DATA SUMMARY

LOCATION

Date and time	**Wednesday, 2001 August 8th; 9:30 hours**
Site	**Fuentesaúco de Fuentidueña (Segovia)**

AIRCRAFT

Registration	**EC-FJG**
Type and model	**PIPER PA-36-300**

Engines

Type and model	**LYCOMING IO-540-K1G5**
Number	**1**

CREW

Pilot in command

Age	**32 years**
Licence	**Airplane commercial pilot**
Total flight hours	**250 hours**
Flight hours on the type	**Without data**

INJURIES

	Fatal	Serious	Minor
Crew		**1**	
Passengers			
Third persons			

DAMAGES

Aircraft	**Important**
Third parties	**None**

FLIGHT DATA

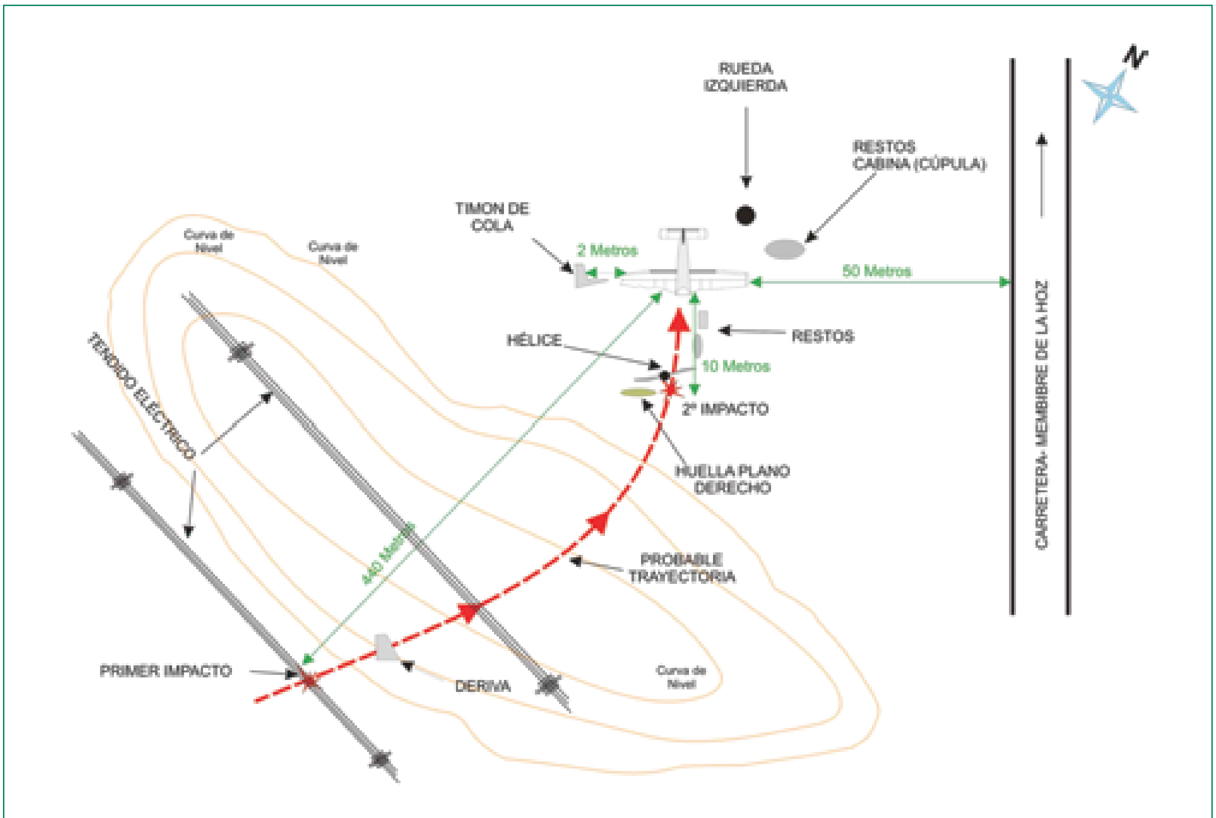
Operation	**Aerial work – Commercial – Agricultural**
Phase of flight	**Manoeuvring – low flying**

1. FACTUAL INFORMATION

1.1. History of the flight

The pilot was fumigating on an irregularly-shaped beet field. A power line ran along the side of the field. Beyond the power line, the land rose forming a hill, with a second power line behind it. The pilot was carrying out the spray runs so that at the end of each run he would pass under the first power line, then immediately climb to clear both the hill and the second power line, and finally turn to begin another spray run.

During what was supposed to be the last spray run, with the hopper practically empty, the aircraft impacted against the two lowermost wires of the three-wire power line that ran along the edge of the field being sprayed. These impacts were produced somewhere in between the protective cable that goes from the wire cutting sheet located in the front of the cabin to the uppermost end of the vertical stabilizer (fin).



Due to the impact with these two wires the fin and rudder were detached from the aircraft, although the latter remained linked to the fuselage through the control cables. The electric wires were left frayed and tangled, but remained in place without breaking completely.

Then the aircraft impacted with the terrain about 440 metres from the point where contact was made with the power line, approximately in the same direction as the spray run.

1.2. Markings of impact against terrain and wreckage distribution

On the ground, an impact marking was found of the leading edge of a wing. Beside that mark, the impacts of the nose and the aircraft engine were found. This is where the propeller became detached.

The aircraft was left 10 metres away from the aforementioned marks in a normal attitude, but turned approximately 180° with respect to the direction of flight.

