FOKKER F-28 MK 0100, XY-AGC
ACCIDENT NEAR HEHO AIRPORT (VYHH)
ON 25 DECEMBER 2012

Executive Summary

At 0826 local time[1] on 25 December 2012, a Fokker 100 aircraft, registered XY-AGC operated by Air Bagan, departed Mandalay International Airport (VYMD) on a scheduled passenger flight to Heho Airport (VYHH), Myanmar. On board the aircraft were the pilot in command (PIC), first officer (FO), 4 cabin crew and 65 passengers (71 POB). The FO was the designated handling pilot for this flight.

The aircraft arrived overhead Heho Airport at about 0845 and commenced a non-precision Non Directional Beacon (NDB) approach to runway 36. During the final approach, at about 0853, the aircraft struck power lines, trees and collided with terrain short of the runway, coming to rest approximately 0.7 NM from the threshold. During the ground collision, both wings separated and fire commenced almost immediately after and an emergency evacuation was initiated by the cabin crews. One aircraft occupant and one motorcyclist on the ground were fatally injured. 70 of the occupants and one motorcyclist survived and the aircraft was destroyed by fire.

Registered owner and operator	-	Air Bagan ltd.
Air craft type	-	Fokker F-28 MK 0100
Nationality	-	Myanmar
Registration	-	XY-AGC
Place of Accident	-	Near Heho Airport (VYHH) Runway 36 Latitude N 20. 72605 Longitude E 96.79745
Date & Time	-	25 December 2012 at 08 53 (local time)
Type of operation	-	Scheduled passenger flight
Phase of operation	-	During final approach

1) FACTUAL INFORMATION

1.1) History of the flight

1.1.1) Departure and En-route

On 25 December 2012 at 0603 local Time, an Air Bagan Ltd Fokker 100 aircraft registered XY-AGC (MSN-11327) departed Yangon International Airport (VYYY) on a scheduled passenger flight to Mandalay International Airport (VYMD) with the Pilot in command (PIC) as pilot flying. The aircraft was refueled after 60 passengers disembarked and 46 passengers boarded. The PIC made briefing and completed the aircraft checks. At 0826 local time, departed Mandalay International Airport (VYMD) to Heho Airport (VYHH). On Board the pilot in command (PIC), first officer (FO), 4 cabin crews and 65 passengers (Total 71 POB) and the First Officer was designated as the Pilot Flying for the flight. (Figure 1).

Figure.1: Air Bagan, Fokker-100 (XY-AGC)

The aircraft climbed to FL. 130 and cruised with an indicated airspeed of 250 Kts. The Pilot in command contacted Heho ATC at flight level 130 and 50 NM to Heho. Heho ATC provided the present weather condition (wind calm, visibility 3000M, Distinct fog, Temperature 17· C, QNH 1018 mb, RW 36). At about 0836 local time, the first officer started crew briefing and called out "Radio Altimeter" alive . The aircraft started descend to 9000ft and continued overhead Heho NDB. At about 0847 local time, while heading 220 degrees and

descending to 6000ft and commenced a non-precision Non Directional Beacon (NDB) approach to runway 36 (Figure 2):

Figure 2: MDY-HEHO route

1.1.2) Collision with terrain

During the final inbound track at about 2.5 NM to the runway at 08:52:349, the EGPWS aural warning called out "500". The Pilot in command initiated "Alt hold" at about 0853, just before the EGPWS alert "100" "50" 40" "30" and the aircraft struck 66 KV power lines, trees, telephone cables, fence and collided with terrain short of the runway, coming to rest approximately 0.7 NM from the threshold. During the ground collision, both wings separated and a fire commenced almost immediately. An emergency evacuation was initiated by the cabin crews. One aircraft occupant and one motorcyclist on the ground were fatally injured, 70 of the occupants and one motorcyclist survived and the aircraft was destroyed by fire. (Figure 3).

Figure 3: Accident site,

1.2) Injury to persons

One passenger and one motorcyclist were fatally injured and two crews, seven passengers and one motorcyclist were seriously injuried.

Injuries	Crews	Passengers	Other	Total
Fatal	0	1	1	2
Serious	2	7	1	10
Minor/Nil	4	57	0	61
Total	6	65	2	73

1.3) Damage to aircraft

Both wings had separated before the aircraft came to rest. The main fuselage, both engines and the landing gear remained together. The tail assembly had detached but remained connected to the fuselage by the flight control cables. The remainder of the aircraft was subsequently destroyed by fire. (Figure 4).

Figure 4: Damage to Aircraft

1.4) Other damage

There was other damage to a 66 KV power lines, trees, 11 KV power lines, a telephone cables, a fence and a motorcycle. As the aircraft struck the trees, a motor cycle with two motorcyclists passing on the road, aircraft debris struck the motorcycle. The motorcycle was destroyed. (Figure 5).

Figure 5: Damage to motorcycle

1.5) Personnel information

1.5.1) Pilot in command

Personal details	Male, 49 years of age
Type of license	Airlines Transport Pilot (aero plane)
Total flying hours	5937:12 hours
Total flying hours last 90 days	79:11 hours
Total flying hours last 30 days	30:15 hours
Total flying hours (F-100) Command hours	2547:35 hours 1735:32 hours
Last line check	31 March 2012
Last proficiency check	16 July 2012
Last instrument rating check	16 Jan 2012
Medical Expiry	5 Jan 2013
Marital status	Married.

Prior experience

The pilot in command obtained his ATPL license (364) on 12 March 2004. and joined the airline on 18 Dec 2004, as a First Officer. On 26 May 2006, he was appointed and assigned as a Fokker 100 commander.

Crew Resource Management and Dangerous Goods training accomplished on 24 Feb 2012. Fokker-100 simulator (187:00) hour and last check date (10-08-2012). Last flying date was 23 Dec 2012 and Medical status class1.

1.5.2) First Officer (FO)

Personal detail	Male, 29 years of age
Type of license	Commercial Pilot license 364
Total flying hours	849:56 hours
Total flying hours (F-100)	486:12 hour
Total flying hours last 90 days	101:07 hours
Total flying hours last 30 dap.	35:20 hours
Last line check	30 April 2012
Last proficiency check	15 Oct 2012
Last instrument rating	15 Oct 2012
Medical Expiry	15 May 2013
Marital Status	Un-Married

Prior experience

The FO joined the air line on 1 April 2010 and he obtained his CPL license on 19 Jan 2011. On 22 Dec 2010 he was assigned as Fokker 100 First officer.

Crew Resource Management and Dangerous Good training accomplished on 29 April 2012. Fokker-100 simulator (88:00) hour and last check date (15-10-2012). Last flying date was 17 Dec 2012 and Medical status class 1.

1.5.3) Crew relationship

There was difference in age and flying experience level between the pilot in command and First officer. The pilot in command experienced on Fokker-100 (2547:35) hrs. The FO had Fokker-100 (486:12) hrs.

Based on log book entries and Air Bagan roster, the pilot in command and copilot operated as a crew eight days before. The crews had operated together on that route and there was no tension between the pilot in command and the copilot.

1.6) Aircraft information

1.6.1) Aircraft data

Registration mark	XY-AGC
Manufacture	Fokker Service, Netherland
Type/model	F-28 MK 0100
Manufacture S/N and date	11327, 21 Feb 1991
Received date	30 June 2005
Certificate of Airworthiness	23 July 2013
Total airframe hours	27378 hours
Total airframe cycle	32584 check
Last time check (-125 hr)	22 Dec 2012
Last 'A' check (A-6 inspection)	23 Nov 2012
Last Base check (C-2 + 6 yrs)	28 Aug 2011
The Fokker 100 (MSN-11327) received from British Midland Airways on 30 June 2005 with total flying hr (18647:27)	

The Fokker 100 is a twin-engine aircraft designed for short and medium range operation. Maximum take of weight 43740 kg and the maximum operation altitude is 35000 ft. Pressurized fuselage with 8 emergency exists.

