FINAL REPORT ON INCIDENT TO M/s LIGARE AVIATION LTD FALCON 2000 AIRCRAFT VT-AVH AT HUBLI ON 26/04/2018

Foreword

In accordance with Annex 13 to the Convention on International Civil Aviation Organization (ICAO) and Rule 3 of Aircraft (Investigation of Accidents and Incidents), Rules 2017, the sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents and not apportion blame or liability.

This document has been prepared based upon the evidences collected during the investigation, opinion obtained from the experts and laboratory examination of various components. Consequently, the use of this report for any purpose other than for the prevention of future accidents or incidents could lead to erroneous interpretations.

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1. Aircraft
   - Type : Falcon 2000
   - Nationality : Indian
   - Registration : VT-AVH
2. Owner/ Operator : Ligare Aviation Ltd
3. Pilot – in –Command : ATPL on TYPE
   Extent of injuries : Nil
4. First Officer : ATPL on TYPE
   Extent of injuries : Nil
5. Place of Incident : Hubli
6. Date of Incident : 26th Apr 2018
7. Last point of Departure : Delhi
8. Point of intended landing : Hubli
9. Type of operation : Non-Scheduled Operation
10. Crew on Board : 2 Cockpit Crew + 1 Cabin Crew + 1 Engineer
    Extent of injuries : Nil
11. Passengers on Board : 5
    Extent of injuries : Nil
12. Phase of operation : During cruise
13. Type of incident : Excessive Banking with Altitude Loss

All timings in UTC

SYNOPSIS:

M/s Ligare Aviation Ltd., Falcon 2000 aircraft registration VT-AVH operating flight from Delhi to Hubli was involved in an incident during enroute flight on 26/04/2018. Both the operating crew were duly qualified and current on type Falcon 2000 aircraft to operate the flight. There were 05 passengers including passenger under SPG protectee - Z+ category and 04 crew members on board the aircraft.

The flight from Delhi was uneventful, however during cruise at flight level 410 (41,000 feet) at about 0532 UTC near waypoint (BOGAT), the yaw damper failed indication came on Primary Flight Display (PFD) and the auto pilot disengaged. The aircraft banked excessively to the right and lost 730 Ft (Approx.), the bank angle warning also got activated during this period. The PIC took over control manually and stabilized the aircraft. Thereafter the PIC climbed back to its assigned level of FL 410 (41,000 feet) and informed ATC that they were Non-RVSM due technical. The ATC gave step descend to VT-AVH and brought below RVSM level. The PIC thereafter flew the aircraft manually and made contact with Hubli ATC. The aircraft landed at Hubli at 0603 UTC and parked on Bay no 07.

The incident was reported by M/s Ligare Aviation Ltd. to DGCA. Subsequently, DGCA ordered an inquiry under rule 13(1) of Aircraft (Investigation of Accidents and Incidents) Rules, 2017 and appointed Sh. A.X Joseph, Deputy Director Air Safety as Investigator-in-charge and Sh. N.C Ghosh, Deputy Director Airworthiness as member to investigate into the cause of the incident.

1. FACTUAL INFORMATION.

1.1 History of the flight:

On 26th April 2018 M/s Ligare Aviation Ltd, Falcon 2000 aircraft VT-AVH was scheduled to operate flight (Delhi to Hubli). The flight was under the command of PIC holding current Air Transport Pilot License (ATPL) with First officer holding current Air Transport Pilot License (ATPL) approved on type. There were 05 passengers including passenger under SPG protectee - Z+ category and 04 crew members on board the aircraft.

Aircraft took off from Delhi at around 0353 UTC and flight was uneventful. At around 0532 UTC, FL410 (41,000 feet) the PIC requested Hyderabad ATC for direct routing to way point (BOGAT). At this time the yaw damper failed indication came on Primary Flight Display (PFD) and the auto pilot got disengaged. Both the pilots got busy in isolating the autopilot failure and did not realized that the aircraft has gone into right bank. After 15 seconds of autopilot disengaged, the bank angle warning got activated that was the time when crew realized that the aircraft has gone into a bank. The PIC took over control manually, by the time aircraft had gone into excessive bank of around 65 degrees. During this time aircraft had lost around 125ft from its cruising altitude. While the PIC was in the process of controlling the bank angle, the aircraft continued to lose height by another 610ft in 09 seconds from the time when bank angle warning activated. Thereafter, PIC stabilized the aircraft and climbed back the aircraft to its assigned level of FL 410 (41,000 feet).

The Hyderabad ATC was monitoring VT-AVH on radar noticed descend of aircraft and immediately called up VT-AVH for reasons of descend. The PIC intimated that they had descended due technical reasons and later informed ATC that the autopilot had tripped. When the aircraft banked to the right and descended the PIC did not declare any emergency to Hyderabad Controller. The crew as per the procedure tried to reengage the autopilot however it did not happen. The crew informed ATC that autopilot was not available hence the aircraft was Non-RVSM. The ATC acknowledged and initiated step descent of VT-AVH to Non-RVSM level. The PIC thereafter flew the aircraft manually and got in touch with Hubli ATC at around 70 Nm with visibility CAVOK and temperature 32□. The aircraft landed on runway 08 at Hubli 0603 UTC and parked on Bay no 07.

As per the statement of the ATC Controller, on 26.04.2018 at 0530 UTC VT-AVH Falcon 2000, operator M/s Ligare Aviation Limited, carrying SPG protectee - Z+ category along with 4 other passengers. The aircraft contacted Hubli at around 70 NM while descending from FL 220 (22,000 feet) TO FL 110 (11,000 feet).The prevailing weather at Hubli was informed to VT-AVH and aircraft was given descend as per procedures. Aircraft reported airfield insight and was cleared visual approach RWY 08.Aircraft landed safely at 0603 UTC. Thereafter the aircraft back tracked on RWY vacated via "C" link to bay no. 07. There was no injury to any of the occupant on board the aircraft. There was no fire.

1.2 Injuries to persons:

There was no injury to any of the occupant on board the aircraft.

1.3 Damage to aircraft:

There was no damage to the aircraft.

