

COMMANDO DA AERONÁUTICA
CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE
ACIDENTES AERONÁUTICOS



FINAL REPORT
A - 020/CENIPA/2014

OCCURRENCE:	ACCIDENT
AIRCRAFT:	PP-DFW
MODEL:	C-140
DATE:	29 January 2014



NOTICE

According to the Law n° 7565, dated 19 December 1986, the Aeronautical Accident Investigation and Prevention System – SIPAER – is responsible for the planning, guidance, coordination and execution of the activities of investigation and prevention of aeronautical accidents.

The elaboration of this Final Report was conducted taking into account the contributing factors and hypotheses raised. The report is, therefore, a technical document which reflects the result obtained by SIPAER regarding the circumstances that contributed or may have contributed to triggering this occurrence.

The document does not focus on quantifying the degree of contribution of the different factors, including the individual, psychosocial or organizational variables that conditioned the human performance and interacted to create a scenario favorable to the accident.

The exclusive objective of this work is to recommend the study and the adoption of provisions of preventative nature, and the decision as to whether they should be applied belongs to the President, Director, Chief or the one corresponding to the highest level in the hierarchy of the organization to which they are being forwarded.

This Report does not resort to any proof production procedure for the determination of civil or criminal liability, and is in accordance with item 3.1, Annex 13 to the 1944 Chicago Convention, which was incorporated in the Brazilian legal system by virtue of the Decree n° 21713, dated 27 August 1946.

Thus, it is worth highlighting the importance of protecting the persons who provide information regarding an aeronautical accident. The utilization of this report for punitive purposes maculates the principle of “non-self-incrimination” derived from the “right to remain silent” sheltered by the Federal Constitution.

Consequently, the use of this report for any purpose other than that of preventing future accidents, may induce to erroneous interpretations and conclusions.

N.B.: This English version of the report has been written and published by the CENIPA with the intention of making it easier to be read by English speaking people. Taking into account the nuances of a foreign language, no matter how accurate this translation may be, readers are advised that the original Portuguese version is the work of reference.

SYNOPSIS

This is the Final Report of the 29 January 2014 aeronautical accident with the C-140 aircraft, registration PP-DFW. The accident was classified as “System/component failure”.

The aircraft was about to join the downwind leg in the traffic pattern when control was lost, and it crashed into the ground.

The aircraft was substantially damaged.

The two aircraft occupants perished in the crash.

An accredited representative of the National Transportation Safety Board – NTSB (USA) was designated for participation in the investigation.



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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ANAC	National Civil Aviation Agency
ATS	Air Traffic Services
CA	Airworthiness Certificate
CAVAG	Agricultural Aviation Course
CENIPA	Aeronautical Accident Investigation and Prevention Center
CHT	Technical Qualification Certificate
CMA	Aeronautical Medical Certificate
DCTA	Aerospace Technology and Science Department
GSO	Operational Safety Manager
INVA	Flight Instructor (airplane category)
MNTE	Class qualification – ASEL (Airplane, Single-Engine, Land)
NTSB	National Transportation Safety Board
PCM	Commercial pilot license (airplane category)
PLAN	Glider pilot license
PRI	Instructional Registry Category
PPR	Private Pilot license (airplane category)
RELPREV	Preventative Report
SERIPA	Aeronautical Accident Investigation and Prevention System
SIPAER	Regional Aeronautical Accident Investigation and Prevention Service
SSEP	ICAO location designator – São Sepé Aerodrome
SSKS	ICAO location designator – Cachoeira do Sul Aerodrome
SSSC	ICAO location designator – Santa Cruz do Sul Aerodrome
TGL	Touch-and-Go Landing
UTC	Universal Time Coordinated

1. FACTUAL INFORMATION

AIRCRAFT	Model: C140 Registration: PP-DFW Manufacturer: Cessna Aircraft	Operator: Aero Agrícola Santos Dumont Ltda.
OCCURRENCE	Date/time: 29 JAN 2014 / 13:40 UTC Location: Rural Area Lat. 29°58'49"S Long. 052°56'18"W Municipality – State: Cachoeira do Sul – Rio Grande do Sul	Type: System/Component Failure

1.1 History of the occurrence

At 12:45 UTC, the aircraft took off from SSKS on a closed circuit navigation flight of the Commercial Pilot course, with an instructor-pilot and a student on board.

After performing three touch-and-go landings in SSSC, the aircraft returned to SSKS.

When the aircraft was about to join the traffic pattern, the instructor-pilot made a call on the free frequency (123.45 MHz), reporting that he was having problems with the elevator, and that they would land in three minutes.