There was passenger door, cargo doors, four escape hatches on each side of passenger compartment above wings and two sliding windows in the cockpit.

Ailerons, rudder and elevators are hydraulically operated and pitch trim is obtained using the horizontal stabilizer. Flaps comprise two trailing edge sections of each wing and the flaps, speed brake and lift dumper doors are hydraulically operated.

The landing gear consists of a forward retracting nose gear and two side ward retracting main gears. Each gear is equipped with a shock absorber and two main wheels with skid-control brake unit. The nose gear is equipped with a nose wheel steering and centering system.

1.6.2) Engine Data

Engines	Left Engine	Right Engine
Manufacture	Rolls Royce Tay 650-15	Rolls Royce Tay 650-15
Serial number	17220	17424
Total flying hour	31554 hours	33928 hours
Total flying cycle	33300 cycle	27583 cycle
Time Since Overhaul	5414 hours	5221 hours

The aircraft is equipped with two fuselage mounted Roll Royce Tay Mk 650-15 turbo-fan engines located one on each side of the rear fuselage. The Tay engines are a twin-spool, high bypass ratio engine, low pressure spool comprise a single stage fan and three stage compressors driven by a three stages turbines. The high pressure spool consists of a twelve-stage compressors driven by a two stage turbines. The engine are started by an air starter motor. The thrust reversers can be deployed after touchdown to decelerate. Fire detection and extinguishing systems are installed.

1.6.3) Weight and Balance

MCAR Part. 8, part 8.7 (Aircraft operating and performance limitations) an aircraft may not fly without ensuring that the maximum allowable weight for a flight does not exceed the maximum allowable take off or landing weight or any applicable en-route performance or landing distance limitations.

Air Bagan flight operation Manual (Fokker-100) chapter 10 (weight and Balance) stated to be loaded in accordance with an approved loading schedule weights and associated center of gravity limits special care should be taken to ensure that the loading limitations of the floor and compartment strength are not exceeded.

The reported F-28 Mark 0100 (XY-AGC) weight, conducted on 15 Oct 2010, gave the basic aircraft weight and CG in 38.69% MAC (Appendix-A)

A copy of the load and trim sheet for the accident flight from Mandalay (VYMD) to Heho (VYHH) on 25 Dec 2012 indicated that the aircraft was take off allowable weight of 44450 kg (Appendix-A)

Dry Operation weight	-	26320 kg
Take off fuel	-	+ 7000 kg
Crews, passengers, baggage	-	+ 5308 kg
TOW	-	38628 kg
Trip fuel	-	-1000 kg
Landing weight		37628 kg

1.6.4) Flight/ Navigation Instrument

Six display units are installed at the main instrument panel, two in front of each pilot, display light and navigation information in colour. As part of the EFIS they are described under FLIGHT/NAVIGATION INSTRUMENTS. The other two units which are installed at the center panel, provide engine parameters, alert, procedures and messages in colour.

Two air data computers received information from the respective Pilot Static system, outside air temperature probe and angle-of-attack sensor. The QNH reference pressure can be set at the altimeter set panel. The inputs are converted into electrical signals which are supplied to ;

- Automatic flight control Augmentation System (AFCAS)
- Flight Management System (FMS)
- Attitude and Heading System
- Electronic Flight Instrument System (EFIS)
- Flight Warning System
- Enhanced Ground Proximity Warning System (EGPWS)
- Flight Data Recording system
- ATC Transponders

1.6.5) VOR/ DME/ ADF

Three VOR navigation systems provide directional VHF Omni directional Range (VOR) data. The Distance Measuring Equipment (DME) provides slant range distance to a DME equipped VOR/ Localizer ground station. Each system comprises a VOR/DME panel, installed at the pedestal, receivers, and an antenna. Display functions are provided by the respective Electronic Flight Instrument System (EFIS) and Radio Magnetic Indicator (RMI).

One Automatic Direction Finder (ADF) receive is installed to provide relative bearing and aural information from selected non-directional radio beacon. Bearing information is displayed at the Radio Magnetic Indicator (RMI) and Navigation Display (ND).

1.6.6) Radio Altimeter System

In the Fokker 100, there were three Radio Altimeter (RA) system operating independently of each other. The system gives the pilots accurate information about the aircraft height above terrain with radio signal transmitteds and reflected from the ground. Range of the system is from zero to 2500 fts. The primary components of the system are the transceiver, transmit antenna and receive antenna.

The RA system sends outputs to the:

- Automatic flight control system
- Flight Augmentation system
- Flight Data Recording
- Flight warning system

- Electronic Flight Instrument System (EFIS)
- Enhanced Ground Proximity Warning System (EGPWS)
- Traffic alert and Collision Avoidance System (TCAS)

1.6.7) Enhanced Ground Proximity Warning System (EGPWS)

The Fokker 100 is fitted with a Honeywell EGPWS (part no-965-0976-020-213). Ground Proximity Warning (GPW) gives the pilots visual and aural warning. When the aircraft' s flight path and position with respect to the terrain needs immediate attention from the pilots. It is only operative at the altitudes in the range of the low range altimeter, EGPWS has a computer with 7 modes of operation with automatic.

- Mode 1: excessive descent rate
- Mode 2: excessive terrain closure rate
- Mode 3: altitude loss after take-off
- Mode 4: excessive terrain closure during approach
- Mode 5: excessive descend below glide slope
- Mode 6: Altitude call-outs
- Mode 7: wind shear

See detail on (Appendix-B)

1.6.8) Aircraft Airworthiness and Maintenance

A review of the aircraft maintenance documentation showed that the aircraft (MSN-11327 and manufacture date 21 Feb 1991) received from British Midland Airways BMI on 30 Jun 2005 with aircraft total flying hours (18647:27). Certificate of Airworthiness issued by Department of Civil Aviation, Myanmar on according with Myanmar Civil Aviation Requirement (MCAR) Part-21 and renewal every year.

Line check (125 inspection), A check (A-6 inspection) Base check (C-2 inspection) performed in accordance with MCAR part M.

Review on last maintenance recorded C-2 and 6 year inspection performed at SBU Merpati Maintenance facility, Indonesia on 28 Aug 2011 at aircraft hours (25578). Last line check performed on 22 Dec 2012 and A check on

23 Nov 2012. Certificate of Airworthiness renewed on 23 July 2012. Aircraft was no accident recorded and no significant defects with engines.

1.7) Meteorological information

The Meteorology department (Ministry of transport, Heho aerodrome forecast on 25 Dec 2012 morning (Appendix-C)

Maximum Temperature 26.8° Minimum Temperature 07.0 °

Time	Tem:	Dew Tem:	Pressure	Weather	Wind	Visibility
06:30 hrs MST	08.4° C°	05.5° C°	1019.0 hpa	Fog	Calm	500 meter
09:30 hrs MST	13.4°C°	11.3° C°	1017.9 hpa	Fog	140/01	500 meter

The weather reported at Heho airport at 08:30 MST was temperature 17° C, wind calm, QNH 1018 mb, Visibility 3000m, Distinct Fog and Foggy conditions.
A witness driving on the near by road reported the condition as fogy requiring the use of vehicle head light and other flight crews from other aircraft also reported there was patchy fog in the Heho airport area.

1.8) Aid to Navigation

Heho Airport was equipped with a Non-Direction Bacon (NDB) Brand (Nautel ND 500II) for use on approach to runway 36. NDB is a radio transmitter at a known location used as an aviation navigation aid which is detected by the automatic direction finder (ADF) equipment on the aircraft.

The Heho runway was equipped only with an NDB (non-precision approach runway) with frequency of 360 KHz (Figure 6). The NDB was determined to be functioning normally. All domestic aircraft operations into Heho airport reported that there were no abnormalities with the NDB.