1.4 Other damage: Nil

1.5 Personnel information

1.5.1 Pilot – in – Command:

Age	:	51 yrs.
Licence	:	ATPL
Date of issue	:	26/09/2001
Valid up to	:	02/07/2020
Category	:	Aeroplane
Class	:	Single/Multi-engine, Land
Endorsements as PIC	:	C-152, C310, ATR 42-320/500, 72/500, A320, FALCON 2000
Date of Med. Exam.	:	09/05/2017
Med. Exam valid up to	:	13/05/2018

FRTO Licence No.	:	Valid on the date of Incident
Date of issue	:	03/05/2013
Total flying experience	:	9975:40 Hrs
Experience on type	:	614:00 Hrs
Experience as PIC on type	:	486:20 Hrs
Last flown on type	:	17-04-2018
Total flying experience during last 180days	:	318:45 Hrs
Total flying experience during last 90 days	:	167:10 Hrs
Total flying experience during last 30 days	:	49:15 Hrs
Total flying experience during last 07 days	:	07:40 Hrs
Total flying experience during last 24 Hours	:	Nil

1.5.2 Co-Pilot:

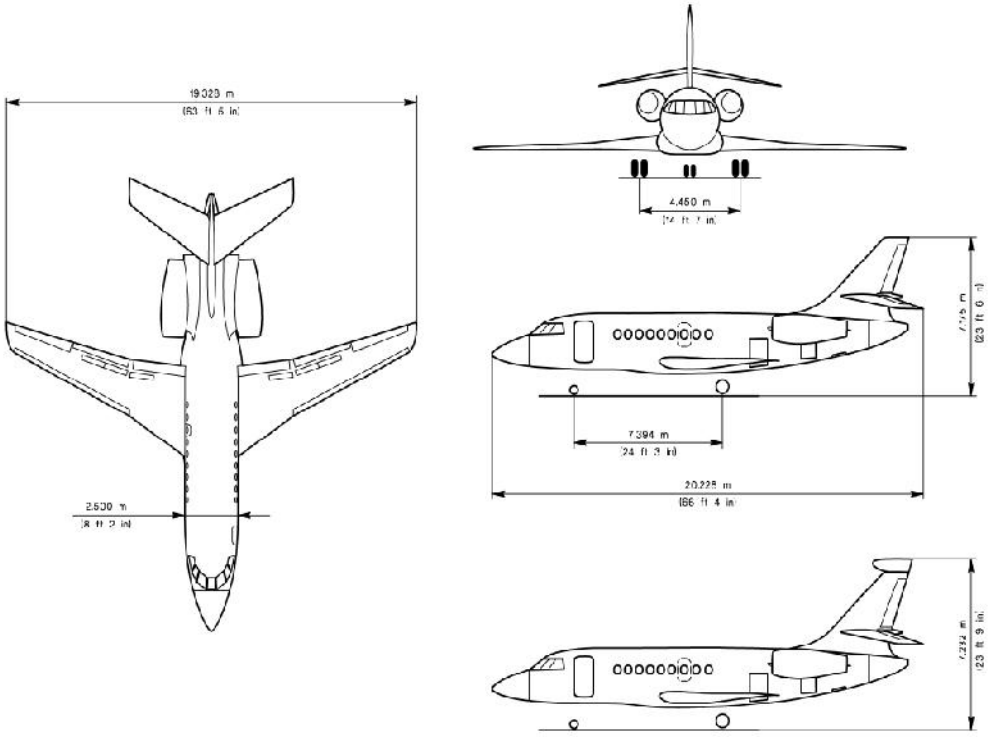
Age	:	45 yrs.
Licence	:	ATPL
Date of issue	:	21/05/2015
Valid up to	:	20/05/2020
Category	:	Aeroplane
Class	:	Single/Multi-engine Land/Sea
Endorsements as PIC	:	Cessna 152-A, Pilatus PC 12, SKA B-200, Falcon 2000
Date of Med. Exam.	:	25/07/2017
Med. Exam valid up to	:	01/08/2018
FRTO Licence No.	:	Valid on the date of Incident
Date of issue	:	25-02-2014
Total flying experience	:	5126:56 Hrs
Experience on type	:	233:16 Hrs
Experience as PIC on type	:	31:53

Last flown on type	:	17-04-2018
Total flying experience during last 180days	:	74: 13 Hrs
Total flying experience during last 90 days	:	70: 23: Hrs
Total flying experience during last 30 days	:	34:03 Hrs
Total flying experience during last 07 days	:	Nil
Total flying experience during last 24 Hours	:	Nil

Both the operating crew were not involved in any serious incident/ incident in past. Both the operating crew were current in all training and had adequate rest as per the Flight Duty Time Limitations (FDTL) requirement prior to operating the incident flight.

1.6 Aircraft Information:

The Falcon 2000 is a subsonic, medium-range, civil transport aircraft manufactured by M/s Dassualt Aviation, France. The aircraft has two high bypass turbofan engines manufactured by M/s CFE Company. The aircraft is designed for operation with two pilots and has passenger seating capacity of 10.



Construction:

The aircraft is certified in Normal (Passenger) category, for day and night operation under VFR & IFR. The maximum operating altitude is 47,000 feet and maximum take-off weight is 16556 Kg. The Maximum Landing weight is 15649 Kg. The Aircraft length is 20.228 meters, wingspan is 19.328 meters and height of this aircraft is 7.175 meters. The distance between main wheel centres is 4.450 meters.

1. AUTOMATIC FLIGHT CONTROL SYSTEMS (AFCS)

1.1 GENERAL DESCRIPTION FUNCTIONS AND CHARACTERISTICS

The flight control system provides the following functions:

1. Mach trim
2. Flight director
3. Autopilot
4. Yaw damping

a) MACH TRIM FUNCTION

This function acts on the position of the horizontal stabilizer through the trim actuator according to the aircraft Mach delivered by (Air Data Computer) ADC 1 and ADC 2.

b) FLIGHT DIRECTOR FUNCTION

The pilot flies the aircraft manually according to the guidance instructions provided by the Electronic Flight Instrument System (EFIS).