Shortly after joining the downwind leg, the crew lost control of the aircraft, and it crashed into the ground.

1.2 Injuries to persons

Injuries	Crew	Passengers	Third parties
Fatal	2	-	-
Serious	-	-	-
Minor	-	-	-
None	-	-	-

1.3 Damage to the aircraft

The aircraft sustained substantial damage.

1.4 Other damage

Nil.

1.5 Information on the personnel involved

1.5.1 Flight experience of the crew

	Hours flown	
	Instructor-Pilot	Student
Total	400:00	73:00
Total in the last 30 days	84:50	37:55
Total in the last 24 hours	05:00	06:25
In this type of aircraft	250:00	37:55
In this type in the last 30 days	84:50	37:55
In this type in the last 24 hours	05:00	06:25

N.B.: Data obtained from company records and information provided by third parties.

1.5.2 Professional formation

The instructor-pilot did his Private Pilot course (airplane category) at the Flying Club of *Osório*, State of Rio Grande do Sul, in 2012.

The student pilot did his Private Pilot course (airplane category) at the *EJ Escola de Aeronáutica Civil* in Jundiaí, State of São Paulo, in 2013.

1.5.3 Validity and category of licenses and certificates

The instructor-pilot had a Commercial Pilot license (airplane category). His technical qualification certificates for gliders, ASEL (airplane, single-engine, land), and Flight Instructor (airplane category) were valid.

The student-pilot had a Private Pilot license (airplane category), and a valid technical qualification for ASEL aircraft.

1.5.4 Qualification and flight experience

The pilots had qualification and enough experience in the type of flight.

1.5.5 Validity of medical certificate

The pilots had valid aeronautical medical certificates (CMA).

1.6 Aircraft information

The high-wing single-engine C-140 aircraft (SN10191) was manufactured by Cessna Aircraft in 1946.

It had been registered in the instructional category, and its airworthiness certificate was valid.

The last inspection of the aircraft (25-hour type) was done on 23 January 2014 by the Aero Agrícola Santos Dumont Ltda. company in Cachoeira do Sul, State of Rio Grande do Sul. After the inspection, the aircraft flew 21 hours and 25 minutes.

The last overhaul of the aircraft (100-hour type) was done on 19 January 2014 by the Aero Agrícola Santos Dumont Ltda. company in Cachoeira do Sul, State of Rio Grande do Sul. The aircraft flew 39 hours after the overhaul.

The aircraft had a total of 4,094 flight hours in the logbook.

The airframe, engine, and propeller logbook records were up-to-date.

The maintenance services were considered periodical.

The aircraft weight and balance parameters were within the limits prescribed by the manufacturer.

1.7 Meteorological information

The prevailing weather conditions were VMC.

1.8 Aids to navigation

Nil.

1.9 Communications

Along its route, the aircraft did not fly in controlled airspaces. Thus, the information about communications with the accident aircraft was based on reports made by other pilots who had been on the free frequency of 123.45 MHz, or on the aerodrome coordination frequency in SSSC.

Only two of these reports were considered of relevance.

According to the first report, after the last touch-and-go landing in SSSC, the instructor-pilot informed on the local coordination frequency that he would climb to 3,000ft to return to SSKS.

According to the second report, when the aircraft was already approaching the SSKS traffic pattern, the instructor-pilot asked whether someone was listening on the free frequency of 123.45 MHz. Upon receiving an affirmative answer, he asked the responder to change frequency to 123.40 MHz. On this new frequency, he informed that he was having elevator problems, which would make landing difficult, and said that he expected to land in three minutes.

1.10 Aerodrome information

The occurrence was outside of aerodrome area.

1.11 Flight recorders

Neither required nor installed.

1.12 Impact and wreckage information

The accident occurred in a rural area, 1.3NM to the north of Cachoeira do Sul Aerodrome (SSKS).

The wreckage had a concentrated pattern. There had been only one frontal impact, at a pitch-down angle of about 90° with the ground. The impact occurred in a soybean plantation area.

The aircraft was equipped with a fixed landing gear. The vertical speed indicator (Climb) showed a rate of descent of 4,500 feet per minute; the speedometer indicated 134 mph, already in the yellow segment (operation with caution); and the oil temperature gauge marked 180°F, in the range of normal operation (green segment).

The damage to the aircraft elevator was not compatible with impact with the ground, since it precluded a pitch-down movement of the aircraft, since the elevator had gotten stuck in the junction with the horizontal stabilizer.



Figure 1 – Position of the aircraft after the impact.

1.13 Medical and pathological information

1.13.1 Medical aspects

No evidence was found related to physiological issues or problems of incapacitation that could have affected the flight crew performance.