The runways at Heho Aerodrome were fitted with lighting systems to aid the approach and landing. A precision approach path lighting (PAPI) system was

installed for both runway 18 and runway 36. Runway 36 also had a simple approach lighting system (SSLS) installed.

1.9) Communication

Heho airport installed HF Brand (codan Dual) and VHF Brand (OTE Dual). It had two ATC VHF frequencies for approach (119.7MHZ) and tower (118.1 MHZ). There were no recording facilities for either frequency. Two way communication with aircraft and controllers should be recorded in ATC logbook.

1.10) Aerodrome information

Airport name	-	Heho Airport
Airport	-	VVHH
Type of Traffic permitted	-	IFR/VFR
Aerodrome reference point	-	N 20˙ 44' 49˙ 36"
		E 98˙ 47' 31˙ 28"
Minimum sector altitude (25)NM	-	8900 ft
Transition sector altitude	-	11000 ft
Transition level	-	Fl-125
Obstacle clear high (OCH)	-	4380 (530)ft
Runway Dimension	-	8500 x 100 ft
Elevation	-	3934 ft
Runway direction	-	18 / 36
Type of pavement	-	Asphalt concrete
Runway lighting	-	runway threshold, end and edge
Approach lighting	-	18/36 PAPI
	-	36 SALS

The Airport had an Air Traffic Control (ATC) control tower controlling Class C airspace with no radar surveillance capability.

1.11) Flight recorders

1.11.1) Flight data recorder

Myanmar Civil Aviation Requirement (MCAR), part-7 mentioned requirement FDR and CVR. The aircraft was equipped with a Honeywell solid state universal flight data recorder (SSUFDR) part no-980-41020 DXUN SSUFDR type 1, capable of recording at least the 78 parameter with 25 hours of recording time.

The SSUFDR's crash survivable memory unit (CSMU) provides for complete data recovery when subjected to the crash conditions stipulated_

- Impact shack - 3400 G, 6.5 milliseconds
- High Temperature Fire - 1100· C, 30 minutes
- Deep sea Pressure - 20,000 ft, 30days

The SSUFDR's construction was outer steel housing, insulation liner, thermal block and memory board with 9 chips. The SSUFDR was severely burnt during the post-impact fire and significantly damage by fire. SSUFDR circuit board was removed at ATSB Lab. It is required special techniques to recover the recorded information. ATSB contacted to manufacture Honeywell and with the instruction of Honeywell carefully removed each chip from circuit board and downloading. A track plot of the flight is contained in figure and recorded information from the flight is included in (Appendix-D).

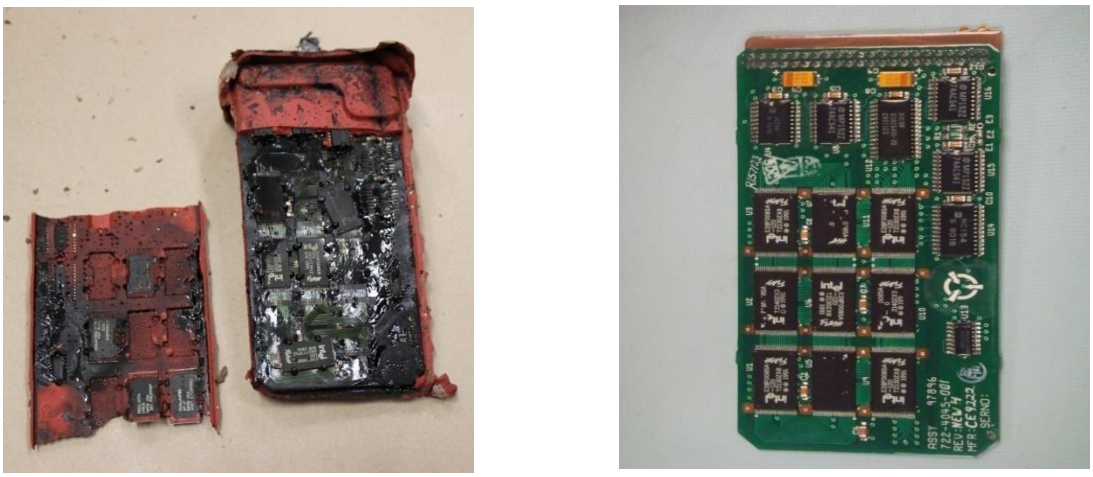


Figure 6: FDR memory module (accident module on left, normal module on right)

1.11.2) Cockpit voice recorder

The aircraft was equipped with a Honeywell solid state cockpit voice recorder part no 480-6020-001. SSCVR was recorded 4 channel allocation with minimum 30 minutes of recording time. It also a crash survivable system. For

recording the internal acoustic environment of flight deck, internal cockpit crew conversation through a cockpit area microphone, boom microphone and public address system (PA) and radio telephony communication.

The SSCVR data was downloaded at ATSB and according with the downloaded data, FO was the designated handling pilot for this flight. While approach to MDA, the PIC reported to ATC about fog layer between the aircraft and runway. During the final approach, GPWS call out alert warning sound to crews with "500" "100" "50" "40" "30". PIC initiated to "Alt Hold" at about MDA 100 ft. The CVR transcript at (Appendix-E).

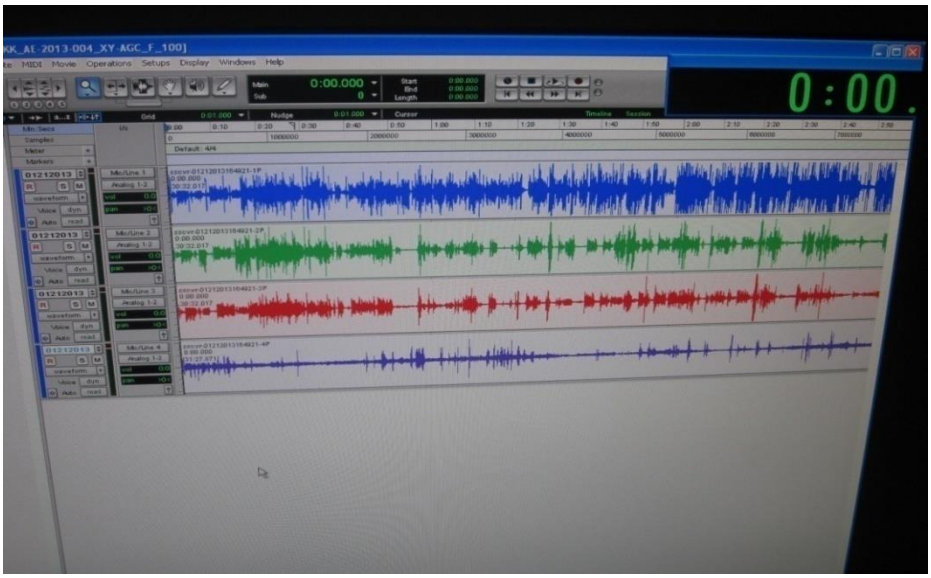


Figure 8: Cockpit Voice Recorder Downloaded

1.12) Wreckage and impact information

The accident site was located in a paddy field about 0.7 nm from the threshold of Heho runway 36 at an elevation of 3934 ft. The initial strike with 66 KV electrical power lines was about 39ft. After aircraft struck the trees located both sides of road, left wing separated and fell on the road. For that moment a motor cycle with two motorcyclists, were passing on the road and were struck with aircraft debris and burned with aircraft drainage fuel. Right wings separated before the aircraft came to rest. The main fuselage, both engines and the landing gears remained together. The tail assembly had detached but remained connected to the fuselage by the flight control cables. The aircraft was subsequently destroyed by fire.

