FINAL INVESTIGATION REPORT ON ACCIDENT TO M/S CHIMES AVIATION ACADEMY PVT LTD. CESSNA-172 VT-CAI IN BARGI DAM, JABALPUR ON 06.04.2009.

1.	Aircraft		
		Type	Cessna-172
		Nationality	Indian
		Registration	VT-CAI
2	Owner/Operator		Chimes Aviation Academy Pvt. Ltd
3	Pilot – in –Command		Student Pilot
		SPL No	CAA/D/133
		Extent of injuries	Fatal
4	Co-Pilot		N/A
		CPL No	N/A
		Extent of injuries	N/A
5	No. of Passengers on board		Nil
	Extent of Injuries		N/A
6	Last point of Departure		Dhana Airstrip
7	Intended landing place		Dhana Airstrip
8	Type of operation		Solo Cross-country flight
9	Place of Accident		Bargi Dam, Jabalpur 22deg 50'N 79deg 58'E
10	Date & Time of Accident		06/04/2009; 1100 UTC Approx

ALL TIMINGS IN THE REPORT ARE IN UTC

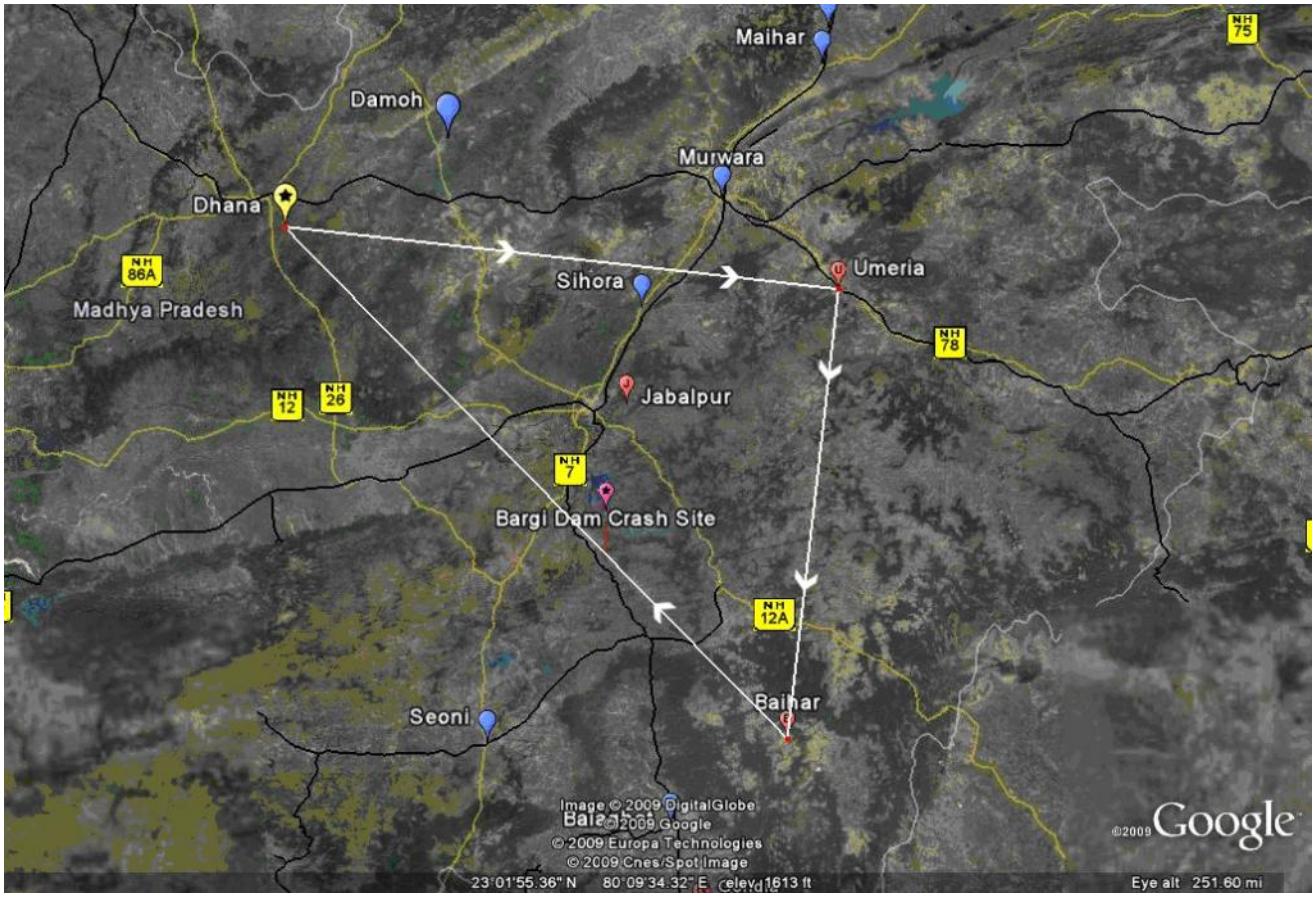
SUMMARY

Cessna 172R, VT-CAI aircraft was owned and operated by M/s Chimes Aviation Academy, Dhana, Sagar MP. The aircraft was used for flying training purpose for PPL and CPL courses for VFR operations only. On 06th April 2009 the aircraft VT-CAI took off at 0815 UTC for the non stop cross-country flying on the sector Dhana – Umeria – Baihar-Dhana. The student pilot during his last leg went to the right of his track approximately 10 KM over the Bargi dam. He approached the water body from 090 (easterly) direction and made a low pass. Thereafter he again approach at the same location were the local fishermen were available and just went into the water. The local fisher men immediately put a buoy in water for identifying the location of crash and informed the district administration. The district administration made an attempt to recover the aircraft through navy divers but failed however the parents continued the search with private divers/villagers and got the aircraft wreckage with body on 29/05/2009. The aircraft got damaged with engine hanging and propeller facing down. The body was recovered by cutting open the fuselage.