1.13.2 Ergonomic information

Nil.

1.13.3 Psychological aspects

The flight instructor began his aviation career in February 2012, by doing a Private Pilot course. Later, he did the Glider Pilot course, and the theoretical part of the Commercial Pilot course.

In June 2013, on the recommendation of a former instructor, he started a practice commercial pilot course. Upon completion of this course, he remained working as a flight instructor, with the intention of accumulating flight hours so that he could start an Agricultural Pilot course.

Influenced by a neighbor, who was an Agricultural Pilot, he started the courses required for his training as Agricultural Pilot. According to accounts, this friend of his had offered him a job opportunity for when he completed the course.

Interviewees said having heard from him that he had started a course on aerobatic flights which was never concluded. They also reported that, notwithstanding, he used to do aerobatic maneuvers in his spare time.

He liked to go to the flying club, and fly as a passenger with local pilots on seaplanes and two-seater gliders. He sometimes used to fly solo on gliders and on single-engine aircraft.

The instructor-pilot was described by his family and colleagues as a polite, relaxed, loving, nice, hardworking, safe and helpful person. He worked hard to achieve his objectives. He was very fond of flying, and thought that the more adrenaline the better.

According to some of his former instructors, the pilot was a good student, but his overconfidence was conspicuous. He had a different limit for risk in comparison with other students, showing no fear, and taking chances.

In his role as an instructor, he was seen by his students as the "best instructor", for being relaxed in flight and for being devoted to transmitting as much knowledge as possible. In addition, he did his best to make students learn, demanded performance from them, and showed to be confident in flight.

According to information gathered, his delivered training sessions were intense, with large numbers of simulated failures. An example to illustrate this was a 30-minute flight in which 10 different failures were simulated.

Although presenting, at times, a calm and safe profile, he was also sometimes perceived by the students as a bold, daring pilot. He would often perform maneuvers used in agricultural aviation on aircraft not approved for such maneuvers.

He used to perform other inflight maneuvers in addition to those prescribed for the training sessions, such as tight turns, lazy eights, spins, and slow *tonneaux*.

The instructor was not scheduled for the flight of the occurrence in question. However, a few minutes prior to departure, he asked the other instructor to allow him to take over the instruction flight.

According to data collected, the instructor appeared to be relaxed on the day of the accident. He had flown with another student before the accident flight. On that flight, they had practiced entering into and recovering from spin maneuvers.

The student involved in the accident began his Private Pilot course in 2010, but due to financial difficulties, the course was discontinued. He resumed and completed the course only in 2012. In January 2014, twenty days before the accident, the student had started a commercial pilot course.

According to testimonies, the student intended to become an agricultural pilot, since he had been offered a job in the area.

His family and flying school colleagues described him as a relaxed, humble, cheerful, caring, hardworking, and proactive person, who was able to learn things easily.

He liked to help the flying school mechanics in his spare time, and the school began to informally pay him for the help provided.

According to the flying school instructors and students, he was always ready to accept feed-backs related to his own performance, which was considered good.

The instructor-pilot and the student got along well with each other, and had a good relationship with everybody in the flying school (students, instructors and mechanics). The instructor was highly communicative and, therefore, everyone felt comfortable with him.

The school focused on the training of agricultural pilots, and had a certified maintenance shop. It had 04 (four) flight instructors and 23 (twenty three) active students at the time of the accident.

The owner of the flying school, in addition to his managerial functions, was also the inspector responsible for the maintenance services and coordinator of the commercial pilot practice course. The Operational Safety Manager was also a flight instructor. There were aircraft mechanics and administrative personnel in the company as well.

The students had to undergo a selection process conducted by the flying school owner, according to criteria established by him. Good behavior was considered a more important criterion than the number of hours flown. In relation to the instructors, he had preference for professionals graduated in his school in order to maintain standardization.

At the flying school, there were no formal procedures for evaluating, monitoring and controlling the instructors' performance. The instructors only had the student's notebook as a base for their training and evaluation.

The school lacked a formal communication channel aimed at the instructors and students, such as weekly meetings, exchange of emails, folders, bulletin board information, etc., for standardization and exchange of information. The pieces of information were commented whenever possible.

The instructors and students were aware that the instructor involved in this occurrence used to perform unplanned unsafe maneuvers; however, according to reports, this was not spread for fear that the instructor could be suspended from the air activity.

The flight training schedule allowed just a short interval between flights, making it difficult to deliver briefings and debriefings, and there is no checklist establishing the criteria to be transmitted to the students during the instructions and feedback.