The following components information was noted

- Both of the wings were broken off and separated from the aircraft fuselage .
- The landing gears was fully extended (down and locked).
- Flap position was fully extended (42°).
- Both forward doors were opened, the forward cabin left door slide activated and deployed. The service door slide on the right side was not deployed .
- Left side over wing exits were opened but right side over wing exists remained closed.
- Both engines were in tacted with fuselage and compressors can be freely rotated.
- All the instruments and avionics compartment were burnt .
- SSCVR was collected along the wreckage trail but SSFDR was collected at crash site after post-impact fire .
- The aircraft structure was totally destroyed by the post-impact fire .

1.13) Medical and pathological information

6 crews and 64 passengers survived at the crash site. 11 victims of survivors were send to local hospital with local transportation facilities for urgent medical treatment and the remaining were medically checked. One local passenger received near left over-wing emergency exit with fatal burned and one motor cyclist on the road was fatally injured. The test results of both pilots for drugs and alcohol were negative.

Within the limitations imposed on the samples because of their conditions, there was no evidence of in-flight incapacitation of crews or passengers from either toxic fumes of fire.

On that evening two foreigners were transferred to Bangkok hospital and 7 passengers and one cyclist were transferred to Yangon General Hospital for special medical treatment. Transportation were arranged by airlines. They had suffered back pain, head injury, both hand and leg injury and body burned.

1.14) Fire

Both of the wings were broken off by the trees and the aircraft fuel tanks were disrupted during the impact sequence. The aircraft fire was initiated by electrical arcing and / or ignition of the residual fuel. There was no evidence of an in-flight fire (Figure 9).

Figure 9: Fire Fighting

1.15) Survival aspects

The cabin crew initiated an emergency evacuation as soon as the aircraft came to rest. The Fokker 100 aircraft has 8 emergency exits, 2 at the front of the cabin, 4 over wing exits and 2 sliding windows for the flight crew in the cockpit. Both forward doors, 2 over wing exits on the left side and 1 flight crew window on the right side were opened and used. The 2 right side over wing exits remained closed due to the presence of fire.

The forward cabin door left door slide activated and deployed but the cabin crew deactivated the service door slide on the right side, due to the close proximity of the ground and so it was not deployed (Figure 10).

Figure 10: Forward cabin door (right side).

Heho airport had an aircraft rescue and fire-fighting vehicle. That vehicle deployed to the scene immediately but had difficulty accessing the site due to the location being off the airport and surrounding trees and debris as a result of the accident. The vehicle arrived at the scene within 10 minutes and was assisted by 9 local fire vehicles.

Local authority, police, military and citizens provided care and assistance to the injured persons until they could be taken to the regional hospital. Among the injured persons, 2 passengers were transferred to Bangkok in Thailand and 8 passengers were transferred to Yangon, Myanmar the same day. The air transport was arranged by the airline.

1.16) Test and Research

1.16.1) Vertical Flight Path analyses Heho

FDR and CVR data showed the accident flight path to Heho airport. The layout of Heho airport was examined and geographic features was used to plots flight path. (Appendix-D)

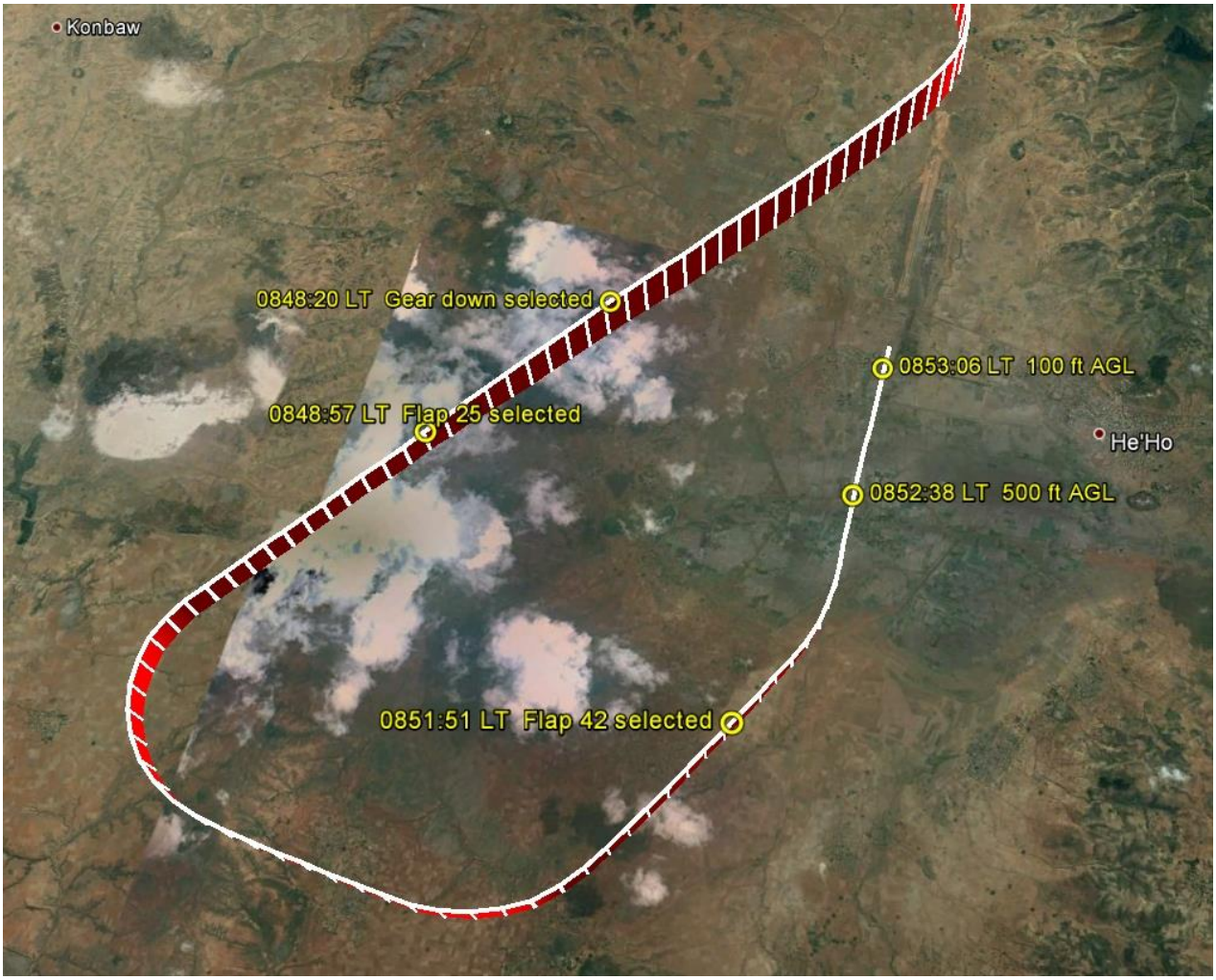


Figure 11: Vertical flight path Heho

Runway 36 Threshold was determined to be used the recalculated positional data the range distance from the Threshold position was calculated with the Haversine formula.