The flight director function enables the pilot to select most of the following lateral and vertical modes on the mode selector:

Lateral Modes:

- Roll mode (basic mode),
- Selected heading mode (HDG),
- Selected track mode (TRK),
- Navigation mode (NAV),
- Approach mode (APPR),
- Back Course Mode (B/C),
- Half bank mode (BANK),
- Go around mode (on the lateral plane),

- Synchronization function in lateral mode.

Vertical Modes:

- Pitch mode (basic mode),
- Glide Slope Mode (G/S),
- Altitude Mode (ALT),
- Preselected altitude mode (ALT SEL),
- Vertical speed mode (VS),
- Flight level change mode (FLC),
- Overspeed Mode,
- Vertical plane go around mode,
- Vertical navigation mode (VNAV),
- Synchronization function in vertical mode.

The pilot and copilot flight directors are mutually synchronized except during the capture phases in Instrument Landing System (ILS) approach mode.

c) AUTOPILOT FUNCTION

The autopilot delivers control signals to the aileron and elevator servomotors following the flight guidance signals from the flight director selected by pressing the "CPL" pushbutton.

It delivers the elevator automatic trim command signals.

i. Selection

By pressing in the "AP" pushbutton on the mode selector.

NOTE: The autopilot can only be engaged under the following conditions:

- the "AP/YD" bar on the mode selector is in the high position,
- the aircraft speed or altitude is within the flight envelope,
- the FCCs have completed their initial power-on checks,
- No failure has been detected in the autopilot immediately prior to engagement.

ii. Display

The green "AP" symbol is displayed on the PFD. If the autopilot disengages, the "AP" symbol turns red and starts flashing. The warning panel "AP" light illuminates and an audio warning sounds.

When the AP is engaged at takeoff, the red "TO CONFIG" warning panel light illuminates.

d) YAW DAMPER

The yaw damper "YD" delivers the control signals to yaw damper actuator.

i. Yaw Damper Function

By pressing in the "YD" pushbutton on the mode selector.

NOTE: The yaw damper can only be engaged under the following conditions

- the "AP/YD" bar on the mode selector is in the high position,
- the aircraft speed or altitude is within the flight envelope,
- the FCCs have completed their initial power-on check
- No failure has been detected in the yaw damper immediately prior to engagement.

ii. Automatic Selection

By engaging the autopilot.

iii. Manual Deselection

By pressing in the "YD" pushbutton or lowering the "AP/YD" bar on the mode selector.

iv. Automatic deselection

If yaw damper failure is detected by the FCC (L145CA)/ (R145CA).

v. Display

- Disengagement of the yaw damper is indicated by the white "YD" symbol on the PFD.
- Yaw damper disengagement causes the yellow "YD" symbol to flash for 10 seconds on the PFD.

- Rudder actuator off-centering is indicated by the yellow "R" on the PFDs.

1.2 DESCRIPTION OF SYSTEMS AND COMPONENTS

The aircraft flight control system comprises the following items of equipment:

- Flight Control Computer ,
- a mode selector,
- elevator servomotors ,
- a yaw damper actuator .

Each flight control system is connected to the following items of equipment:

Modules inside the Integrated Avionics Processor Assembly (IAPS):

- Two power supply modules (PWR),
- Two input/output modules (IOC). These redundant modules connect the FCC to the equipment external to the IAPS and read the input data from the following equipment: Electronic Flight Instrument System (EFIS), Air Data System (ADS), Attitude and Heading Reference System (AHRS), Air traffic Controller (ATC), Flight Management System (FMS), radio navigation sensors, Data Acquisition Unit (DAU).

a) FCC

These two modules are installed in the IAPS.

The IAPS is divided into two sections:

- a LH section containing the modules assigned to the pilot,
- a RH section containing the modules assigned to the copilot.

Each FCC contains a main computer and an input/output monitoring computer.

The I/O monitoring computer receives the digital, analog and discrete data which are stored in a memory zone accessible to the main computer. The main computer generates the laws and operational calculations which are stored in a memory zone for transmission to the exterior by the input/output monitoring computer.

The main computer sends the equivalent of a half-control signal to the servomotors and checks that the servomotor slaving is effective. The monitoring computer checks the aircraft response and generates the "cutout" signals if the AP flight envelope is exceeded.

b) Mode Selector

The mode selector is connected to FCC. Its front panel features the mode selection keys, a switch, rotary selectors with push or pull function engagement, and a thumbwheel. The mode selector transmits discrete inputs to the FCC. The discrete inputs comprise:

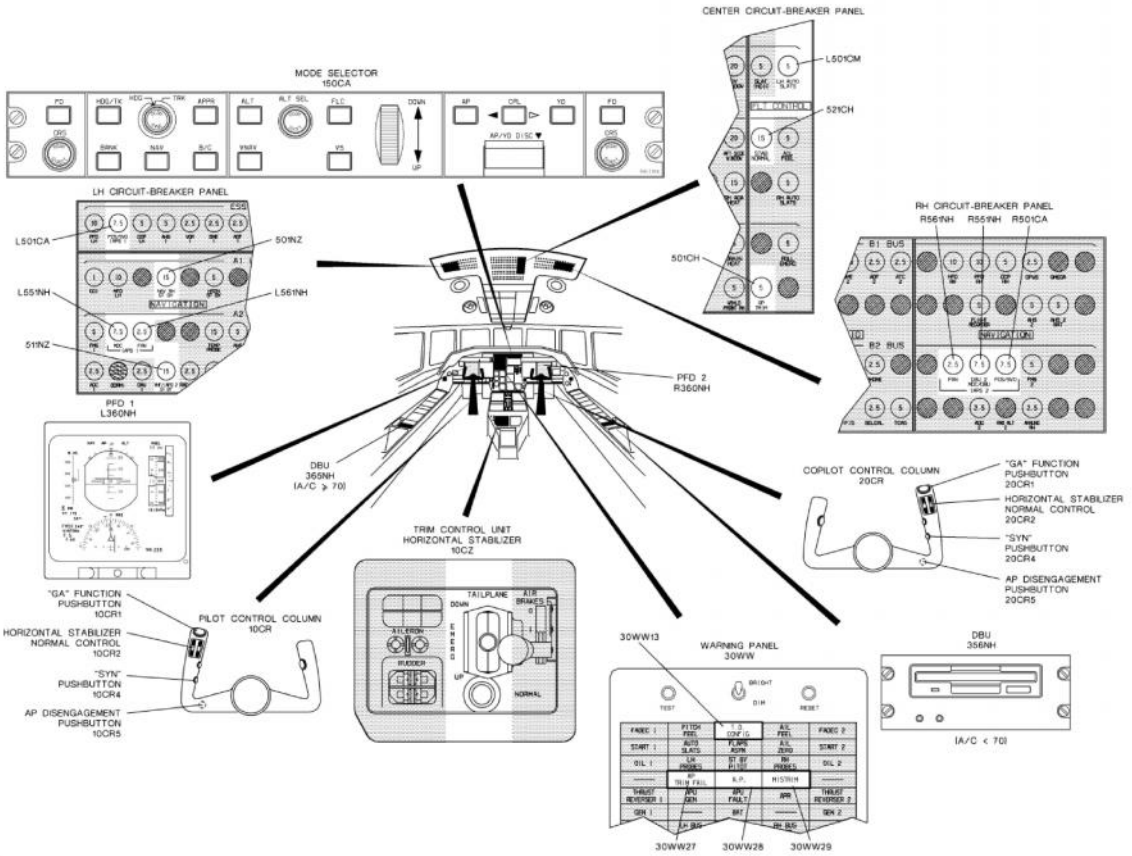
- the IAS/MACH selection from Display Control Panel (DCP 1) and DCP 2,
- the "stall warning" signal from the DAU,
- the discrete signals from the pilot and copilot control columns: "GA" and, "SYN", AP disconnection, pitch trim actuation,
- the emergency pitch trim actuation signal from the trim control unit,
- the discrete signals concerning yaw damper and AP engagement authorization (engagement of roll and pitch servomotors),
- The yaw damping control signals.

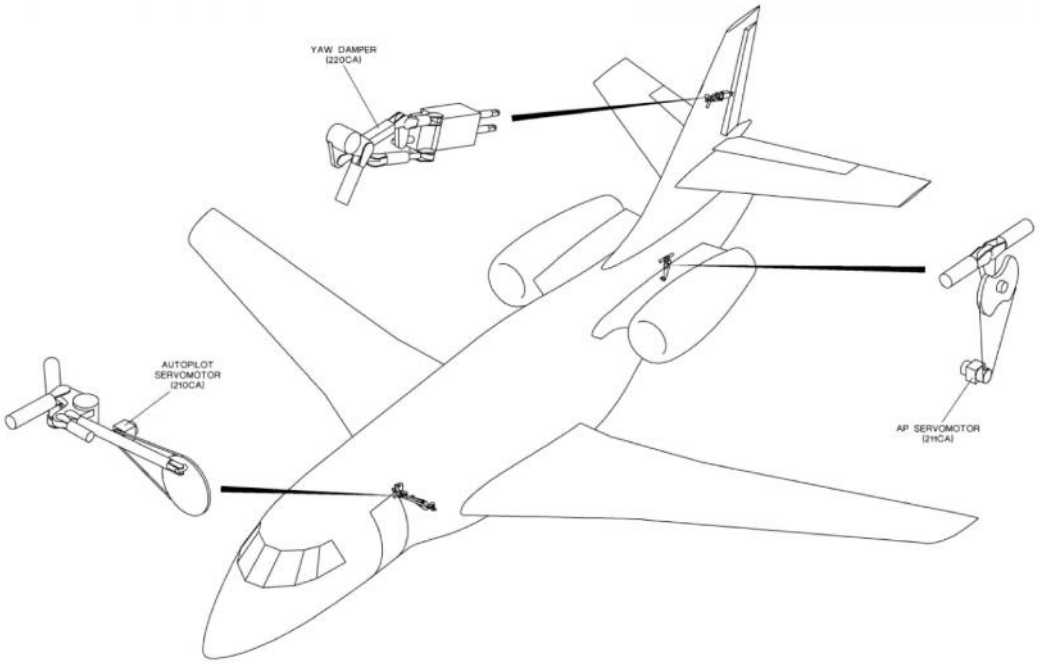
c) Roll and Pitch Servomotors

One servomotor (roll or pitch) receives an engagement signal from the mode selector at the flight control linkage. Each FCC sends the equivalent of a half-control signal. After summing the two signals, the servomotor rotates, driving two generators and the flight control linkage. Each generator feeds back the servomotor rotation speed to an FCC.

d) Yaw Damper Actuator

Each FCC sends the equivalent of a half-control signal through the mode selector. After summing the signals, the linear actuator drives two internal position feedback potentiometers and the flight control linkage. Each potentiometer sends the FCC a voltage signal representing the position of the actuator.


CENTER CIRCUIT-BREAKER PANEL
L501OM
521CH
501CH
MODE SELECTOR
150CA
LH CIRCUIT-BREAKER PANEL
L501CA
501NZ
L551NH
L561NH
511NZ
PFD 1
L360NH
RH CIRCUIT-BREAKER PANEL
R561NH
R551NH
R501CA
B1 BUS
B2 BUS
PFD 2
R360NH
DBU
365NH
(A/C ≥ 70)
TRIM CONTROL UNIT
HORIZONTAL STABILIZER
10CC2
COPILOT CONTROL COLUMN
20CR
"GA" FUNCTION
PUSHBUTTON
20CR1
HORIZONTAL STABILIZER
NORMAL CONTROL
20CR2
"SYN"
PUSHBUTTON
20CR4
AP DISENGAGEMENT
PUSHBUTTON
20CR5
"GA" FUNCTION
PUSHBUTTON
10CR1
HORIZONTAL STABILIZER
NORMAL CONTROL
10CR2
"SYN"
PUSHBUTTON
10CR4
AP DISENGAGEMENT
PUSHBUTTON
10CR5
PILOT CONTROL COLUMN
10CR
30WW13
WARNING PANEL
30WW
30WW27
30WW28
30WW29
DBU
356NH
(A/C < 70)


YAW DAMPER
(220CA)
AUTOPILOT
SERVOMOTOR
(210CA)
AP SERVOMOTOR
(211CA)

1.6.1 Airworthiness certificate:

Falcon 2000 aircraft VT-AVH (MSN 103 was manufactured in year 2000. The aircraft was registered with DGCA under the ownership of M/S Ligare Voyages Limited. The aircraft is registered under Category 'A' and the Certificate of registration No. 4184/6.