Both the instructor-pilot, who also worked with update and preparation of manuals, and the student, who performed maintenance services, did not have a formal job contract with the flying school. The same was true for the other flight instructors.

The flying school, according to interviewees, encouraged the newly-selected instructors to perform the first flights, preferably, with students already graduated as private pilots (PPR), or with students of a more advanced level of another category, or, still, with more experienced students, in order to maintain flight safety.

However, such agreements were made informally, and the result was that it was not possible to determine who the most experienced students were for the flights with the newly-selected instructors, since the decisions were made shortly before the flights.

1.14 Fire

No evidence of either inflight or post-impact fire was found.

1.15 Survival aspects

Nil.

1.16 Tests and research

During the post-accident field investigation, it was observed that the aircraft elevator had free movement only halfway up (pitch-up movement) because it was stuck in the horizontal stabilizer.

The Aerospace Technology and Science Department (DCTA) conducted tests of the elevator, elevator trim, and respective cable.

The report issued by the DCTA showed that there was plastic deformation of the elevator structure (Figure 2), making it lock when in contact with the horizontal stabilizer. Moreover, the report made it clear that there were friction marks in the deformed structure, with damage to the paint.

The report also detailed that there had been a rupture of the elevator trim cable due to overload (Figure 3). Another rupture (shearing) of the cable was made by the SERIPA V in order to remove it from the aircraft.

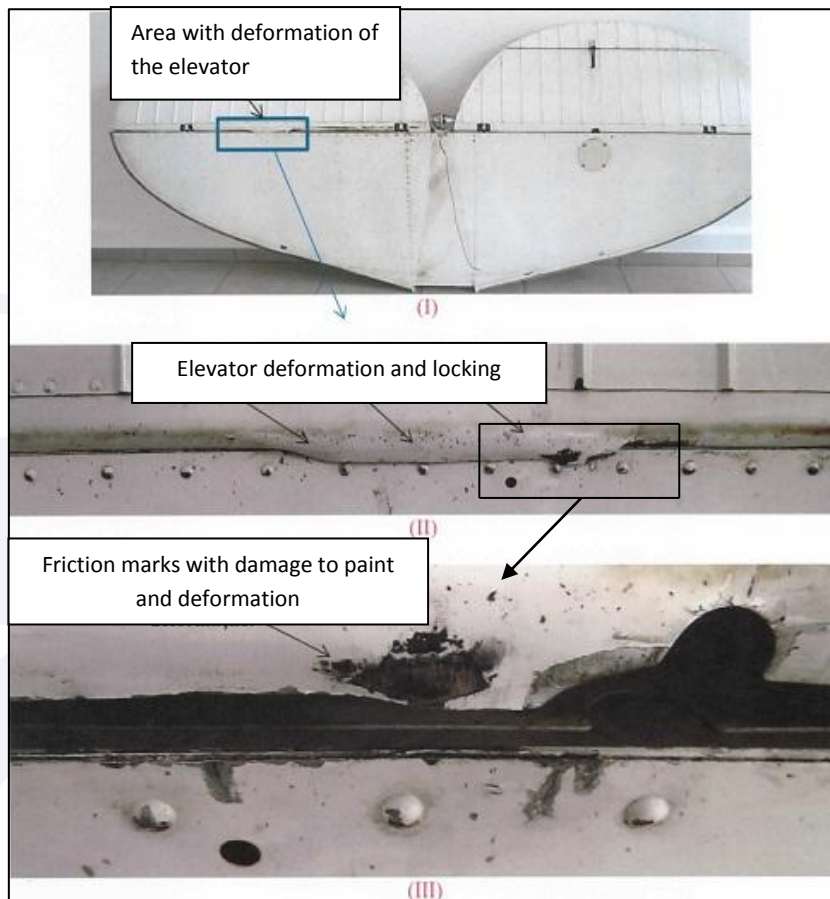


Figure 2 – Aspect of the plastic deformation of the elevator structure.



Figure 3 – Aspect of the elevator trim cable rupture due to overload.

Due to the damage resulting from the accident, it was not possible to verify whether the elevator amplitude adjustments were in accordance with the aircraft maintenance manual prescriptions.

1.17 Organizational and management information

The Aero Agrícola Santos Dumont Ltda. company, whose headquarters is located in Cachoeira do Sul Aerodrome, State of Rio Grande do Sul, began operations in 1979, and implemented its Agricultural Aviation course (CAVAG) in 1990.

At the time of the accident, the company had certification for delivering practice courses in the following areas: Private Pilot (airplane category), Commercial Pilot (airplane category), Flight Instructor (airplane category), Agricultural Pilot (airplane category), as well as theoretical Agricultural Pilot course (airplane category). The company also provided services as an aircraft maintenance workshop (Standard "C", classes 1 and 2).