1. FACTUAL INFORMATION.

1.1 History of flight

The aircraft C-172, VT-CAI was flown by another student after daily inspection on 6th April 2009 for cross country on the same route. These sortie was for 4 hrs and he did not report any snag after completion of flight. The aircraft was again refueled with 100 liters and with total fuel of 200 liters on board it was released again after pre-flight. The student pilot involved in accident was duly authorized for a solo VFR cross-country flight on 6th April 2009, as a part of his flying training for CPL. The cross-country route was Dhana - over fly Umeria - over fly Baihar - Dhana. Distance & Track Dhana - Umeria was 097˚ / 108 nm FL 075, Umeria - Baihar was 187˚ / 86 nm FL 085, Baihar - Dhana was 316˚ / 138 nm FL 085, Total distance 332 nm. A Flight Plan was filed with Mumbai FIC and FIC number and ADC number were obtained.



THE PLANNED CROSS COUNTRY FLIGHT ON MAP

Aircraft Cessna 172, VT-CAI was allocated to the student for the solo flight. The pre-flight inspection was duly carried out by the AME. He took off at 0815 UTC with the endurance of 6 hrs, reported over Umeria at 0925 UTC and over Baihar at 1020 UTC. Last radio contact with the other aircraft was at 1050 UTC when he reported 85 nm inbound to Dhana from Baihar. His ETA Dhana was 1150 UTC. After 1050 UTC a number of rad io calls were made by Dhana ATC and other airborne aircraft but radio contact was not established with the aircraft. Overdue action was initiated at 1150 UTC. At about 1215 UTC information was received from Gon dia ATC through District authorities of Jabalp ur/Seoni about an aircraft crash at Bargi Dam located South of Jabalpur.

1.2 **Injuries to persons.**

INJURIES	CREW	PASSENGERS	OTHERS
FATAL	One	Nil	Nil
SERIOUS	Nil	Nil	Nil
MINOR	Nil	Nil	Nil

1.3 **Damage to aircraft.**

Maximum damage was observed on the forward fuselage section and engine bay.

The aircraft was substantially damaged in the crash.

1.4 **Other damage:**

There was no consequential damage to the movable/immovable property and to human life adjoining the crash site in the Bargi Dam, Jabalpur due to crash.

1.5 **Personnel information:**

1.5.1 **Pilot – in – Command:**

Age:	19 yrs approx
Licence:	CAA/D/113
Date of Issue:	22/08/2008
Valid up to:	21/08/2013
Category:	Student Pilot
Endorsements as PIC:	Cessna-172
Date of last Med. Exam:	Class-1 24/03/2009 at AMTC, AF, Hindon.
Med. Exam valid up to:	23/03/2010
FRTO License No:	3484

Date of issue:	16/09/2008
Valid up to:	15/09/2018
Total flying experience:	103:45 Hrs (on the date of accident)
Experience as PIC on type:	55:50 Hrs
Total flying experience during last 90 days:	54:05 Hrs.
Total flying experience during last 30 days:	37:00 Hrs.
Total flying experience during last 07 Days:	13:20 Hrs.
Total flying experience during last 24 Hours:	Nil

1.6 Aircraft information:

The Airplane is high wing monoplanes of all metal semi-monocoque construction, equipped with fixed tubular spring steel main gear struts and a steer-able nose gear in tricycle configuration. The nose gear has an air/oil fluid shock strut. Cabin has a four place seating arrangement with all up weight (AUW) 1111.3 kg. This aircraft is powered by four cylinder horizontally opposed, air – cooled normally aspirated Lycoming IO-360 - L2A engine with power output 160 BHP at 2400 RPM driving a McCauley fix pitch all metal Propeller. Engine operates with AV GAS 100 LL / 100 and the Total fuel capacity 211liters (56 U.S.G) and total usable 200 liters (53 U.S. Gal). Wings are of all metal, strut – braced, semi-monocoque construction, utilizing two spars and full- cantilever, all metal tail group consists of a vertical stabilizer and rudder, and a horizontal stabilizer and elevators.

Navigation equipments on board VT- CAI:-

1.	Automatic Direction finder (ADF)	BENDIX – KR 87
2.	Instruments landing system (ILS)	
	a. Localizer Receiver	GARMIN – GMA 1347
	b. Glide Path Receiver	GARMIN - GMA 1347
	c. VOR Receiver	

3.	Marker Receiver	GARMIN – GMA1347
4.	ATC Transponder Mode C	GARMIN – GTX 33
5.	GPS Receiver	GARMIN – GIA 63
6.	ELT	ARTEX ME 406

The following communication equipments (a) installed on CESSNA 172R , VT- CAI:-

1. Communication set 1	GARMIN	GIA 63
2. Communication set 2	GARMIN	GIA 63

1.7 **Meteorological information:**

Chimes Aviation Academy has a Weather Station installed at its premises which gives the wind velocity, QNH, Relative Humidity, rainfall and temperature. In addition Dhana ATC gets regular weather updates from IMD website and from neighboring airports through telephone. Local weather at Dhana on 6th April 2009 is given below:-

a) **0630 UTC:** 310˚ 08Kts, Vis 6 Kms Partly Cloudy

b) **0930 UTC:** 330˚ 10-15Kts, Vis 6 Kms Partly Cloudy

c) **1130 UTC:** 350˚ 10Kts, Vis 6 Kms Partly Cloudy

1.8 **Aids to navigation:**

Students prepare a map and flight log for the cross – country flight which is checked by their flight instructor before the flight. The aircraft Cessna-172 VT-CAI is equipped with Garmin-1000 GPS system which is capable of giving 3-dimensional aircraft position in relation to the ground from any number of way points on a moving map display. Garmin-1000 also gives TAS, Ground Speed, Heading required to be flown to maintain the desired track, EET & ETA to a way point.

1.9 **Communications:**

Dhana ATC is equipped with licensed VHF radio station with elevated antenna and normal radio range at flight level 075 is about 100 nm. En route aerodrome Jabalpur was off the air.