The Certificate of Airworthiness Number 6293 under "Normal category" subdivision Passenger was issued by DGCA on 04-02-2011. The specified minimum operating crew is two and the maximum all up weight is 16,556 Kg. At the time of incident the Certificate of Airworthiness/ Airworthiness review certificate was current and was valid up to 04-04-2019.

The Aircraft was holding a valid Aero Mobile License No A-134/005/RLO (NR) at the time of incident. This Aircraft was operated under Non-Scheduled Operator's Permit No 01/1998 which was valid up to 07-08-2022. As on 26-04-2018 the aircraft had logged 6123:27 Airframe Hours and 5628 Landings.

The Falcon 2000 aircraft and its Engines are being maintained as per the maintenance program consisting of calendar period/ flying Hours or Cycles based maintenance as per maintenance program approved by Regional Airworthiness office, Delhi.

Accordingly, the last major inspection '2C' check carried out at 4693:13 Airframe Hours and 4480 Landings. Subsequently all lower inspections (Pre-flight Inspection, A Inspection, Z Inspection) were carried out as and when due before the incident.

The aircraft was last weighed on 11-08-2017 at New Delhi and the weight schedule was prepared and duly approved by the office of Director of Airworthiness, DGCA, Delhi. As per the approved weight schedule the Empty weight of the aircraft is 10, 038.541 Kg. Maximum Usable fuel Quantity is 5,513 Kg. Maximum payload with fuel tanks full is 536.3 Kg. Empty weight CG is 12.401 meters aft of datum. As there has not been any major modification affecting weight & balance since last weighing, hence the next weighing is due on 11-08-2022. The weight and balance of the aircraft for this flight was well within the operating limits.

All the concerned Airworthiness Directive, mandatory Service Bulletins, DGCA Mandatory Modifications on this aircraft and its engine has been complied with as on date of event.

Pre-flight/transit/Post flight Inspections were carried out as per approved Inspection schedules and all the higher inspection schedules including checks A inspections, Z Inspections were carried out as per AMM/EMM as specified in Maintenance Program and are approved by the Continuing Airworthiness Manager (Post Holder for Continuous Airworthiness).

The last fuel microbiological test was done on 18-01-2018 at 6045:11 Hrs and 5561 Landings by Spectro Analytical Labs Limited (DGCA APPROVED) and the colony count was within acceptable limits.

The left Engine S/N P-105397 had logged 5898:38 and 5435 cycles and the Right Engine S/N P-105262 had logged 5932:28 Hrs. and 5446 cycles. There was no defect report on the engine on the previous flight.

1.6.2 Defect isolation/ rectification work was carried out at Hubli

At Hubli CVR & FDR data was download and following checks were carried out on the aircraft to confirm the defect of Autopilot tripping during flight.

- An extensive inspection almost equivalent to inspection for Airworthiness Review Certificate (Physical Survey) was carried out and found satisfactory.
- Inspection covering to flight through severe turbulence (W.O AVH/540) carried out and found satisfactory.
- Further purpose of confirming autopilot system integrity a high power run-up was sought which was carried out by both flight crew and no abnormality was noticed.
- For reconfirming associated parameters such as hydraulic, electric, avionics systems, etc a high speed taxi was carried out and found satisfactory. During high speed run up and high speed taxi auto pilot engagement and disengagement check performed, auto pilot functions found satisfactory.

The aircraft operated flight on 28.04.2018 from Hubli to Delhi. No snag was reported on this flight. The autopilot was engaged during the flight and all operations were satisfactory. The aircraft landed at Delhi safely. The aircraft was again grounded for detailed inspection on the avionics system and checks on the Yaw damper.

INSPECTION CARRIED OUT AT DELHI

- Carried out leak test of pilot and copilot static pressure system as per AMM CH 34-11-00-790-801. Found both pilot and co-pilot static system leak within limit and satisfactory.
- Physical inspection and hydraulic leak check on Yaw Damper was carried out and found satisfactory.
- Further Troubleshoot carried out at Delhi on Flight Control Computer (FCC), found satisfactory. Operational test on Automatic Flight Control System carried out as per AMM 22-10-00-710-801, found all operation normal. Thereafter fault isolation was carried out as per Maintenance Diagnostic Computer (MDC) fault history code. Operation test of IRS, system carried out as per AMM 34-21-00-710-801 the fault could not be reproduced on ground, however FCC no: 2 (R145CH) was suspected faulty and replaced as per AMM 22-10-02-900-802 as a precautionary measure.

The fault on the Auto pilot system could not established in any of the checks. However the FCC # 2 was suspected to be functioning intermittently hence removed and sent to the manufacturer i.e. Honeywell for investigation.

1.6.3 Defects during last three months

The defect details on the aircraft VT-AVH for the period of last three months was reviewed and the rectification action carried out as per AMM.

DATE	DEFECT REPORTED	RECTIFICATION	STATUS
01-02-18	During walk around LH I/B & Rh O/B main wheel tyre found worn out	LH I/B main wheel assy replaced.	Closed
23-04-18	During FMS data updation it was observed that 'FD' red flag appears on pilot PFD intermittently	FCC#1 is replaced as per AMM with overhauled unit	Closed
23-04-18	During FMS data updation it was observed that MCD registered fault message of low battery of FMS-2.	FMS-2 was replaced as per AMM with overhauled unit.	Closed
24-04-18	During detailed inspection of main wheel tyre RH I/B & LH O/B found worn out	RH I/B & LH O/B main wheel assy replaced.	Closed

1.7 Meteorological information

Departure Station:

At Delhi (VIDP) during take-off wind true direction was 290 degrees with speed 5 knots. Visibility was 3000 metres with haze and temperature was 30 degrees Celsius with dew point 06 degrees Celsius. QNH (Sea-level pressure) was 1004 hPa. No significant changes expected in the weather.