There were no records of flight safety activities performed in the company. There was neither control nor management of Prevention Reports (RELPREV). The investigation commission found no Prevention Reports filed, nor any contingent dissemination of any of the mentioned reports.

From the records of the flight hours kept by the company, it was possible to observe that the instructor-pilot used to fly a lot of training hours on the same day. On 15 January 2014, for instance, he flew 8 hours and 12 minutes with five different students.

At the time of the accident, the company fleet was composed of 14 aircraft, being one C-140, two C-140As, two C-A188As, one C-170A, one C-170B, one C-210D, one EMB-201, two EMB-201As, two EMB-202s, and one EMB-810D.

1.18 Operational information

At 09:05 UTC on the day of the accident, the instructor-pilot and his student took off with the PP-DFW on a navigation flight from SSKS to SSEP, and returned to SSKS, where they landed at 10:00 UTC.

At 10:35 UTC, the PP-DFW took off with another instructor and student, and landed at 11:25 UTC. The instructor-pilot and his student later reported that they did not notice any type of problems with the aircraft during the flight.

During this time interval, the accident instructor-pilot delivered a training session to another student aboard the PT-AGS aircraft.

The PP-DFW aircraft was refueled and, at 12:45 UTC, the instructor-pilot and the student took off again for another navigation mission along the SSKS-SSSC-SSKS route, on which the accident occurred at 13:40 UTC.

Since the instructor who had been originally designated for the flight was busy with other activities in the company, the accident instructor-pilot insisted and was granted permission to substitute for him on the flight schedule.

According to the flying school pilots, the navigation flights along the company's usual routes, such as the SSKS-SSSC-SSKS circuit, were normally performed at an altitude of 1.500ft.

1.19 Additional information

Flight indiscipline

During the investigation, videos were found which showed the instructor-pilot performing fly-bys and abrupt pitch-up maneuvers during solo flights on C-140 aircraft of the Aero Agrícola Santos Dumont company, simulating crop dusting flights and daring maneuvers, such as tight turns, spins and slow *tonneaux*. The videos depicted aerobatic flights being performed at an altitude of 3,000ft. In an interview with students and instructors of the flying school, they confirmed that the instructor-pilot performed those maneuvers with students on board.

According to reports, when he was just a student at the flying school, the instructor-pilot would make maneuvers allowed for the aircraft, such as lazy eights, but intentionally at speeds different from those prescribed, a fact that was observed in the videos, where he is shown flying in the yellow speed range (operation with caution) during the aerobatic maneuvers.

In addition, the pilots stated that, since the company focused on providing training to pilots who wished to stay in the flying school to take up the Agricultural Pilot course, they would, on some flights of the Private Pilot, Commercial Pilot, and Instructor Pilot courses, perform aircraft maneuvers typical of agricultural aviation, as a form of previous training.

Thus, it was observed that the aspect of flight indiscipline was recurrent in the operation of aircraft, since they utilized aircraft not certified for agricultural aviation tasks in the inappropriate simulation of maneuvers of this kind of aviation on their training flights.

The aerobatic maneuvers appearing in the instructor-pilot videos turned to be examples of flight indiscipline, since the C-140 aircraft was neither certified for agricultural aviation nor for aerobatic flights. In addition, the instructor-pilot was neither qualified as an agricultural pilot nor as a stunt pilot.

Aircraft speed limits

The aircraft manual, in its section of speed limits, reads that:

- a) the speeds between 115mph and 140mph (yellow segment of the speedometer) correspond to the range of operation with caution;
- b) the aircraft is not designed for purely aerobatic flights;
- c) maneuvers such as tight turns, spins, stalls, lazy eights, and chandelles, are allowed to be performed only within the recommended speeds;
- d) the aircraft accelerates quickly when at a pitch-down attitude;
- e) appropriate speed control is an essential requirement for the execution of any maneuvers, whereas excessive speeds must be avoided; and
- f) abrupt inputs on the controls are to be avoided.

In addition, spins with the flaps extended are prohibited due to the fact that recovery cannot be done without exceeding the speed limit. Maneuvers that require high negative "G" forces shall not be attempted.

In the instructor-pilot videos, it was possible to observe that the information contained in the aircraft manual was repeatedly disregarded, since aerobatic flights were made both with allowed and not allowed maneuvers, and at speeds different from those recommended. Furthermore, although there was no proper speed control, the flight controls were sometimes used in an abrupt manner.