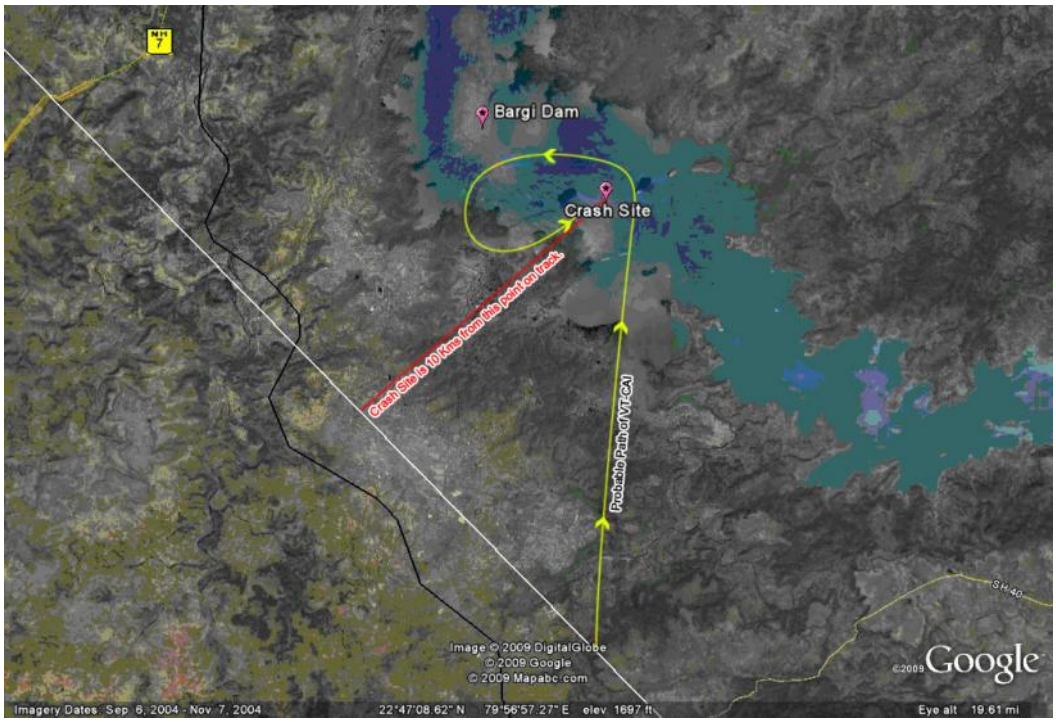
1.10 **Aerodrome information:**

Dhana aerodrome information is given below:-

a.	Runway Orientation	35/17
b.	Length	3000 ft
c.	Width	70 ft
d.	Elevation	1709 ft
e.	ARP	N 23˚45, E 78˚ 51
f.	Airspace	5 nm radius from the aerodrome- Unrestricted; beyond that after submission of Flight Plan to Mumbai FIC
g.	ATC Tower facilities	ATC tower with VHF radio manned by Chimes ATC Officer

1.10 **Wreckage and impact information:**

The aircraft was on the last leg of the cross country flying from Baihar to Dhana and was flying on heading 316˚/ 138 nm at FL 085. The aircraft approached from temple side to the huge water body of Bargi dam opposite to Gadaghat village. Then again he approached from same temple side second time on the approx heading of 280° at this time the aircraft was precariously low, it touched the water and went inside immediately with big bang and splash.



The fishermen tried to hook some rope to the aircraft but it happened so sudden that they could only manage to keep a buoy as a marker for the rescue and to retrieve the wreckage. The instrument reading cannot be relied upon as it has entered in water and hence will show higher than actual. The aircraft came at very high speed and touched the water and tipped over and entered in water. The student pilot tried to escape but was not able to exit from the aircraft. The door remained closed and the body was found at the rear with top torso hanging behind rear seat back rest. The propeller blades had curled in due to impact of water however it was not that severe because the power configuration was of cruise phase. Due to impact the all the top mountings have broken and the engine was hanging on the lower attachments.

COMPLETELY DAMAGED AIRFRAME AND ENGINE

The aircraft observed to have received impact while coming in contact with water. Following damage was observed as follows –

- The engine mount was broken and engine was tilted down.
- The propeller blades were found twisted & bend.
- The Nose landing gear was missing.
- Engine cowlings were missing & firewall yielded inward to cabin.
- There was distinct black sooth deposit on the top half portion of the firewall.
- Lower instrument panel found buckled with engine controls intact. The position of throttle was full in and mixture was one inch out to lean position.
- Centre console found distorted with parking brake assembly broken. The Fuel Selector Valve (FSV) was found selected in BOTH position.
- The flap motor position was checked to identify the position of the flap and was found in retracted position.
- Seat head rest found bend.
- There was no post impact fire as the aircraft went in the water body.

The wreckage consists of cabin, empennage with aft fuselage cut open for recovery of body from inside. The wings & empennage were removed for transportation to hanger for further examination. The engine also separated from fuselage & was sent for strip inspection.

1.12 **Medical and pathological Information:**

The aircraft crashed in to Bargi dam on 06/04/2009 and it was retrieved along with the body on 29/05/2009 i.e., on 54th day. The post-mortem was carried out on the same day at site at around 0845 UTC and body was handed over to relatives for last rites.

The post- mortem revealed that the body was in advanced state of decomposition. Bones of both the forearms and hands were separated and also jaws detached from socket indicating a strong impact received by the hands and face. Bones of both the foot are separated probably due to first impact received by the forward lower portion of the nose of aircraft.

The body was not found entangled in the seat harness however the head was found in the tail portion and the torso on the back rest of the two rear seats indicating probably an attempt to reach out for exit as his front(Nose) portion got engulfed in water immediately. The Death certificate was issued by the local administration of Seoni, district.

1.13 **Fire:**

There was no post impact fire as the aircraft had immediately got completely submerge into water. However the fire wall top portion is seen completely blacken due to soot it seem there was superficial fire .

1.14 **Survival aspects:**

The accident was not survivable as the aircraft immediately entered in water on impact.

1.14.1 **Search and Rescue:**

The aircraft Cessna-172 crashed in Bargi dam at Madanpur, Tehsil Ghansor, Dist Seoni. District collector, Jabalpur immediately ordered the search operation through M/s Mekal Resort(Govt. of MP). The steamers and boats with the help local divers were pressed for search on 06/04/2009. On 07/04/2009 the Collector requisitioned the help from Naval divers from Vishakhapatnam and Barabanki. The team of 8 divers arrived from Eastern Naval Command, Vishakhapatnam for the search and retrieval operation of the aircraft. The team reached the site on 08/04/2009 and initiated the process of locating and retrieval of the wreckage.

The search and rescue operation was carried out by this team from 08/04/2009 to 16/04/2009. The efforts were made on war footing to retrieve the aircraft and body of the student pilot, however in spite of best diver in the business from Navy they failed to locate the aircraft. The main cause of failure was due to the depth of water and the uneven surface with lots of huge trees at the bottom of the water bed.