Destination Station:

At Hubli (VOHB) wind direction was 090 degrees with speed: 07 knots. Visibility was 10km and temperature was 32 degrees Celsius with dew point 16 degrees Celsius. QNH (Sea-level pressure) is 1015 hPa. No significant changes expected in the weather.

1.8 Aids to navigation

There is one single runway available at Hubli which has the orientation 08/26. For landing runway 08/26 VOR/DME approach is available. PAPI is available for both sides of the runway. NDB is also available at Hubli for approach and landing. The ATC is controlled and manned by Airports Authority of India

1.9 Communications

There was always two way communication between the ATC and the aircraft.

1.10 Aerodrome information

ICAO : VOHB
Coordinates : 152143.3N 0750504.8E
Elevation : 2180 feet

Runway Declared Distances

RWY designator	TORA (M)	TODA (M)	ASDA (M)	LDA (M)
08	2600	2600	2600	2600
26	2600	2600	2600	2600

Meteorological Services

Meteorological Office hour of service is 0200 UTC to 1500 UTC. TAF, Trend Forecast and briefing is available. Flight Documentation is provided in Chart and Tabular form in English language. Metar is provided to the ATC after an interval of every half an hour.

1.11 Flight recorders:

Both the CVR and the DFDR were downloaded from the aircraft for the further investigation.

1.11.1 Cockpit Voice Recorder:

Model: Honeywell/ Allied Signal, P/N: 980-6022-011, S/N: 1235

Time	ATC/Radar	PF	PM	A/C
00:00:13	Climb to FL 410		Climb to FL410 and direct IBANI	
00:12:36				Altitude
00:14:01			ALT Green	
00:15:22	Contact Nagpur 123.9		123.9 VVH	
00:38:08		Maintaining HDG confirm resume normal		
	Resume Normal			
00:39:20		Req. DIR GUMIT		
00:40:12		Destination VOHB Req. DIR to BBM		
	Right HDG 180	Right HDG 180		
01:07:39		Shamshadbad Req. VVH		
01:07:45		DIR BOGAT Destination VOHB		
01:08:06				AP AP AP
01:08:20		YD	YD	
01:08:21				Bank angle, Alt
01:08:28		My control		
01:08:36	VVH Report level			
01:08:42			Coming up FL 410	
01:08:43	Conform your Descending		Due to Technical, coming up on FL410	
01:08:48		Autopilot fail		
01:08:55			We got AP disengage	
01:09:04		YD off	YD off	
			YD is not coming up	
01:09:20		YD, AP disengaged , manual(Briefed)		

01:09:45			AP on, not taking	
01:10:35		NAV engage		
01:11:06	Proceed DIR BOGAT and estimates		DIR BOGAT, stand by estimates	
01:11:12		Give me DIR BOGAT		
01:11:44		Give me HDG , DIR to BOGAT		
01:12:04	VVH Report Level		FL 410 , - ve RVSM	

1.11.2 DFDR

Model: Honeywell/ Allied Signal, P/N: 980-4700-025, S/N: 5554

Relative Time	PRESS ALT FT	IAS KNTS	MAG HDG_DEG	VERT ACC_'g'	LONG ACCN_'g'	PITCH ANGLE_mV	ROLL ANGLE_DEG	A/P_STAT
24:34:02	40932	244	182.1972138	0.9176067	0.02535	1.4941402	0.7031248	ENG
24:34:03	40933	244.25	182.1972138	0.8970012	0.0234	1.4941402	0.3515624	ENG
24:34:04	40935	244.25	182.2851044	0.9176067	0.0234	1.4062496	0.2636718	ENG
24:34:05	40934	244.25	182.1972138	0.8970012	0.0234	1.4941402	0.7031248	...
24:34:06	40929	244.25	182.2851044	0.9464544	0.02535	1.5820308	3.6914052	...
24:34:07	40925	244	182.4608856	0.9382122	0.02535	1.6699214	7.7343728	...
24:34:08	40924	243.75	182.812448	0.9382122	0.02535	1.757812	12.304684	...
24:34:09	40921	243.75	183.4276822	0.9382122	0.02535	1.757812	17.2265576	...
24:34:10	40923	243.5	184.130807	0.9464544	0.02535	1.6699214	22.0605406	...
24:34:11	40928	243.75	185.1854942	0.9382122	0.02535	1.4941402	27.0703048	...
24:34:12	40924	243.5	186.4159626	0.9464544	0.02535	1.4062496	32.080069	...
24:34:13	40910	243.5	187.9101028	1.0659663	0.0273	1.4062496	33.5742092	...
24:34:14	40899	243.5	189.404243	1.0783296	0.0273	1.0546872	33.6620998	...
24:34:15	40915	244	190.6347114	0.9093645	0.0234	0.5273436	38.4960828	...
24:34:16	40905	244	192.040961	0.9753021	0.02535	0.3515624	43.1542846	...
24:34:17	40893	244.25	193.8866636	0.9464544	0.0234	-0.5273436	48.6913924	...
24:34:18	40877	244.75	195.7323662	0.9588177	0.02145	-1.318359	54.3163908	...
24:34:19	40849	245.5	197.5780688	0.9382122	0.02145	-2.197265	59.9413892	...
24:34:20	40810	246.5	199.951115	0.9464544	0.0195	-3.6035146	64.9511534	...
24:34:21	40718	247.75	203.2030672	1.3544433	0.01365	-3.4277334	61.4355294	...
24:34:22	40557	247.5	207.1581442	1.7706744	0.01365	-2.9882804	46.9335804	...
24:34:23	40501	248.5	208.2128314	1.5522561	0.0195	-2.1093744	33.6620998	...
24:34:24	40444	249.5	209.2675186	1.5234084	0.01755	-0.7031248	24.0820244	...
24:34:25	40356	249.75	210.7616588	1.7418267	0.01365	0.3515624	19.2480414	...
24:34:26	40294	249.25	211.2890024	1.6099515	0.0156	0.7031248	17.2265576	...
24:34:27	40284	250	212.0800178	1.4327442	0.0078	2.5488274	11.865231	...
24:34:28	40230	249.5	212.4315802	1.7624322	0.00585	3.955077	3.3398428	...
24:34:29	40200	248.5	211.9921272	1.5522561	0.0039	2.9882804	-4.5703112	...