Aircraft design

The very aircraft design made it possible for the elevator to interfere with the horizontal stabilizer, since the position, shape, and type of material used in its leading edge allowed it to sustain deformation if the aircraft was operated above its limits, and locking of the elevator was a possibility.

The elevator leading edge consisted of two curved upper and lower metal sheets. Should the structure be subjected to a high G load, it would have its normal curvature reduced, getting closer and closer to the horizontal stabilizer. In such situation, a higher load or an input with a large amplitude on the elevator could cause a displacement of the

metal sheets going beyond the limits of the horizontal stabilizer, resulting in a jammed elevator due to contact with the horizontal stabilizer.

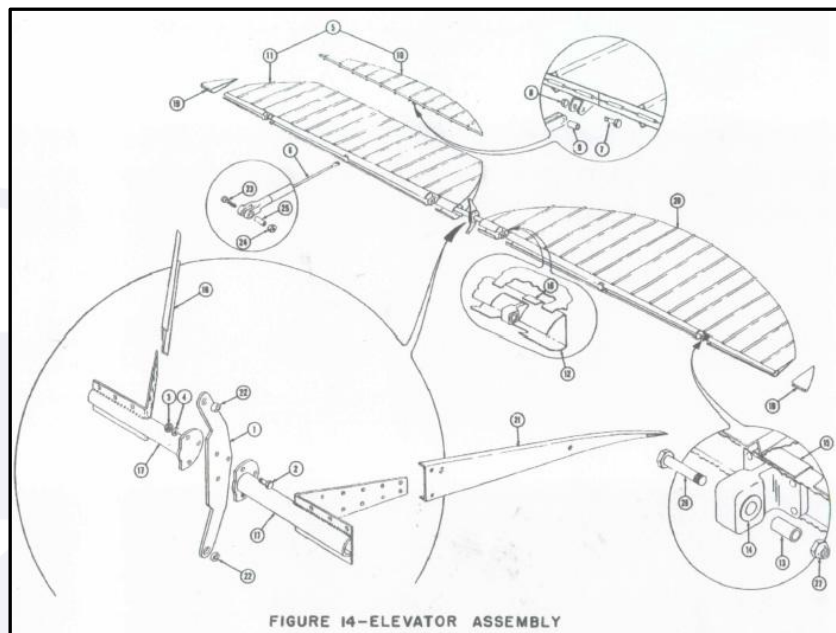


Figure 4 – Drawing of the aircraft elevator assembly.

1.20 Utilization of other investigation techniques

Nil.

2. ANALYSIS

The instructor was regarded by his fellow instructors and students as a fearless pilot, bold and audacious; someone who would take chances and was overconfident in his own skills.

He was highly motivated for flying, and would often conduct a large number of flights on the same day. This high level of motivation may be observed in his request to be the instructor-pilot on the accident flight, for which he was neither scheduled nor appropriately prepared.

Although not having completed his aerobatic flight pilot course, the instructor-pilot performed aerobatic flights in his spare time; he also performed maneuvers not prescribed for the training flights.

Since the flying school did not have a system for the formal oversight of the activities performed by the flight instructors, and since there were no routines and formal procedures established, the existing discrepancies of the training flights were not detected by the management sectors.

Besides, the other instructors and the students who were aware of these facts did not report them for fear that the instructor could be suspended from training. Even with a flight profile acknowledged by the group as a bolder profile, exceeding the limits, and with attitudes contrary to safety, the instructor-pilot was considered the best in the flying-school for his dedication towards student learning.

This fact indicates a group culture permeated by ambivalence of flight safety on the basis of established relationships. Since the behavior adopted by the instructor-pilot at the flying school created a good relationship with his students and fellow instructors, his

procedures contrary to flight safety did not arouse critique. In this sense, the group culture became permissive and fragile with respect to flight safety.

The flying school did not have a formal communication channel aimed at standardization and at the exchanging of information. The schedule was busy, making it difficult to carry out briefings and debriefings. Therefore, students would take off for their training flights without undergoing an initial preparation of the phase to be performed in flight or without receiving a debriefing upon returning from the mission, based on the retrospect of the training session delivered, with evaluation of the student's performance and recommendations to be followed.

The school had a simple organizational structure in which the functions were performed cumulatively by the few employees, including the owner. The selection of students and flight instructors was based on subjective criteria established by the owner. The management of labor, control systems and responsibilities within the organization was done informally, for there were no established routines or formal procedures.

The way the work was organized at the flying school had consequences on the flight training delivered, for which the instructors did not have standardized teaching procedures.

There were no records of activities related to flight safety in the company. Similarly, there weren't any filed Prevention Reports, denoting the low priority given to the issue of safety in the company and in the operational environment.