THE PRIVATE DIVER & VILLAGERS ENGAGED IN WRECKAGE RETRIVAL

The parents and relatives of the deceased had camped at the site in nearby village for approximately for 2 months. The relatives of the deceased student pilot along with the villager and private divers hired from Vishakhapatnam first located the aircraft on 28/05/2009. The wreckage was retrieved on 29/05/2009 by using a balloon to lift the wreckage from the water bed. Immediately the body of the deceased was released for post mortem at the site and handed over to the relatives.

1.15 **Tests and research:**

1.15.1 Engine investigation at Bombay Flying Club: The Engine was tested at Bombay Flying Club on 30/07/2009 and the following observations were made –

- Externally the engine suffered an impact resulting damage of external fittings including exhaust pipes and muffler.
- Damaged exhaust pipes removed from engine and while removing exhaust pipes water came out through exhaust port No.1 cylinder.
- Engine mount was found damage.
- Ignition wires were found damaged; some baffles were removed to facilitate inspection of other components.
- Rocker box cover of no.4 cylinder removed. Water and oil started coming out from the Rocker Box.

No conclusive investigation could be done hence the engine was shifted to the Lycoming approved facility in M/s HAL, Bengaluru.

1.15.2 Engine Investigation at M/s HAL: The was shifted to M/s HAL, Bengaluru, Engine Overhaul facility M/s Lycoming and the examination was carried out on 17/08/2009. The following observation –

- The engine was intact but showed obvious water damage from submersion. Damage to engine was superficial. Most damage was secondary from retrieval from the crash site.
- Visual inspection of the engine verified that the engine was intact and free from any mechanical failure.
- External accessories were removed for separate bench investigation for testing magnetos, fuel injectors and fuel pump were found intact and in operable condition.
- The engine core was systematically disassembled. The main power section was free to rotate. There was no sign of loss of lubrication or oil starvation. All connecting rods were intact and free to rotate.

- The cylinders and piston were removed in sequence. The cylinders and valve train was found normal condition. The accessory housing, gears and oil pump were found in serviceable condition.
- No defects were found with the engine power section.
- The magnetos were inspected. Both magnetos were intact the LH magneto was mounted on the test stand and functioned normally despite being submerged for an extended period. The RH magneto failed to run due to internal corrosion from water submersion.
- The spark plugs were inspected but could not be tested due to water corrosion. The high tension harness was damaged during retrieval of the aircraft from crash site.
- The fuel system was inspected and number of qualitative tests carried out.
- The flow divider was undamaged and tested in an as is condition all test were normal and within the specification.
- Fuel Nozzles were tested as received and no fault found.
- The fuel injector filter was removed and an internal inspection found no major obstruction or contamination.
- A small quantity of fuel was still present inside the injector fuel section.
- The manual mixture and metering valve assemblies were found in serviceable condition.
- A small amount of residual fuel was found in the injector body.
- The fuel injector was on the test stand for bench testing function and calibration simulations were found within limits. All response tests functioned normally. On disassembly the main metering stem on the fuel diaphragm was found bent. Damage was consistent with sudden crash impact.

In conclusion the inspection of engine and its accessories did not reveal any mechanical failure that would cause a loss of power. All accessories were found serviceable and operable. The engine was operating at the time of impact.

1.15.3 Fuel Sample Investigation at R & D, DGCA: The two fuel samples were retrieved from the fuel tank and the lowest point from the fuel filter was tested at DGCA, R & D laboratory for any deviation from standard specification. The sample quantity volume available was less than required for the testing purpose however the same was still sent for testing. The specification did not match for appearance and distillation

details and the remark made was the same could be due to insufficient quantity of sample which was available

1.15.4 The Junction box investigation at M/s Air India, Accessory Overhaul Division:

The following observation were made during the shop investigation –

The Junction Box was received in contaminated condition the wires were cut from the connector for facilitating easy removal. The external examination revealed that there was no fuse in the alternator sense line and the fuse holder was also found damaged. After opening the plastic cover the unit was found fully corroded due to water ingress. The overheating marks were observed on cable routed close to contactor P/N X61-0027 and on the terminals of contacts and also on the mounting bolt. Both 5 Amp fuse were found OK. All the solenoid checked for electrical operation and it revealed –

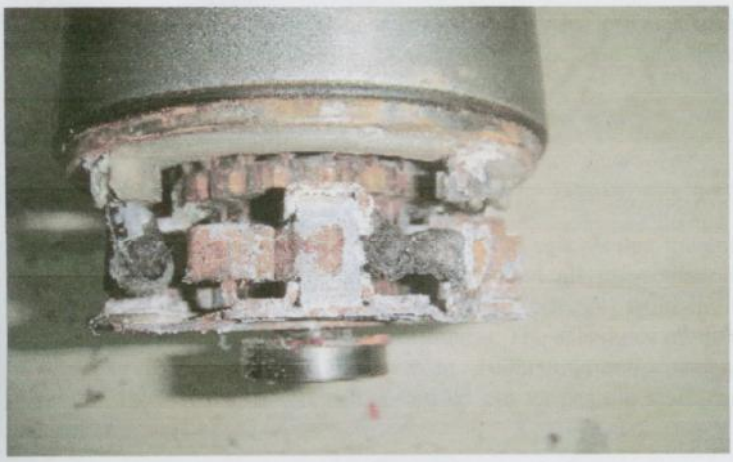
a) Contactor P/N X61-0027 was supplied with 20 & 24 VDC; the click sound of relay operation was heard but the contact remained open and found to be with resistance of 180 K Ohms. After opening the contactor, it was observed that the solenoid plunger and spring found corroded due to water ingress. The resistance between blackened internal contact of the terminal and the plunger plate is high. This indicates the faulty contactor.

b) Contactor P/N X61-0007 (3 Nos) were supplied with 24VDC; the operations was found satisfactory and the contact resistance was 0.10 Ohms. The solenoid coil resistance was found approximately 64 Ohms

The above indicate that the Contactor X61-0027 remained in closed condition thereby causing the contacts to burnout and making it open circuit.