$$\Delta\text{lat} = \text{lat}_2 - \text{lat}_1$$

$$\Delta\text{long} = \text{long}_2 - \text{long}_1$$

$$a = \sin^2(\Delta\text{lat}/2) + \cos(\text{lat}_1).\cos(\text{lat}_2).\sin^2(\Delta\text{long}/2)$$

$$c = 2a\tan 2[\sqrt{a}, \sqrt{(1-a)}]$$

then

$$d = Rc.$$

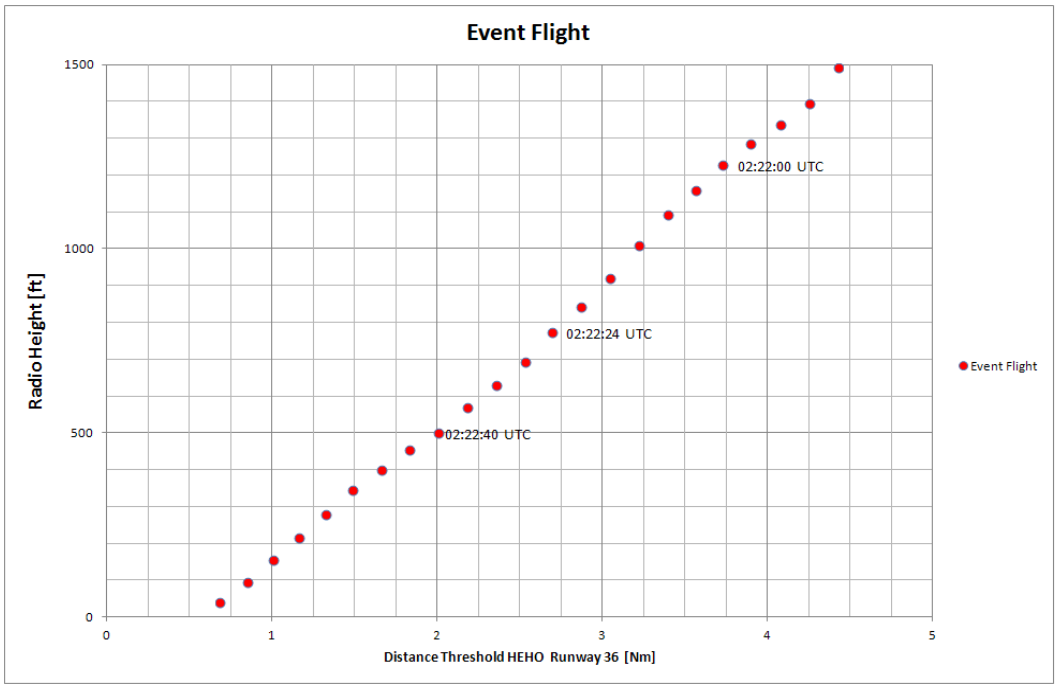


Figure 12: Distance Threshold Event Flight (*FMS latitude and longitude corrected).*

1.16.2) Air Bagan Ltd. stabilized approach procedure

All flights must be stabilized by 1000 feet above airport elevation in instrument meteorological conditions (IMC) and by 500 ft above airport elevation in visual meteorological conditions. Air Bagan Ltd. Standard Operating Manual paragraph 12.0 on page 5 stated that:

Stabilized Approaches

Organize the descent profile so that from 3000 ft AGL the aircraft can easily start configuration for approach. By 1500 ft AGL the aircraft must be in a stable situation at or ready to configure in the final landing configuration.
From 1000 ft AGL on descent: (Appendix-F)

- the aircraft must be stabilized with landing flaps selected and speed within 5 kts of the approach speed or target speed appropriate to the conditions,
- thrust must be above approach idle (spun 2 up), and
- maximum descent rate of 1000 fpm. In normal operations a go-around must be initiated if the aircraft is not stabilized on the

approach slope ,in the landing configuration at the nominated approach speed or has a descent rate of more than 1000 fpm by 500 ft AGL.

1.17) Organization and management information

1.17.1) The Operator Air Bagan

Air Bagan was found do 4 Nov 2004. It has an Aircraft Operator Certificate number 001/206/ (issue 005) 1 Nov 2012. Following Myanmar Civil Aviation Requirement part 1, part 7 and part 8. Air Bagan has deposited standard operation procedure and Fokker 100 flight operation manual approved by Department of Civil Aviation, Myanmar. The last authority audit was performed in 24-26 Nov 2012 for operation in Myanmar.

The fleet is composed of 2 Fokker-100, 2 ATR-72-500/200, 2 ATR-42-320, 38 pilots are authorized to perform public transport operations. The company is organized as follow. (Appendix-F)

- Managing Director
- Deputy Managing Directors
- Directors (Flight operation, Engineering, Human resources and admin, Finance and account, commercial)
- Manager (training, Quality Assurance, Airline safety, Airline security)

The company operation manual includes operational information, regulation information and instructions in orders to carry out flight operations and ensure supervision of the services with trained personnel and adequate means.

1.17.2) Aircraft Systems of Company Policy

Air Bagan standard operating procedure (F-100) paragraph 5.2 on page 3 stated that:

Enhanced Ground Proximity Warning System

Installation for each aircraft system is described in detail in the aircraft operating manuals. All pilot must fully understand the Enhanced Ground Proximity Warning System (EGPWS) equipment installed and follow the correct procedures if a warning or alert is activated.

Ground Proximity Warning System Activation

Pilot must respond positively, to all EGPWS activations. During daylight in VMC, with terrain and obstacles clearly in sight, the alert may be considered cautionary. Take positive corrective action until the alert ceases or a safe trajectory is ensured. Perform the appropriate EGPWS warning or alert procedure at all other times and climb the aircraft to the LSALT when en route or to the MDA when in the terminal area.

The aircraft was equipped with an approved Honeywell Mark V EGPWS. The EGPWS provided aural altitude alert and warning sound to the flight crew radio altimetry from the radio altimeter.

At 0852:49, EGPWS "500 ft' call out sound occurred at MDA, the flight crews did not notice to altitude hold and the PF continued the approach with minimum weather condition.

Although the weather condition was minimum, the captain did not attempt to take control of the aircraft from the first officer and follow the procedure of non-precision NDB approach.

Air Bagan Simulator Training Policy

The Air Bagan Fokker-100 simulator training did not include training or proficiency checks in the vital action and responses to be taken in the event of GPWS or EGPWS alert and warning that should be included for the safety of the flight .

Landing Minima of Descent Procedure

The Air Bagan Standard Operating Manual States the following:

CAUTION

Publish minimum descent altitude (MDA) do not include any allowance for height loss in a missed from a runway-aligned approach. Pilots must initiate a missed approach sufficiently early to ensure that the aircraft does not descend below the published MDA. (Appendix -H)

When the ceiling height is 500 ft and /or below and visibility is 3000 m and below pilot must not fly Auto Pilot.

1.17.3) Regulatory information

Department of Civil Aviation published the Aeronautical Information Publication (AIP, Myanmar) date 1 Jan 2011 for Heho airport instrument approach chart.

