved to be inadequate and did not protect against human failures arising from the combination of active, latent and local factors.

3. CONCLUSIONS

3.1 Findings

(a) The operator was correctly authorised by the Iranian CAO to operate Fokker F27 Mk.050 aircraft on scheduled international commercial operations.

(b) The aircraft was correctly registered, insured, and held a valid Certificate of Airworthiness.

(c) The aircraft was serviceable on departure from Kish Island with no known mechanical defects for the flight to Sharjah.

(d) The aircraft was within the centre of gravity limitations and carried sufficient flight fuel, plus reserves. The load-sheet was determined to be correct for the manifested passengers, cabin baggage and fuel.

(e) The crew were correctly licensed, rated, and met the recent experience and proficiency requirements for the Fokker F27 Mk.050.

(f) Each crewmember held a valid and appropriate medical certificate and neither suffered from a known medical condition or injury.

(g) All required information for the safe conduct of flights and the maintenance of Fokker F27 Mk.050 aircraft was current and available.

(h) The crew approach briefing for a non precision approach to Sharjah Runway 12 VOR/DME stated non-published approach chart figures for final approach track and minima.

(i) Just prior to intercepting the final approach in day VFR conditions the Captain advised the First Officer to fly the approach. The First Officer either for cultural or professional reasons, stated that he did not consider himself capable or prepared for this approach.

(j) The First Officer flew the approach adequately in azimuth but high on the descent profile; at least 60 kt fast initially and not configured correctly in accordance with the SOPs.

(k) The flap 10, flap 25 and landing gear were lowered above their respective limiting speeds, as described in the AOM and SOPs to decelerate the aircraft.

(l) The selection of the landing gear down deactivated the second safety device (solenoid secondary stops) for a period of 16 sec. This was a known abnormality associated with an unmodified Skid Control Unit as fitted to this aircraft.

(m) There was no legal requirement for the Skid Control Unit to be modified however an Airworthiness Directive was in effect for modification of the Skid Control Unit with a future compliance date of 31 May, 2004

(n) The Captain took over during the final approach and shortly afterwards, the ground range selectors were lifted and the power levers momentarily moved from the flight idle position through the mechanical stop to the ground control range at a time the secondary (automatic) stop was not available. This action was not in compliance with the Standard Operating Procedures and Aircraft Flight Manual warning.

(o) The pitch on both propellers moved rapidly into a ground control range to an undetermined blade angle but considered to be approximately +3 degrees.

(p) The aircraft pitched down most likely due to a combination of disrupted airflow created by the propellers over the wing and tailplane and altered aerodynamic moment effects. The asymmetric propeller drag effects induced and maintained a roll to the left.

(q) Within 2 sec of the commencement of the event, the power levers were moved back into the flight control range to the take off setting. Due to the unpredictable propeller behaviour within the ground control range in flight, movement of the power lever to the flight control range would have little initial effect on the movement of the propeller pitch towards the flight control range.

(r) The left propeller pitch continued to move to a full reverse position due to resultant negative blade twisting moments, localized forces and a lack of oil pressure hydraulic effect. It remained in a full reverse position until impact. The right hand propeller pitch gradually moved from the ground control range towards the flight control range as permitted by the resultant positive blade twisting moments, localized forces and hydraulic effect.

(s) The aircraft descended in an extreme nose low left bank attitude until impact.

(t) The aircraft crashed 2.6 nm from the runway onto an unprepared sandy area adjacent to a road and residential buildings. The aircraft broke apart on impact and a fire started immediately.

(u) The Crew Resource Management training provided by the operator did not promote good flight deck communication and actions on this occasion.

(v) The training and awareness programmes and other defences provided by the operator did not protect against human failures.

(w) The Civil Aviation Organization’s safety oversight of the operator’s procedures and operations was adequate.

(x) Evidence and information regarding this flight would have been enhanced had a crash-protected image recorder been installed

3.2 Cause

The power levers were moved by a pilot from the flight idle position into the ground control range, which led to an irreversible loss of flight control.

3.3 Contributory Causes

3.3.1 By suddenly insisting the First Officer fly the final approach, the pilot in command created an environment, which led to a breakdown of crew resource management processes, the non observance of the operator’s standard operating procedures and a resultant excessive high approach speed.

3.3.2 An attempt to rectify this excessive high approach speed most likely resulted in the non compliance with the Standard Operating Procedures and the movement of the power levers below flight idle.

3.3.3 The unmodified version of the Skid Control Unit failed to provide adequate protection at the time of the event.

4. RECOMMENDATIONS

4.1 The Dutch Transport Safety Board and Civil Aviation Authority is recommended to note the circumstances of the accident.

4.2 The Civil Aviation Authority of The Netherlands is recommended to ascertain the modification status of the Skid Control Unit of all Fokker F27 Mk.050 aircraft and to strongly urge non-compliant operators to modify the Skid Control Units.

4.3 The Iranian CAO is recommended to ensure Kish Airline pilots are made aware of the pertinent contents of this report and to ensure initial and recurrent training stresses the prohibition on the use, or attempted use, of the ground control range in flight.

4.4 ICAO is recommended to consider the installation of crash-protected image recorders on aircraft used in commercial air transport operations.

5. APPENDICES

1 - SHARJAH APPROACH PLOTS

2 - ATC TRANSCRIPT

3 - CVR TRANSCRIPT

4 - REPORT ON CVR SPECTRUM ANALYSIS

5 - DFDR GRAPHS

6 - DOWTY PROPELLER REPORTS AND ANALYSIS

7 - ACCIDENT PHOTOGRAPHS

8 - DOCUMENTATION (Not included - GCAA use only)