The Starter operational check without load was carried out at 24 VDC the solenoid operated and pushed the meshing gear forward however it did not start even at 19 Amp. The unit was jammed and not rotating with hand. The burnt marks observed on the cable at positive terminal. Brush assembly cover is opened and the brush holders and brush assembly found overheated and burnt. The carbon deposit was not found indicating that the armature was in standstill condition and not rotating. Condition of brushes found in good condition.

On the basis of the shop findings it was concluded that the Starter has drawn very high current in standstill condition leading to armature burnt at the point of contact of brushes. The cable connecting to positive terminal of Starter to Brush assembly found overheated but the sleeve over the cable did not burn. Overheat marks observed on cable connecting Starter and Contactor X61-0027. The lug on contactor terminal (external & internal) found blackened. This indicates the failure of Starter.



Secondly, the pull force of the contactor plunger is not sufficient to close the contacts properly hence can give rise to excessive heat at contacts due to heavy current demand from Starter.

1.16 **Organizational and management information:**

Chimes Aviation Academy is an approved Flying Training Institute by DGCA letter no. AV.22011/6/2007-FG Dated-21st April, 2008, for a period 21st April 2008 to 21st April 2009; and vide DGCA letter no. AV.22011/6/2007-FG Dated-20th July 2009, for a period 22nd April 2009 to 21st April 2010. Chimes Aviation is an approved Maintenance organization under CAR 145, vide letter no. Q-3 CAPL/7693 Valid up to 31 December, 2009

Management and Office Bearers. Chimes Aviation Academy is a subsidiary of Chimes Aviation Pvt. Ltd. with its registered office at 18, Nehru Place, New Delhi. Director is a head of Chimes Aviation Pvt. Ltd., the Accountable Manager and Chief Operating Officer oversees the functioning and operations of the Academy. The Chief Flying Instructor, Maintenance Manager and the QCM are stationed at Chimes Academy Dhana. However both, the Maintenance Manager and the QCM have left Chimes Aviation with effect from August 2009 and September 2009, respectively. Day to day functioning of Chimes Aviation Academy at Dhana

is managed by the CFI. The airstrip is on a 10 years lease from the State Government. The Academy has a hangar and associated buildings for maintenance of aircraft and conduct of flying training.

1.17 **Additional information:**

1.17.1 **Maintenance Aspect:**

a) **Engineering Records:** The Airframe Record reveals that the current airframe hrs were 704:10 hrs since new and all inspections were carried out on the aircraft serial no 17281476 (MSN) from the time since assembly/ certificate of airworthiness. The schedules of 400hrs / 02years Inspection, 200 hrs/01 year, 100hrs/06month inspection, 50hrs/01month inspection where carried out as per the maintenance program.

The engine records reveal that the engine was manufactured by M/s Lycoming and the Model No is IO-360-L2A and S/N is L-33804-51E had logged 704:10 hrs since new. The McCauley Propeller Model No 1C235/LFA7570 and S/N is ABE48501A had been installed on the engine and it had logged 704:10 Hrs since new.

All the Inspection Schedules carried out on L-33804-51E Engine Time since Assembly /C of A. The 50hrs/01month inspection, 100hrs/06month inspection, 200hrs / 01year Inspection, 400hrs / 02years Inspection were carried out as schedule as per maintenance program.

Major Component Replacement Record.

Component	**Date**	**TSN**	Remark
Starter S/N-FN290712	11/10/08	104:55	Installed new Starter S/N-FN310779 Hrs done 03:50
Starter S/N-FN310779	04/04/09	699:50	Installed new Starter P/N 149NL/ec.

As per the stores records submitted the P/N 149 NL/ec, S/N FNE 510811 was issued to the AME for installation however on the aircraft after crash S/N FNE 510813 was found. The said replacement

/installation of starter was carried out by AME license No 1884 at Dhana airstrip hanger. The task was completed only by 05/04/2009. There was no flying done after the starter replacement. The first sorties was done on the morning of 6th April 2009 which was incident/snag free, however second sortie was involved in accident.

b) Study of Starter on C-172:

The study of Starters revealed that there were frequent failures of starter on Cessna 172R NAV III aircraft operated by other operators. Though the crews are following starter duty cycle the starter failures continued. The matter was taken by them with starter manufacture and aircraft manufacture. According to starter manufacture the problem is with all and most 12V and 24V Cessna's manufactured before and they suspect this issue has been rectified in the "new Cessna's" but have not been able to determine a "switchover" date as of yet. They have indicated in their web in this regard and indicated that factory analysis of affected starter(s) showed Burned metal smell. Internal starter inspection in the factory revealed damaged/discolored and often burned components including armature (commutator), brushes, brush insulator(s), motor housings (field) and other internal components and also often accompanied by da maged and/or deteriorated drive pinion and/or aircraft ring gear. They have indicated that the probable cause is aircraft's starter solenoid being stuck closed. When the start switch was released, the starter relay failed to open usually due to arcing/welding across the starter contactor's plunger/contacts. This may lead to a situation with the starter being engaged and a heavy current being drawn through arcing / welded internal parts of starter, overheating cable, failure of other parts in the vicinity.

Model 149 NL starters of Sky tech, was introduced on 172 aircraft as a product improvement during 2nd April 2007. These starters are installed with a modification to aircraft by installing Cessna Modification Kit MK 172-80-01 . The kit applicability is for aircraft Sl. Nos. 17280001 thru 17281376. After Sl. No. 17281376 it is done at production line itself.

1.17.2 Operational Aspect:

1.17.2.1 Training of Student pilot before solo flights:

As per the Chief Flight Instructor the Student involved had joined Chimes Aviation Academy on 07 July 2008. He was given 156 hours of Ground training from 07 July to 07 August 2008. His SPL test was held on 07 August 2008, which he passed. He was issued SPL No. CAA/ D/ 113 on 22 August 2008.

First training flight of involved student pilot was on 22 August 2008. Initially he was slow on the uptake as a result of which CFI personally flew along with trainee pilot a total of 7:30 hrs before clearing him for First Solo on 11 Dec 2008. After the first Solo he

was assigned to fly with his Instructor. His performance in flying after first solo improved rapidly. He was cleared for first solo cross-country after flying two Dual cross-country flights. He flew his first solo cross-country on 4 March 2009. Since then he had flown a total of 35:45 hrs of solo cross-country.