At the post-accident field investigation, the investigators observed that the collision had been a frontal one at high speed, a situation consistent with an inadvertent spin. The elevator had free movement only halfway upward (pitch-up), and the elevator trim cable was broken.

According to the DCTA report, there was plastic deformation of the elevator structure, causing the elevator to get locked when contacting the horizontal stabilizer. In addition, the rupture of the elevator trim cable was found to be on account of overload. Such deformation is compatible with the type of damage expected as a result of incompliance with recommendations and prescriptions contained in the aircraft manual relative to overspeed and sustainment of high G forces.

The aircraft engine was not disassembled, since the investigation commission found no evidence of failure in this component. In contrast, some pieces of evidence, such as: the type of deformation of the propeller; the engine oil temperature within normal flight parameters; the communication made by instructor, reporting problems with the elevator; and the witnesses' accounts that they saw the aircraft flying normally and suddenly losing control, with an abrupt pitch-up attitude not compatible with engine failure, confirmed that the aircraft engine was developing normal power.

In addition to the reports made by other pilots that the instructor-pilot practiced maneuvers and stunts in flight, videos were found showing that he performed the maneuvers and stunts in the C-140 aircraft of the company. The stunts were usually performed at high speeds at the altitude of 3,000ft, precisely the altitude reported by the instructor-pilot on his return to SSKS.

The design of the aircraft elevator allows its leading edge to be deformed when the aircraft is operated above the prescribed limits. Such deformation may cause the elevator leading edge to rub the horizontal stabilizer, and in a more critical situation, may cause it to get stuck to the horizontal stabilizer.

The elevator is thought to have gotten stuck to the horizontal stabilizer in the segment SSSC-SSKS as a result of the maneuvers and stunts performed by the instructor-pilot and/or the student. It is possible that at some of these maneuvers and

stunts, the pilots exceeded the limits of speed and "G" load of the aircraft. When they exceeded these limits, a plastic deformation of the elevator would have occurred, causing it to get stuck to the horizontal stabilizer.

Such possibility is enhanced by the pilot's communication of problems with the elevator.

It is inferred that in trying to unlock the elevator, the pilot has caused an abrupt pitch-up attitude (observed by witnesses of the accident), making the instructor-pilot lose control of the aircraft and enter into the spin.

Although, according to witnesses, the pilot recovered from the first spin, he had no effective pitch control, and entered into another spin, from which he was not able to recover due to his low height.

On account of the damage caused by the accident, it was not possible to determine whether the elevator amplitude adjustments met the prescriptions of the aircraft maintenance manual. This observation becomes relevant since a hypothetical inappropriate adjustment of the elevator amplitude could have contributed to its getting stuck to the horizontal stabilizer.

3. CONCLUSIONS

3.1 Facts

- a) The pilots had valid aeronautical medical certificates (CMA);
- b) The pilots had valid technical qualification certificates (CHT);
- c) The pilots had qualification and enough experience for the proposed flight;
- d) The aircraft had a valid airworthiness certificate (CA);
- e) The airframe, engine, and propeller logbook records were up-to-date;
- f) The aircraft weight and balance parameters were within the prescribed limits;
- g) The prevailing weather conditions were VMC;
- h) The aircraft performed three touch-and-go landings in SSSC, and returned to SSKS;
- i) The instructor-pilot reported problems with the elevator, and told that they would land in SSKS in three minutes;
- j) Upon joining the downwind leg in SSKS, the aircraft made an abrupt pitch-up maneuver and entered a spin;
- k) The pilot managed to recover from the first spin;
- l) The aircraft entered into a new spin, and crashed into the ground;
- m) During the flight, the structure of the elevator sustained plastic deformation, and it got stuck in a pitch-up setting;
- n) The elevator-trim cable broke in flight on account of overload;
- o) The frontal collision of the aircraft with the terrain occurred at a pitch-down angle of approximately 90 degrees;
- p) The whole structure of the aircraft was substantailly damaged; and
- q) The pilots perished in the crash.

3.2 Contributing factors

- Attitude – undetermined

The excessive confidence demonstrated by the instructor in his own piloting ability may have made him perform once more a maneuver not prescribed for the training session, similarly to what had already been done in previous training flights, probably in the presence of a complacent student, since that instructor's behavior was known to everyone in the flying school, and he had never been questioned before.

- Motivation – a contributor

The instructor-pilot's deep passion towards flying led him to offer himself as instructor of the training flight which culminated in the accident, even without being scheduled or prepared for such. His excessive stimulation for conducting the flight compromised his ability to analyze critically the conditions involving the realization of the flight without prior planning.