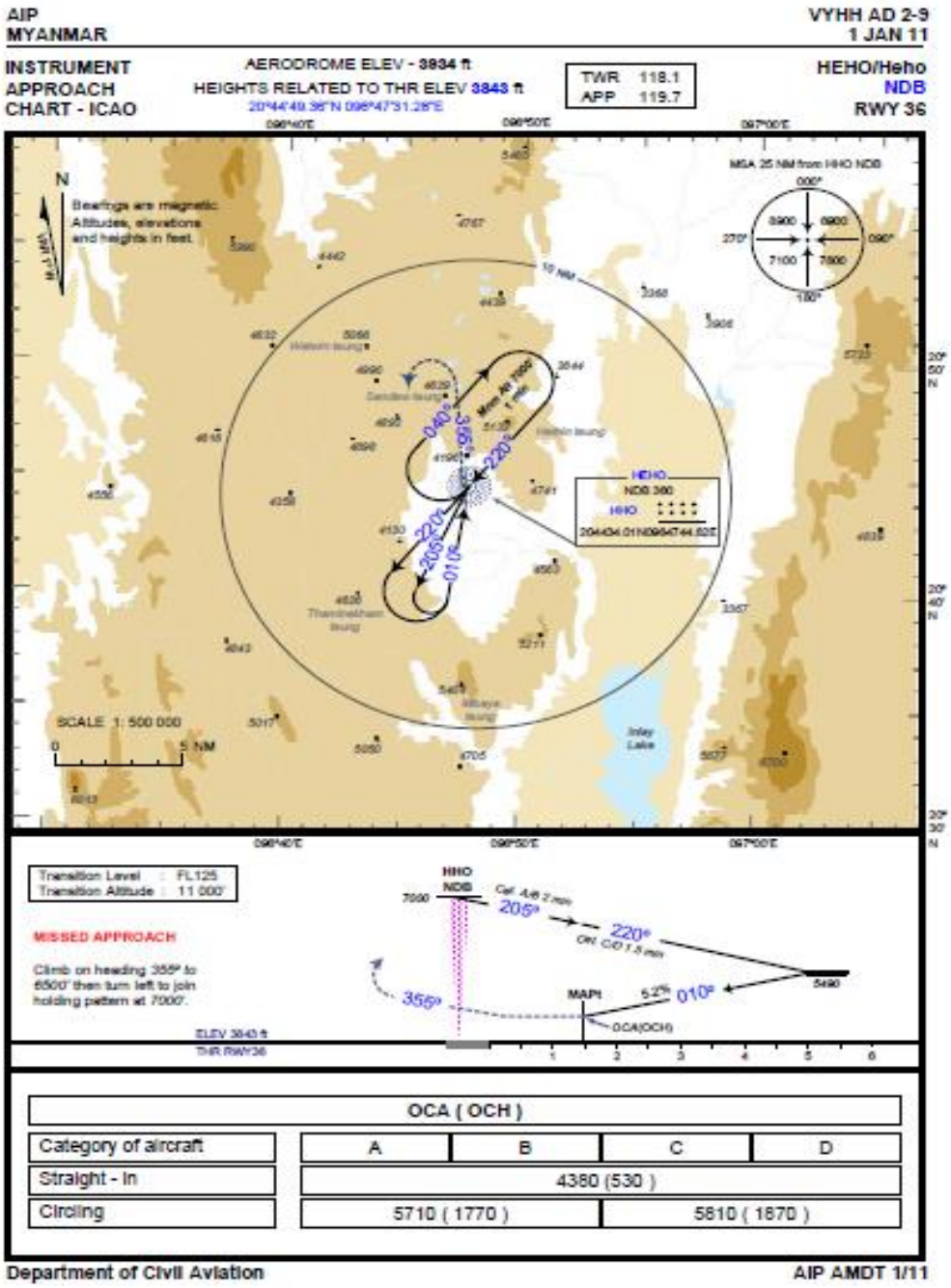


Figure 13: Instrument approach chart

1.18) Additional information

1.18.1) Testimony of the pilot in command

The pilot in command explains that at about 0826 local time contract to Heho ATC for weather information and the aircraft departed from Mandalay International airport to Heho airport with 6 crews and 65 passengers on board. For this flight FO was PF. At approximately 40 NM, permission to ATC for descending and approaching to 9000ft and approximately 10miles to the airfield, found field insight. At that time he did not noticed terms feature at the last moment the terrain feature on EGPWS.

At the approach site of RW 36, he saw some cloud and decided Non-precision approach. Overhead NDB let down and called again field insight. At 7000 ft, intercept out bound 220° track and descended to 6000 ft and landing gear down, lift dumper arm and set flap 25° and intercept inbound track 010 degrees.
As for airfield insight visually, PF instructed to select landing flap 42°. There was some cloud between runway and aircraft, while PF monitored the instruments in head-down condition aircraft passing in the cloud. The Pilot in Command instructed PF for "Alt hold" as the same time call out EGPWS "100". The Pilot in Command pushed altitude knob to get level flying at Minimum Descent Altitude MDA and intended to disconnect auto-pilot and manual go around. But he felt abnormal sounds and impact. As soon as aircraft stopped, instructed FO to do emergency evacuation check list and open side window and get out. Then he contacted to passengers and assist the evacuation.

1.18.2) Testimony of the First Officer

The Co-pilot explained that, for Mandalay- Heho flight he was pilot flying. At 08:10 he requested Heho weather and prepare for this flight (Quick aligned the IRS, LDG ALT set to destination elevation, fill in flight documents FMS set up). He filled in FMS the ZFW,CG block fuel, TO weight, V speed, TO runway and thrust, altitudes, TRP). Aircraft take off from RW 35° and climbed to FL-130 and RT change over to Heho and contact Heho latest weather. At 45 NM to Heho, as per publish AIP chart (TOD 30 NM, Elevation set, MDA set to 4380 ft, FMS, LDT, WT check and Approach speed, FMS FLT) plan to NDB approach. ATC approval to 7000 ft and overhead out bound 220 track and descend to 6000

ft. Then turn in bound track 010° and initiate descend to MDA with initial vertical speed 1000 ft per min. At 6 NM, runway was in sighted and radio altimeter was showing 1800 ft. At 5 NM aligned with runway and flap down 42° and approach speed 139 knots. At about 4 NM, reduce vertical speed to 700 ft per min and passing the cloud. At 3 NM pressing the alt hold button and call out EGPWS 100 ft. Suddenly he heard noise and impact, captain tried to take over control of aircraft, but after a few seconds the aircraft has touched the ground and stopped. He initated the ground emergency evacuation procedure and callout "May Day" and let the passengers evacuated outside of aircraft. Then he got out from the cockpit, and contacted passengers in the cabin with the captain.

1.18.3) Testimony of the cabin crew

Cabin crew explains that she was assigned rear cabin station on that route she sensed the aircraft normal approached to runway, but at final approach she heard loud noise and aircraft impacted some where. At that moment some window glass broken and aircraft fire started. As soon as aircraft stopped, she instructed the passengers to go forward and bend down. Front cabin crews opened service doors call out passengers with bend down position and evacuate one at a time to prevent blockage.

Some passengers opened left over wing exits and jump down out side while cabin crews open front cabin doors. She callout all the passengers and got out at the last moment while cabin was flame and smoke. Cabin crews, local authorities, Military, Polices and local organization assisted the survivors and take care medical treatment.

1.18.4) Testimony of the witness

One passenger explains that she sit the fifth last row aisle side seat and beside her a passenger (who was fatally injured) sat at window side. Weather condition was upper sky clear but lower fogy. As soon as aircraft impacted into ground, smoke came out and she was alerted by her neighbor to get out immediately. She jump down from open emergency exit and go away with the help of some foreign passengers.

1.18.5) Testimony of the witness

One foreign passenger explains that, aircraft left turn circuit and reduced speed with normal approaching to runway. At final approach he noticed there was fogy and landing height too low. Aircraft struck with trees and impacted with ground, Crew callout brace warning and as soon as aircraft stopped, he bend down and got out from opened front door. Outside local authority and people assisted the survivors.

1.18.6) Testimony of the Witness

A witness driving near by road reported that there was fogy in the runway area and requirement to use car head light. A pilot from other aircraft which following up to approach to Heho Airport state that there was foggy in the area. The motorcyclist explained that while driving on the road near by runway, un-expected of branches of tree, aircraft debris and fuel fall down and burned with spark.

2. ANALYSIS

2.1) Introduction

The analysis will discuss the relevant issues resulting in the controlled flight into terrain (CFIT) involving a Fokker F100-28, registered XY-AGC during the approach to Heho airport, Myanmar on 25 December 2012. The investigation determined that there were no issues with the aircraft and that all systems were operating normally. The analysis with there fore focus on the following issues:

- Crew response to the weather conditions
- Situational awareness
- Conduct of the approach

2.2) Crew response to the weather conditions

During the approach to Heho airport, there were foggy conditions reported in the Heho area, including low fog on the approach to runway 36. As the aircraft descended on the approach, the crew briefed for a possible go-around. However,

during the final approach, the aircraft passed through the MDA and the crew continued the approach in reducing visibility conditions. Due to the low fog, it is likely that the crew were not aware of the tress, power lines and other obstacles short of the runway.