DFDR readout revealed the following:

- At 24:34:04 Relative time, with Altitude of 40935 feet aircraft flown steadily with Auto pilot engaged.
- After one second at 24:34:05 relative time, Auto pilot gets disengaged.
- Banking angle increased from 0.2636718 deg.
- After 12 seconds at 23:34:17 relative time banking angle exceeds 45 degree and give master warning to pilots.
- At 24:34:20 bank angle was maximum at 64.95 deg.
- At 24:34:21, pilot initiates corrective action to control the bank angle.
- After 9 seconds at 24:34:29, with altitude of 40200 feet, pilot brought the bank angle to -4.5703112 deg
- There after the pilot flew the aircraft manually and landed at Hubli (VOHB) airport.
- After the auto pilot got disengaged, it took 24 seconds for the pilots to control the situation.
- The aircraft lost 735 feet during this period.
- There was no other exceedance observed during entire sector of the flight.

1.12 Wreckage and impact information:

Nil

1.13 Medical and pathological Information:

Both the cockpit crew had undergone pre-flight medical examination prior to flight at Delhii and same was negative.

1.14 Fire:

There was no fire.

1.15 Survival aspects:

The incident was survivable.

1.16 Tests and research:

The FCC#2 was suspected for a transient fault and was removed and sent to the Manufacturer i.e. M/s Rockwell Collins for shop investigation. As per shop report

the failure was due to intermittent configuration module A4 the same was replaced with newer version and unit was made serviceable.

Rockwell Collins

Service Memorandum

Service Notification: 105538984 **Page 1 of 3**

Customer: RC GLOBAL LOGISTICS SOLUTIONS LLC	Contract Number: Cust Reject #: Govt Incoming Doc # : Date Equipment Received: 05/22/2018	Repair Station Certificate #: R9CY096N FR.145.0121
Customer P.O. Number: 3056326/001000/POOL		ROCKWELL COLLINS FRANCE R9CY096N FR.145.0121 PO Box 20008 F-31700 BLAGNAC France For Questions Regarding This Service Work, Please Contact Customer Service at: Phone : +33 561717786 Fax :

	Outgoing Equipment	Incoming Equipment	Aircraft Information	
Equipment Type/Model	FCC-4002	FCC-4002	Type	Falcon 2000
Part Number	822-0327-508	822-0327-508	Serial Number	0103
Serial Number/MCN	3YDF	3YDF	Tail No	VTAVH
Description	FLT CONTROL COMPUT	FLT CONTROL COMPUT	Position	
Mil Nomenclature			Removed at Gateway:	
Customer Part Number:			Date Unit Removed :	05/22/2018
Customer Serial Number:				

Customer Complaint/Instructions
OVERHAUL AND APPLY SB's AS NECESSARY. FCC MEMORY RESET (SUSPECTED). MDC FAULT CODE 071-010022, 351-000400

Preliminary Inspection Results:
RC seals intact. Lack of SB FCC-40XX-22-43 and SB FCC-40XX-22-51.

Hidden Damage Inspection Results
None.

Was the Complaint Verified? YES **Were There Any Defects Found?** YES

Description of What Was Wrong with the Equipment:
Found label#350 failures due to intermittent configuration module A4.

Airworthiness Directives
No AD's applicable to this article.

Description of Service Work Performed:
Replaced A4 card with newer version to cure failure. Applied SB FCC-40XX-22-51 Rev- and SB FCC-40XX-22-43 Rev1. Bench test - OK.

Note: Unit overhauled in accordance with IB 523-0768039 3rd ED Rev-.

1.17 Organizational and management information:

M/s Ligare Aviation ltd. is a Non-scheduled airline with a fleet of 2 Falcon 2000, 2 SKA B200, 1 Falcon &X aircrafts and 1 Agusta 109S Helicopter operating flights on domestic and international sectors. The company Head Quarter is located at New Delhi. The Air operator permit of the Airlines is valid till 07-08-2022. The Company is headed by CEO/Accountable Manager assisted by a team of Heads of various departments. The Flight Safety Department is headed by Chief of Flight Safety. The Chief of Flight Safety is senior management official who reports directly to the CEO/Accountable Manager.

1.18 Additional Information:

The aircraft VT-AVH was taken over by Enforcement Directorate and was sealed on 23-07-2015 at Madurai. The aircraft had logged 5575.31Hrs at that time.

Following maintenance work was carried out during the period aircraft VT-AVH was grounded in Madurai by the enforcement directorate.

Sl/No.	Scheduled maintenance	Date
1.	1A (400 Hrs./08 months) inspection	23-03-2016
2.	1A+ (08 months) inspection	23-03-2016
3.	DFDR sensor element calibration	23-03-2015
4.	APU starter generator brush check	20-01-2016
5.	Over pressure relief valve vaccum supply line check	20-01-2016
6.	Fuel drained for MBT	21-01-2016
7.	Detailed inspection of MLG & NLG	23-03-2016
8.	04 weekly inspection	12-08-2015
9.	Sb f000-406 complied	06-11-2015
10.	Functional test if ADC #1, #2, SFD.	12-08-2015
11.	Functional Test Of Air Data Unit	12-08-2015
12.	04 weekly inspection	08-09-2015

Subsequently the aircraft was released for flying on 21.4.2016 after a grounded period of 9 months. The aircraft thereafter had logged 552.39 Hrs. prior to the incident flight. There is no major incident during this period. The aircraft was maintained as per the approved maintenance programme.

1.19 **USEFUL AND EFFECTIVE TECHNIQUES :**

NIL

2. ANALYSIS

2.1 Serviceability of the aircraft

Aircraft VT-AVH (MSN 103) had been manufactured in year 2000. The aircraft was registered with DGCA. At the time of incident Certificate of Airworthiness was current and valid.

This Aircraft was operated under Non-Scheduled Operator's Permit No 01/1998 which was valid up to 07-08-2022. As on 26-04-2018 the aircraft had logged 6123:27 Airframe Hours and 5628 Landings. The aircraft and its Engines are being maintained as per the maintenance program approved by Regional Airworthiness office, Delhi.