- Decision-making process – undetermined

The instructor's excessive self-confidence and motivation may have contributed to the valorization of aspects not relevant for the training, such as the performance of non-prescribed maneuvers, in disrespect of the operational limits of the aircraft.

- Work-group culture – a contributor

The acceptance by the other instructors and students of the inappropriate attitudes of the instructor-pilot during training flights, such as the one that occurred on the accident flight, reflected that the group culture was permissive of unsafe actions, as well as fragile and inconsistent with a flight safety culture. This group's attitude functioned as reinforcement for his continuation of unsafe behavior.

Organizational culture – a contributor

Due to lack of monitoring by the instructors, and lack of standardized organizational and operational procedures, it was observed that the organizational culture was permeated by informal attitudes which did not value operational safety and, consequently, affected the flight in question.

- Training – undetermined

The flying school did not have a training program aimed at the instructors, and the justification was that they had been trained as pilots at the very flying school. However, this condition led to discontinuation of the monitoring and development of their professional formation as instructors.

- Work organization – a contributor

The flying school did not have routines and formal procedures established for both the training delivered and for the instructors, something which contributed to attitudes of improvisation on the part of the instructors during the flights.

Furthermore, the instructors' workload was intense with only short intervals between flights, hampering, for example, the conduction of briefings and debriefings, thereby generating a training routine based on informal and even unsafe parameters.

- Organizational processes – a contributor

The flying school utilized subjective criteria for the recruitment and selection of personnel, and the process simply consisted of interviews with the company owner. On the other side, it did not have a system for monitoring the performance of the instructors,

favoring the adoption of behaviors and attitudes by instructors that compromised flight safety.

- **Support systems – a contributor**

The lack of formalization in the flying school concerning the procedures to be adopted for training flights favored the adoption of an improvisation behavior and subjective evaluation criteria, which compromised flight safety.

- **Flight indiscipline – undetermined**

There is a possibility that the instructor deliberately conducted unauthorized aircraft maneuvers, generating load factors that were not supported by the elevator structure, causing its deformation and subsequent locking.

- **Piloting judgment – undetermined**

There is a possibility that the instructor ignored the aircraft operational limitations, and subjected it to loads above the prescribed limits, demonstrating inadequate assessment of aspects related to the aircraft operation.

- **Aircraft maintenance – undetermined**

It is possible that an improper adjustment of the elevator amplitude contributed to its getting stuck.

- **Managerial supervision – undetermined**

Because the performance of acrobatic maneuvers is considered as the most probable hypothesis for the locking of the elevator, it is possible that inadequate supervision by the management in relation to the implementation of operational activities contributed to the accident, since flight indiscipline was recurrent in the company and managerial supervision was not able to curb the such behavior.

4. SAFETY RECOMENDATION

Safety Recommendation is a measure of preventative or corrective nature issued by the SIPAER Investigation Authority (or by a SIPAER-link) within their respective area of responsibility, aiming at suppressing a hazard or mitigating a risk generated by a latent condition, or an active failure. It results from the investigation of an aeronautical occurrence, or from an action of prevention, and shall never be used for apportion of blame or civil, criminal or administrative liability.

In accordance with the Law 7565/1986, the recommendations are issued solely for the benefit of flight safety, and shall be treated pursuant to the provisions of the NSCA 3-13 (“Protocols of Civil Aviation Aeronautical Occurrences Investigations conducted by the Brazilian State”).

Recommendations issued concomitantly with the publication of this report:

To the National Civil Aviation Agency (ANAC):

A - 020/CENIPA/2014 - 01

Issued on 22/04/2016

Conduct administrative negotiations with the Aero Agrícola Santos Dumont company aiming at an effective participation of the company's Operation Safety Manager in raising the operations safety level.

Publicize this report to operators and maintainers of C-140 aircraft, and work with them so that they identify any friction marks on the elevator leading edge, and correct any inappropriate adjustments of the amplitude of the elevator.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN

On 5 and 6 February 2014, still during the investigation of the accident, the SERIPA V delivered classes at the Aero Agrícola Santos Dumont on flight safety, addressing issues, such as, the SIPAER, aircraft accident prevention tools, and flight indiscipline, among others.

On 9 May 2014, during the investigation of the psychological aspect related to the event, the SERIPA V delivered a class on aeronautical accidents case studies, addressing issues, such as, planning factors, flight indiscipline, meteorology, theoretical preparation, maintenance, weight and balance, fuel, Crew Resource Management (CRM), and role of flight instructors in training, among others.

On April 22th 2016.