2.3 Situational awareness

Situation awareness (SA) is defined as the Pilot's "perception of elements in the environment within a volume of time and space, the comprehension of their meaning , and the projection of their status in the near future" (Endsley, 1995, P 36)

During the approach to Heho, the crew briefed for a possible go-around, which is normally action when the aircraft reaches the MDA and the crew decide to continue, based on remaining visual with the runway or, if not visual, conduct a go-around. The MDA at Heho was 530ft.

While on final approach at an altitude of 660 ft, the pilot flying called "I visual", however there was no similar call when the aircraft reached the MDA at 530 ft. At 500ft, the EGPWS aural alert sounded"500" with no response from either crew member. The approach was continued without any crew call out on the visual conditions at the time until. at 02:23:04, at eight of just above 100 ft, the PIC called "Not OK, indicated that the crew were previously satisfied that the crew likely maintained some visibility of the runway or the runway environment. However, by not calling out the standard MDA call at 530 ft, the crew missed an opportunity to ensure that the approach was still within all normal parameters at a point where they could execute a successful go-around.

In addition, the aircraft EGPWS aural alert announced callout heights of "100","50", "40", "30". These callouts are standard alerts to provide height cues to the crew during the flare and landing and are not used for terrain avoidance. Despite the EGPWS callouts, there were no further actions taken by the crew apart from activating the Alt Hold function at a height that was too low to prevent terrain collision.

2.4 Conduct of the approach

Prior to the top of descent, the crew conducted a briefing indicating that they would conduct either an NDB or visual approach to runway 36. The NDB approach would require the aircraft to track overhead the Heho NDB and turn right onto an outbound heading of 220 degrees. This would be followed by a left turn onto 010 degrees to align with the runway heading during the descent.

However, the crew conducted the initial right turn onto 220 degrees prior to the aircraft passing overhead the Heho NDB. This resulted in the aircraft being further to the west on the outbound leg and at the commencement of the left turn. The aircraft tracked outbound for 2 minutes (similar to the NDB approach) and was then turned to a heading 010 degrees for about 50 seconds and then to 030 degrees to intercept the final runway heading. This amended approach procedure indicated that the crew were not following the NDB approach and were likely visual with the runway environment at the time. At about the time of the final left turn onto the runway heading, there were a series of radio transmissions to and from the Captain, including one that indicated "runway in sight" and that there was "low cloud between the aircraft and the runway". The remaining transmissions were in Myanmar Language.

Soon after, the aircraft passed the published MDA for the approach of 530 ft with no acknowledgement or visibility discussion from the crew. The EGPWS alert then called "500" with a short crew discussion about runway alignment. Between 500 ft and 100 ft, there were no action for missed approach except Captains comment "Not OK, Alt Hold".

The Air Bagan Standard Operating Procedures (SOP) for a non-precision approach were clear in their guidance in regard to calling "visual" at the MDA of and approach and that if the aircraft entered IMC after passing the MDA, the crew were to conduct a go-around.

It is apparent that from the recorded evidence that the crew did not follow the requirements of the Air Bagan SOP's and Heho NDB letdown procedure during the approach to Heho.

2.5 Other Potential technical problems consider by investigation

There was no indication that the altimeter were not functioning correctly prior to the accident. The barometric scale on the left altimeter was to the appropriate QNH, computed air speed and pressure altitude were normal function weight and balance were within allowable limit.

According to the CVR Transcript, R/A call out (500, 100, 50, 40, 30) aural activated and Terrain Clearance Floor (TCF) alert warning are not activated. Fokker 70/ 100, AMM 0100 Manual chapters-34,43,00 ZZ 2-810-E, Page-4 (Terrain Clearance Floor and Runway Field Clearance Floor) and Page-9 (Figure-34- 43 – 00 – 990- 040- E00, EGPWS Terrain Awareness Alerting) describe that, when the aircraft goes through a limit (boundary) of the alert envelope, the GPWS warning lights come on, the aural warning "TOO LOW TERRAIN" is given. In regard of the FDR results the aircraft was above the limit of the alert envelope before collision.

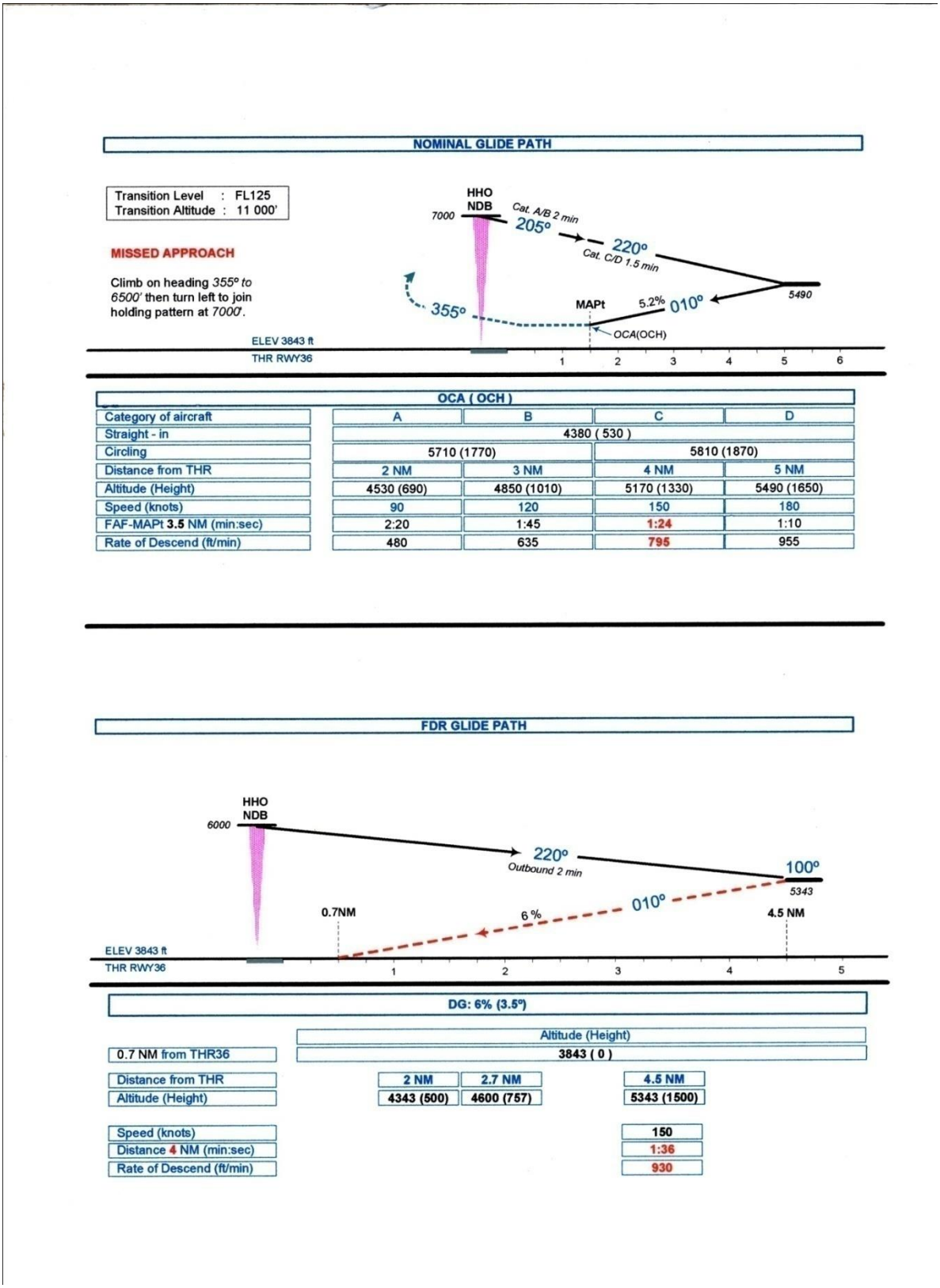


Figure 14: Normal Flight path & FDR Flight path

Potential Analyze

The investigation considered a range of different scenarios to explain why a descent below the required flight profile was conducted-

a) A potential scenario is that the crew were attempting to descend the aircraft through a layer in the fog, but lost visual contact with the ground and continued descending in IMC.

b) A second potential scenario is that the crew were attempting to conduct a constant angle descent procedures, but lost awareness about their position along the approach.

c) A third potential scenario is RT confusion of communication, there were other aircraft approaching to RW 36 and the Captain was distracted by communications with them just prior to the aircraft reaching the MDA.

d) A fourth potential scenario was considered where by the crew attempted to descend to the MDA as early as possible in order to increase their chance of getting below cloud base and obtaining visual contact with the ground.