The Falcon 2000 and Engines are being maintained under continuous maintenance as per maintenance program consisting of calendar period based maintenance and Flying Hours / Cycles based maintenance as per maintenance program approved by Office of DDG, DGCA, Northern region. Accordingly, the last major inspection '2C' check carried out at 4693:13 Airframe Hours and 4480 Landings. Subsequently all lower inspections (Preflight Inspection, A Inspection, Z Inspection) were carried out as and when due before the incident.

All the concerned Airworthiness Directive, Service Bulletins, DGCA Mandatory Modification on this aircraft and its engine have been complied with as & when due. The defect record of the aircraft were scrutinized for a period of three months prior to the date of incident, no defect was found pending on the aircraft. Prior to the incident flight the weight and balance of the aircraft was well within the operating limits. On 23.04.18, during FMS data updation the flight director red flag appeared on the PFD. The FCC#1 was suspected to be faulty and was replaced with overhauled unit.

After the incident, detailed inspection was carried out at Hubli and fault could not reproduced on ground. The aircraft was cleared to operate flight back to Delhi and the auto pilot system was found satisfactory. During detailed inspection at Delhi the fault could not be reproduced on round, however the FCC#2 was suspected for intermittent function and hence was removed and sent to manufacturer for investigation. As per shop report the failure was due to intermittent configuration module A4 which had caused the autopilot disengage during flight.

From the above it is inferred that the serviceability of the aircraft is not a factor however the intermittent nature of the FCC 2 had caused the incident to occur.

2.2 Weather:

Prior to take off from Delhi, the weather was fine with visibility 3000 meters with haze and temperature was 30 degrees Celsius with dew point 06 degrees Celsius. QNH (Sea-level pressure) was 1004 Hpa. The aircraft took off from Delhi at around 0353 UTC and weather reported for Hubli was within the crew operating minima.

When the aircraft came in contact with Hubli ATC, The prevailing weather conditions Winds 090 degrees with speed 07 knots, Visibility was CAVOK, temperature was 32 degrees Celsius with dew point 16 degrees Celsius and QNH (Sea-level pressure) was 1015 Hpa was intimated to VT-AVH. There was no significant change of weather at the time of landing.

From the above it is inferred that the weather is not the contributory factor to the incident.

2.2 DFDR Analysis:

The DFDR data was downloaded and analyzed. It was observed that the aircraft was cursing at FL 410 (41,000 feet) when auto pilot tripped. As the auto pilot tripped, both the crew observed YD (white) on Pilot Function Display (PFD). However the crew did not realize that the aircraft has gone into a bank with yaw damper failure. The crew only realized when the bank angle warning came at 45 degree i.e after 13 seconds of autopilot disengagement. The bank angle kept on increasing with altitude loss and reached a maximum of 64.95 degrees i.e 15 seconds after the auto pilot disengagement and altitude loss of 735 ft from the assigned flight level. The crew initiated corrective action to control the aircraft altitude 15 seconds after the auto pilot disengagement. The aircraft was finally recovered to straight and level flight after 24 seconds from the autopilot disengagement.

From the above it is inferred that the crew actions were slightly delayed to take the corrective actions.

2.3 Circumstances leading to the Incident:

Aircraft VT-AVH was in cruise flight at FL 410 (41,000 feet) near waypoint (BOGAT), the yaw damper failed indication came on Primary Flight Display (PFD) and the auto pilot disengaged. As the auto pilot tripped, both the crew got busy analyzing the fault and did not realize that the aircraft has gone into a bank with the yaw damper failure. The crew only realized when the bank angle warning came at 45 degree. The bank angle kept on increasing with altitude loss and reached a maximum of 64.95 degrees. The crew initiated corrective action to control the aircraft altitude 15 seconds after the auto pilot got disengaged.

The PIC actions were slightly delayed as he took over control manually only after the warning was activated. This delayed actions caused the aircraft to reach high bank angle value and altitude loss which created panic and scare for the passengers in the cabin.

3. CONCLUSIONS:

3.1 Findings:

a) The Certificate of Airworthiness and the Certificate of Registration of the aircraft was valid on the date of incident.

b) The certificate of flight release was valid on the day of incident.

c) Both the crew were type approved to operate the flight.

d) All the concerned Airworthiness Directive, Service Bulletins, DGCA Mandatory Modifications on this aircraft and its engine were found complied with.

e) There was no snag pending prior to the incident flight.

f) The aircraft was at FL 410 (41,000 feet), the Auto pilot got disengaged and the yaw damper failed indication came on Primary Flight Display (PFD).

g) The bank angle kept on increasing with altitude loss and reached a maximum of 64.95 degrees

h) Crew initiated action only when the master cautions warning i.e after 15 sec of autopilot disengage.

i) The aircraft went into bank of 64.95 degrees and altitude loss of 735 ft from the assigned flight level.

j) The PIC took over the control manually and brought back the aircraft to assigned flight level.

k) There was no injury reported to any of the occupants on board the aircraft.

l) Aircraft landed safely at Hubli with auto pilot disengage.

m) During inspection at Hubli the fault could not be confirmed during ground checks.

n) The auto pilot functions normally during the return flight from Hubli to Delhi.

o) During detailed inspection at Delhi the fault could not be confirmed, however the FCC#2 was suspected for a transient fault and was removed and sent to the vendor for shop investigation.

p) As per shop report the failure was due to intermittent configuration module A4 the same was replaced with newer version and unit was made serviceable.

3.2 Probable cause of the Incident:

The yaw damper failure occurred due to intermittent behavior of FCC 2, this caused the auto pilot to disengage and the aircraft went into excessive right bank with altitude loss.

Contributory factor:

Due to lack of situational awareness the crew actions to control of the aircraft manually were slightly delayed.

4. Safety Recommendations

1. Cockpit crew to undergo corrective training.
2. Regulatory audit of the organization to be carried out to check the compliance of regulations.

(N.C Ghosh)
Deputy Director Airworthiness
Member VT-AVH

(A X Joseph)
Deputy Director Air Safety
Investigator-in-Charge VT-AVH

Date: 02.07.2018
Place: New Delhi