1.17.2.2 **Corrective training given by Flight for cross country:**

Flight instructor stated that the involved student pilot undertook one-on-one ground briefing, introduction to cross country and cross country check before releasing him for solo-cross country. Mass ground briefings have been regularly provided to all students on every exercise, so they gain a detailed understanding about navigation, Navigation Log (flight log) and fuel consideration, Weather analysis, En-route emergency management and Weight and balance.

One – on – One briefing was conducted by Flight instructor for the involved student pilot. Where in he was detailed on following:

- The route for cross country introduction was Dhana-Damoh-Tendukeda-Dhana
- Features along the way i.e. important landmarks, heading, time
- Standard checks, such as, Heading – Altimetry – Time (HAT Checks), Turn – Time – Reference Points – Talk (TTRT), Compass – Logs updated – EIS – Ammeters - Radio (CLEAR)
- Appropriate use of all resources incl. Garmin 1000
- Documents to be checked and carried on board
- Preparing Navigation Log, calculations WRT Time (ETE & ETA),
- Distances, fuel requirements, reporting points, weight and balance considerations and aircraft performance and limitations etc.

- Preparation of Map with respect to points en-route, landmarks, headings, track, time, distances, local terrain and all other safety related topics.

- Analysis of weather for the proposed flight

The introduction flight was conducted on 12th February 2009, Cessna 172R aircrft VT-CAH, departing Dhana at 12:35 IST and arrival Dhana 14:25 IST. The duration of this lesson was 1 hours and 40 minutes.

During this lesson, student was introduced to all checks and SOPs covered in both the mass and one-on-one briefings and demonstrated correct checks and procedures. He was made to spot relevant landmarks on the ground and match them with those indicated on his map.

During the first leg Dhana – Damoh, Flight Instructor flew the aircraft and demonstrated all relevant post take off checks, estimating ETEs and ETAs, correcting for winds, navigation/reference points along the route.

During the second leg Damoh – Tendukeda, Flight Instructor allowed student pilot to gain an understanding of the lesson just covered and attempt to do it himself with my continued assistance. It was observed and recorded that the student was clearly confused toward the end of second leg and called out wrong landmarks i.e. he called the town of Deori as Tendukheda, which is along the route. At this point of time it was observed he was clearly confused and did not monitor his headings carefully and follow demonstrated checks; allowing him to drift off track. Besides he was confused with all the landmarks aro und the Tendukheda. At this point, Flight Instructor corrected track and showed him their correct location with respect to ground features, importance of all checks, correcting for winds, relating features on the ground with that on the map and importance of time. Subsequently he was allowed to correct and resume the lesson.

a) During the Third Leg Tendukheda – Dhana, he was encouraged to proactively engage in the exercise and try and work out the lesson and checks himself. He did this leg well and lande d safely.

b) During all of the above said legs, his progress, understanding and awareness was monitored. All input as required which allowed him to understand his first lessons well were given. The aim and objective of this lesson were met and hence returned back to Dhana
c) Appropriate comments were made in his "flying Trainee's progress report.
d) The student was further briefed and advised to read the emergency section of the C172 POH, revise rules of air and all other areas covered for the said lesson.

1.17.2.3 Cross country check by Flight Instructor:

The cross country check flight for the student pilot was conducted on 14th February 2009, Cessna -172R VT-CAH, departing Dhana at 10:30 IST and arrival Dhana 13:10 IST. The duration of this lesson was 2 hours and 40 minutes.

During this lesson, student was examined /checked on his understanding off all checks and SOPs covered in both the mass and one-on-one briefings and demonstrated correct checks and procedures carried out during the introduction flight dated 12 th February 2009.The student was further made to spot relevant landmarks on the ground and match them with those indicated on his map all by himself.

During the third leg, Maihar – Dhana, the student's performance was satisfactory and his level of awareness and appropriate usage of checks was examined. It was also during this leg, he was quizzed on in-flight emergencies and he demonstrated required standards of awareness and appropriate use of checklists. It was also observed that the student was proactive and active during this check and adhered to all instructions and SOPs. In the post flight debrief he was told to increased situational awareness and staying focused. Appropriate comments were made in his "flying Trainee's progress report. The student was further briefed and advised to read the emergency section of the C172 Pilot Operating Handbook. He was also advised to prepare well in advance for all flights, stay focused during all phases of the flight, have situational awareness,

maintain a strong lookout and get appropriate rest and food before every flight.

Few off his cross country flights had been monitored and he had been performing consistently and up to standards. The student pilot had 35 hours and 45 minutes solo cross country experience as on 2 nd April 2009.

From the above statements it is clear that the student was given adequate class room training, preflight briefing/ debriefing on the flights conducted by the CFI/ FI. His all the weak area about the VFR flying were corrected and then he was given the solo and the cross-country flying.

2. ANALYSIS

2.1 Serviceability/Maintainability of the helicopter:

2.1.1 Maintenance aspect: The airframe records of the aircraft serial no 17281476 from the time since assembly/ certificate of airworthiness reveals that the current airframe hrs was 704:10 hrs since new. And all the scheduled inspection like 25 hrs, 50 hrs, 100 hrs, 200 hrs, 400 hrs were accomplished before due date. The aircraft was issued with certificate of airworthiness on 11/07/2008 and was valid till 10/12/2012. The C of A was issued in category-Normal, Sub Division-Passenger the maximum AUW was 1111.3 kg. The aircraft was issued with certificate of registration in category A and the name of owner/operator is M/s Chimes Aviation Pvt Ltd.

2.1.2 Starter Installation: On scrutiny of record reveal that 10 starters P/N 149 NL/ec were received by M/s Chimes 01/04/2009. The Starter S/N-FN310779 was removed from VT-CAI on 04/04/09 at 699:50 hrs of airframe and a new Starter P/N 149NL/ec was installed on the same day. The aircraft carried out one cross-country in the morning of 06/04/2009 for 4 hrs on the same sector. Thereafter again the aircraft was refueled with 100 litres of fuel; the total fuel on board was 200 litres. The student pilot took at 0815 UTC from Dhana airstrip and crashed in Bargi dam at 1100 UTC. He did not report any distress or give any MAY DAY call.