Summary

The above scenarios are potential reasons for the crew continuing the approach in conditions of deteriorating visibility. Apart from the possible distraction as a result of external communications at a critical point of the approach, the investigation considered that the crew continued the approach without positively identifying the aircraft's descent path with reference to the runway environment. The approach was continued below the MDA in deteriorating visibility and likely in IMC, which was contrary to the Air Bagan Standard Operating Procedures (SOP) and Heho NDB letdown procedure.

2.6 Local condition

Crew workload

It is likely that the crew were experiencing a high workload during the approach, such as configuring the aircraft , making radio broadcasts, and conducting check lists have been influenced by some factors.

- During the approach possible distraction of RT communications.
- There was thick fog layer in low altitude between final approach path and runway.
- Possible under pressure by following aircrafts to Heho airport.

Crew resource management conditions

Operating a multi-crew aircraft, particularly in high workload situations, requires the two pilots to work in a coordinated manner and effectively communication with each other, a loss of cross-checking and detection of errors some factors that influenced the potential for CRM-

- Crews need cooperation in CRM skill during final approach.
- FO had less experience and pilot in command had not effectively address with the FO any detected problem with aircraft position, rate of descent.

2.7 Risk Control

Several risk controls were identified as being safety factors-

Pilot training

- The available evidence indicates that, the crews need to provide more training require in the operational aspects of using the EGPWS or CFIT prevention also process for monitory the effectiveness of supervisory pilots.

Standard Operating Procedures

Air Bagan SOP specified for FO handling in landing. When airport weather conditions are less than 500ft ceiling and/ or 3000 m visibility, the captain must fly an instrument approach and the first officers must perform the PNF role. The Pilot in command must carefully assess the FO to perform the landing in view of (ambient conditions, serviceability of aircraft of aircraft, FO capability and experience, PIC's capacity to monitor and take over control of the aircraft if

necessary). When FO is permitted to perform a landing the PIC must always be in a position to take over control of the aircraft.

Aircraft must not continue an approach below the specified decision height or MDA unless the specified visual reference is established and maintained from the height. (Appendix-H)

If conducting a runway instrument approach to an MDA below the Circling minima, initiate a missed approach immediately, if the crew cannot establish visual contact on reaching the MDA. Tracing during the missed approach must be from the missed approach point and in accordance with the missed approach procedure. (Appendix - F)

However, FO was performing as PF to the last moment and the crews initiate "ALT HOLD" after passing the missed approach point and before R/A 100 ft callout.

EGPWS alerts and warning

EGPWS has 7 modes of operations. Mode .1 inadvertent altitude loss and Mode.6 descent through decision height. When pilots expect a EGPWS annunciation, they could consider them to be nuisance alerts and warning that they can then ignore while continuing the approach. However, crews were unawareness EGPWS 500 call out.

Auto Pilot

An autopilot can significantly reduce crew work load during cruise and descent phases of flight. However for an Auto pilot to be useful during a non-precision instrument approach. AT 1 and AT 2 were engaged according FDR data.

2.8 Organizational influences (Air Bagan)

Organization structure of Air Bagan is Managing Director, Director Flight operation, Director Maintenance, Manager Flight operation, Manager Airline safety,

Manager Airline security, Manager Ground operation, Manager Quality Assurance Manger Training.

Flight operation Director is responsibility to ensure full recognition to the need for safe and efficient operation. Flight operation Manager is to establish minimum flight altitude to ensure that operations are only conducted along to such routes and Chief Pilot (Fokker-100) conducted the fleet-specific procedures and regulations where necessary and check the profession standard and development of his personal and prescribe additional training, exchange of information and experience within his feet and to assist FO Manager in determining minimum flight altitudes for individual aerodromes etc. However Air Bagan need to efficiently implement SMS and implementing of flight data analyses programmes.

2.9 Organizational influences (DCA)

An Air Operator's certificate (AOC) holder had a clearly defined responsibility under the Myanmar Civil Aviation Requirement (MCAR) to ensure the safety of its operations. The regulator (DCA) also had defined responsibilities for over sighting the activities of an AOC holder as well as conducting surveillance the activities. Myanmar Civil Aviation Requirement ,Part -8 (8. 5. 1. 24) and Air Operator Certification Manual (4. 4. 8) mention about the FDR analysis programmes.

The last authority audit was performed in 24-26 Nov 2012 for operation in Myanmar. However , DCA need to ensure the Air Bagan's implementation of FDR analyses programmes.

3 CONCLUSIONS

3.1 Findings

- There are no indications of flight control and engines problems, potential for pilot incapacitation and a fire on board aircraft before the crash.
- The crews are completed related training and medical status class1.
- The PIC and FO proficiency checks, and instrument checks are valid.

- The limits on crew duty time were complied with.
- The flight crews had been working together for eight days prior to the day of accident and no tension between them.
- The CVR and FDR data could be analyzed .
- The FDR, CVR data, there are no indication of a fault in the navigation and communication equipments.
- The aircraft EGPWS system was operated normal function.
- Heho airport NDB was functioning normally.
- There were two aircrafts behind (one on 13 miles to Heho and one on overhead).
- During the final approach, the aircraft descended below the nominal flight profile for the aircraft's position on the approach.
- The crews lost situational awareness of the aircraft's position along the final approach.
- The crew probably experienced a high work-load during the approach and possible distraction as a result of RT communications.
- Crews need more practice in multi crews operations and CRM skill.
- PIC need to risk assess FO for landing in view of ambient conditions, serviceability of aircraft, FO capability and experience.
- The crews did not follow the Air Bagan SOP at MDA and need for the effectiveness of supervisory of PIC.
- There would have been insufficient time for the crews to effectively respond to the R/A call out in final 5 seconds prior to impact.
- Air Bagan need to efficiently implement SMS and flight data analyses programmes.
- DCA need to ensure the Air Bagan's implementation of FDR data analyses programme.

3.2 Primary Cause

- During the final approach, the aircraft descended below the MDA and the crew did not follow the operator SOP's.

- The pilots had no corrective action against to change VMC to IMC during bad weather condition and insufficient time for effective respond to last moment.

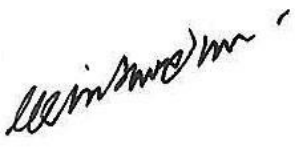
3.3 Secondary Cause

- Captain of the aircraft had insufficient assessment on the risk that assigned the FO as PF.
- There may be under pressure by the following aircrafts as the first plane on that day to Heho.

4 SAFETY RECOMMENDATION

To reduce and eliminate of accidents and serious incidents, MAIB recommended following recommendation -

- Department of Civil Aviation ensure the Air Operator's implementation of FDR analyses Programmes.
- Air Bagan operation ensure the qualitative requirements of operational personal with non-precision NDB approach training with IMC, awareness of MDA, and EGPWS alert.
- Air Bagan operation ensure to access multi-crew operation of CRM training, supervision of captain and the risk FO to perform the PF.



Investigator- in-Charge