2.1.3 Engine Investigation: The engine was investigated at Bombay Flying Club, Mumbai and it was found that engine had suffered external damage to external fittings including exhaust pipe due to impact. Damaged exhaust pipes were removed from the engine and water came out through exhaust port No.1 cylinder. Engine Mount was found damaged. The rocker box cover of No 4 cylinder removed it was filled with oil and water more than the other three.

For detailed examination it was shifted to HAL, Bengaluru as it was the only approved facility by Lycoming, on 17/08/2009. The strip examination was carried out on 17/08/2009.The strip examination concluded that the engine and its accessories did not reveal any mechanical failure that would cause a loss of power. All accessories were found serviceable and operable condition. The engine was operating at the time of impact.

2.1.4 Fire Traces on Fire wall: The fire wall showed distinct traces of fire. It had black soot on the fire wall upper portion adjacent to the junction box. These junction box is in front of LH seat on the engine side This black soot was also on the two wires coming from the fire wall.

The Lycoming representative was asked to explain the burning mark however he was not able to say about the source but confirmed that the engine was producing power and will not be able to comment about the aircraft system.

From the above examinations and the available evidences it could be said with certainty that the over temperature condition existed in the accident flight. This condition did not exist in the first cross-country flight which was of the duration of 4 hrs because the pilot did not report any snag neither AME found any during his inspection.

2.1.5 Starter associated problem on Cessna -172: The study of Starters revealed that there were frequent failures of starter on Cessna 172R NAV III aircraft operated by other operators. Though the crews are following starter duty cycle the starter failures continued. The matter was taken by them with starter manufacture and aircraft manufacture. According to starter manufacture the problem is with all/most 12V and 24V Cessna's manufactured before and they suspect this issue has been rectified in the "new Cessna's" but have not been able to determine a "switchover" date as of yet. They have indicated in their web in this regard and indicated that

factory analysis of affected starter(s) showed Burned metal smell. Internal starter inspection in the factory revealed damaged/discolored and often burned components including armature (commutator), brushes, brush insulator(s), motor housings (field) and other internal componen ts and also often accompanied by damaged and/or deteriorated drive pinion and/or aircraft ring gear. They have indicated that the probable cause is aircraft's starter solenoid being stuck closed. When the start switch was released, the starter relay failed to open usually due to arcing/welding across the starter contactor's plunger/contacts. This may lead to a situation with the starter being engaged and a heavy current being drawn through arcing / welded internal parts of starter, overheating cable, failu re of other parts in the vicinity.

On investigation it was found that Model 149 NL starters of Sky tech, was introduced on Cessna-172 aircraft as a product improvement during 2nd April 2007.

These starters are installed with a modification to aircraft by installing Cessna Modification Kit MK 172-80-01 . The kit applicability is for aircraft Sl. Nos. 17280001 thru 17281376. After Sl. No. 17281376 it is don e at production line itself.

Modification MK 172-80-01 involves mainly;

1. Replacement of starter start cable to a longer one, as the original cable will not reach the starter stud of 149 NL starters.
2. Modification of front engine baffle to accommodate 149 NL starter & starter cable.
3. **Replacement of starter relay from X61-0012 to X61-0027**.
4. Replacement of starter from PM2401 (Lycoming P/N 31B22207) to 149-NL

2.1.6 Starter Modification Status: The accident aircraft Cessna 172R, VT-CAI, MSN 17281476 was a later serial no. and the aircraft arrived with 149 NL starter installed initially with .The aircraft was subsequent to the modification kit issued in April 2007. The Airworthiness Directive and Service Bulletin compliance certificate was issued by FAA on 11/12/2007 it stated that the all FAA AD through sequence Number 2007-25 and all Mandatory Service Bulletin and Service Letter issued through 11/12/2007 are complied. The C of R was issued on 11/04/2008 and the C of A states the

issue date as 11/08/2008 however the officer has appended his signature on 28/08/2008. Which seem logical as the Aeromobile license for VT-CAI was issued on 11/08/2008.

It was found that the said modification was carried out during the delivery by Cessna as the starter initially installed was S/N FN290712 modified type 149 NL it was replaced with S/N FN310779 on 11/10/2008 after approx 40 days after receipt of C of A. **These Starter was again replaced and installed with S/N FNE 510813 which was a modified one i.e., 149 NL/cc from 04/04/2009 to 05/04/2009 on VT-CAI**. The Contactor (Relay) X61-0027 was found installed in the junction box indicating post modification status.

The solenoid checked for electrical operation and visual examination revealed that Contactor (Relay) P/N X61-0027 was supplied with 20 & 24 VDC; the click sound of relay operation was heard but the contact remained and found to be with resistance of 180 K Ohms. After opening the contactor, it was observed that the solenoid plunger and spring found corroded due to water ingress. The resistance between blackened internal contact of the terminal and the plunger plate is high. This indicates the faulty contactor. The other three Contactor X61-0007 were found serviceable.

The above indicate that the Contactor X61-0027 remained in closed condition thereby causing the contacts to burnout and making it open circuit.

The Starter operational check without load was carried out at 24 VDC the solenoid operated and pushed the meshing gear forward however it did not start even at 19 Amp. The unit was jammed and not rotating with hand. The burnt marks observed on the cable at positive terminal. Brush assembly cover was opened and the brush holders and brush assembly found overheated and burnt. The carbon deposit was not found indicating that the armature was in standstill condition and not rotating. Condition of brushes found in good condition.

On the basis of the shop findings it was concluded that the Starter has drawn very high current in standstill condition leading to armature burnt at the point of contact of brushes. The cable connecting to positive terminal of Starter to Brush assembly found overheated but the sleeve over the cable did not burn. Overheat marks observed on cable connecting Starter and

Contactor X61-0027.The lug on contactor terminal (external & internal) found blackened. This indicates the failure of Starter.

This may lead to a situation with the starter being engaged and a heavy current being drawn through arcing / welded internal parts of starter, overheating cable. This could be also the result of perfunctory work carried out by the AME.

This has caused the small electrical fire near the electrical junction box mounted on the firewall during the sortie as the fire cannot occur in the water and neither in previous sortie. Further the aircraft had flown for 02:45 minute from the time it had taken off. However this minor fire was not the reason for crash.

2.2 Operational Aspect:

The statements of the CFI and the Flight Instructor indicate that the student pilot was conversant with the solo flying and was aware of the complete demography of the sector which he was flying. The weather was fair and the visibility was 6 km. The aircraft VT-CAI was used by other student pilot to carryout one cross-country in the morning of 06/04/2009 for 4 hrs on the same sector. Thereafter again the aircraft was refueled with 100 litres of fuel; the total fuel on board was 200 litres. The student pilot took off at 0815 UTC from Dhana airstrip and crashed in Bargi dam at 1100 UTC. He did not report any distress or give any MAY DAY call. The involved student pilot had given the position report at 0925 UTC and 1020 UTC respectively. He did not report of any malfunction to Dhana ATC or the other aircraft which were flying on the same sector ahead of him. The other aircraft VT-CAD gave his ETA of 1015 UTC and also conveyed the ETA of involved aircraft to Dhana. The other aircraft VT-CAH relayed Dhana ATC the revised ETA of VT-CAI. This is an indication that the student pilot had gone off course and hence relayed his revised ETA to Dhana.

The ATC data was recovered to check the flight plan filed by the Chimes Aviation Academy for both the cross country. It was found that flight plans were filed for the aircraft VT-CAI.

There was no distress reported by the aircraft VT-CAI is indicative of the fact that there was no acute emergency faced by him as he had the option to contact other aircraft in air to convey or select better site for forced landing.

The three eye witnesses had stated that the aircraft came from the easterly direction and it came very close over the water and over-flew the fishermen, who were fishing when the aircraft had crashed in the Bargi dam. The flight conducted over the water was very scary. The aircraft came again for second time and came very low. It touched the water and went immediately inside. There was sound of engine and they did not observe any fire.

3. **CONCLUSIONS:**

3.1 **Findings:**

a) The aircraft was maintained in airworthy condition by carrying out schedule maintenance and no defect was pending for rectification as per record. The aircraft had valid C of A.

b) The aircraft had certificate of registration and M/s Chimes Aviation Academy as owner/operator. The aircraft had all the valid documents required for operation of the aircraft.

c) Load and balance of the aircraft during the accident flight was within the specified limits was not contributory factor.

d) The prevailing weather was fine and had no contribution to the accident.

e) The aircraft had the unscheduled installation of starter P/N 149NL/ec. The S/N 510811 was released from the store for aircraft VT-CAI however the S/N 510813 was found on accident aircraft. The stock of 10 starters was received on 01/04/2009. The starter on VT-CAI was replaced on 04/04/2009. The aircraft did not fly on 05/04/2009.

f) The aircraft was under maintenance on 04/04/2009 for replacement of starter and no flights were conducted on 05/04/2009.

g) The four (4) hour cross country was done by another student pilot on 06/04/2009 in the morning session immediately after the replacement of Starter on the same aircraft. The flight was uneventful.

h) The second flight was by involved student pilot for a cross-country on route Dhana-Umeria-Baihar-Dhana. The student pilot during his last leg went to the right deviating approximately 10 KM of his track over the Bargi dam. He approached the water body twice from 090 (easterly) direction and made a low pass, however in his second attempt touched the water and aircraft went into deep water.

i) The aircraft and body of the student pilot was retrieved on 54th day after crash by parents with the help of private diver and villager. The body was completely decomposed and was found on the rear of rear-seat. The body was recovered by cutting open the tail portion of fuselage.

j) The propeller blades exhibited the bend inward normally associated the engine on power. And the top engine mounting found broken due to heavy torque experienced after propeller touching water.

k) The fire wall of the aircraft had very heavy black soot deposit indicating a small electrical fire which was during the sorties however the student pilot was ignorant of the fact hence did not give any distress call neither he made any attempt to land as his flaps were in retracted position. The fire was not the contributory factor for accident neither any effect on engine power output.

l) The Starter generator of new model 149NL/ec S/N 510813 on 04/04/2009 was replaced and all the modifications for new model starter 145 NL were already carried out by the manufacturer during aircraft delivery.

m) On opening the contactor X-61-0027, it was observed that the solenoid plunger and spring found corroded due to water ingress. The resistance between blackned internal contact of the terminal and the plunger plate is high almost 180 K ohm. This indicates the faulty contactor.

n) The other three (3) contactors X 61-0007 of the Junction Box where found serviceable during operational check.

o) New starter 149NL/ec, S/ No. 510813 replaced had caused the overload conditions in standstill condition hence burning mark was detected at single location on armature and one coil of stator got burn along with the brush holder is indicative of the fact that relays X61-0027 has caused starter solenoid being stuck closed. This may lead to a situation with the starter being engaged and a heavy current being drawn through arcing / welded internal parts of starter, overheating cable.

p) The fire in the engine compartment on the fire wall is not the cause for accident it is additional finding during the investigation.

3.2 **Probable cause of the incident**:

The probable cause of the accident is carrying out very low flying over water in cruise configuration at high speed & touching the water causing the aircraft to crash into the dam.

4. SAFETY RECOMMENDATIONS:

4.1 All the Cessna 172R flying in country replacing the Starter with 149NL/ec manufactured by M/s Skytech should check for the X61-0027 relay whether it is available on their aircraft. One time inspection to be carried out and report submitted to DGCA.

4.2 The matter should be taken with the manufacturer for the contactor X 61-0027 modification for higher Ampere rating or restrict the life of the Contactor in view of failure.

4.3 The advisory to be issued to exercise abundant precaution during installation of starter as any misalignment could cause starter armature to become stiff and draw more current.

4.4 The appropriate action may be taken against the concerned AME who performed the removal/ installation of the Starter for perfunctory work carried.

4.5 DGCA should increase the safety oversight on the general aviation and flying club aircraft more so on those operators located at the remote places.

Place: Mumbai
Date: 29.01.2010

(SANJAY K BRAMHANE)
Deputy Director Air Safety
Inspector of Accident-VT-CAI

NEW A/C VT-CAI FIRE WALL WITH A/F HRS=708 HRS

NEW A/C VT-CAI FIRE WALL WITH A/F HRS=708 HRS

NEW A/C CESSNA-172 FIRE WALL WITH A/F =1000 HRS

FUEL DISTRIBUTION VALVE WITH BURN MARK

BLACK SOOT ON EXHAUST & ON ENGINE

BLACK SOOT VISIBLE

STARTER SHOWING SIGN OF OVERHEAT

THROTTLE FULL & MIXTURE LEAN, KEY ON BOTH(MAG)