The aircraft's nose and engine were crushed rearward and downwards. In other words, the nose was almost entirely deformed up to the leading edge of the wing, the landing gear and half of the hopper's length.

The right wing showed signs of a strong impact on the exterior two-thirds of the leading and marginal edges. The left wing did not show any signs of significant damage.

1.3. Interview with the pilot

Investigators had the chance to interview the pilot once he had recuperated from his multiple injuries in order to learn about the sequence of events in more detail. The following is a summary of the information obtained:

He carried out the last spray run and when he was passing under the power line he heard a noise, like a vibrating metal sheet, which he interpreted as the aircraft getting entangled with an electric wire. Comments he had heard other pilots make about what happened in these cases immediately came to mind: «first you notice the entanglement and afterwards a sudden jerk is felt when the cable becomes taut». As a result, once he heard the sound, he did not take any action and waited for the sudden jerk. When this occurred, his left hand, held over the liquid tap lever, was torn by the lever, causing him a great deal of pain. He also recalled that at the moment of the pull, he heard the sound of the tearing of the two vertical straps of the safety harness.

He also noted at the moment of the jerk that a lot of air was entering from the back, and therefore he realized that he had lost the vertical empennage.

Since the aircraft continued flying he initiated the emergency landing procedure, and made a shallow turn to the left, in order to find a suitable field to land. When he first saw an appropriate reaped grain field he reduced power, without completely closing the throttle because he remembered of an accident of a colleague where an aircraft had similarly got entangled with a cable and lost the vertical stabilizer in which, when the pilot closed the throttle down, the aircraft fell suddenly to the ground.

He extended the flaps and carried out the landing in a relatively gentle manner, although once on the ground the landing roll was quite rough. To shut the engine down, he pulled and turned hardly the mixture lever with his left hand, and he fell unconscious because that hand was injured.

When he recovered the consciousness, the aircraft was falling steeply nose down to the ground, his body was hanging head down from the harness straps and his head was leaned towards his chest. He could see how the straps had an intense blue color and how they broke due to the weight of his body before the impact, the left strap in first place and then the right strap. He did not remember views of the exterior previous to the impact.

2. ANALYSIS

2.1. Impact sequence

According to the damages observed on the fin and on the sheet of the wire deflecting cable of the aircraft, the sequence of the impacts with the high tension power wires can be intended to be deduced as follows:

a) One of the electric wires was jammed in the sheet of the end of the wire deflecting cable of the aircraft and eventually broke that cable due to shearing. The cable remained joined in the other end to the wire cut blade installed on the roof of the aircraft.

b) One of the electric wires went above the sheet of the end of the wire deflecting cable and left scratches and other witness marks there.

c) The catenary of the wire deflecting cable was deformed in such a manner that produced interference with the leading edge of the vertical fin from a point located half a meter below the fitting of the wire deflecting cable.

d) The sheet of the end of the wire deflecting cable was deformed towards the left, in the same manner as the deformation noted on the leading edge of the fin. The sheet twisted to the left and broke from its fitting to the fin, which is also coherent with the previous deformations.

e) The interference of the electric wire with the fin and the significant increase of the curvature of the catenary of the wire deflecting cable show that the rear end of that cable moved due to either the breakage of its fitting to the fin or the breakage of one fitting of the fin base.

Consequently, the most likely hypothesis is that the first wire slipped over the wire deflecting cable and passed above the vertical stabilizer. The fin and the rudder remained in place, but it is possible that the catenary of the wire deflecting cable increased and the sheet of the end of the cable was deformed and even the attachment of the fin to the fuselage was damaged.

The impact of the second electric wire eventually damaged the weakest fitting, in such a manner that the relative position of the rear end of the cable was changed. Due to this fact, the electric wire was trapped in the sheet of the deflecting cable cutting it at that point. At the same time, the increase of the catenary allowed the interference of the electric wire with the leading edge of the fin, in which it finally was locked producing the detachment of the fin from the fuselage.

Although no marks of the landing of the aircraft previous to the final impact into the ground were found, due to the fact the area had been subject to intense traffic of vehicles and personnel of the emergency services, that also prepared firebreaks, it is probable that the landing was carried out in a gentle manner, as stated by the pilot.

The marks of the final impact were well noted and documented. The aircraft wreckage was concentrated in a very small area around the spot where it impacted against the terrain, with the exception of the vertical stabilizer that was found in the vicinity of the power line where the first impact occurred. That shows that the impact with terrain had a large vertical component. On the other hand, in light of the damages suffered by the aircraft and the markings left on the terrain, it is presumed that the aircraft was close to an inverted flight at the time of the final impact.

It is quite probable that after the landing the aircraft was uncontrolled, due to the loss of conscientiousness of the pilot and the high speed of the aircraft, together with the big amount of lift produced by the wing in the full flap configuration that made the aircraft to become airborne again until it fell crashing heavily into the ground.

During this impact, the two upper chest straps of the safety harness might have finished breaking, allowing the upper body of the pilot to be thrust forward until impacting against the instrument panel, mainly with his head. This caused serious injuries to his face that put his life at risk.

2.2. Aircraft controllability

During the first impact with the power line, the aircraft lost its vertical stabiliser and rudder. The loss of the vertical stabilizer makes the aircraft flight to be unstable and not having the rudder, the pilot is unable to counter this instability. In this situation turn out well:

— Land as soon as possible (not prolonging the flight until a better landing site is found).

— Reduce to the utmost actions that might result in forces acting upon the vertical axis.
— Handle the flight and engine controls gently.

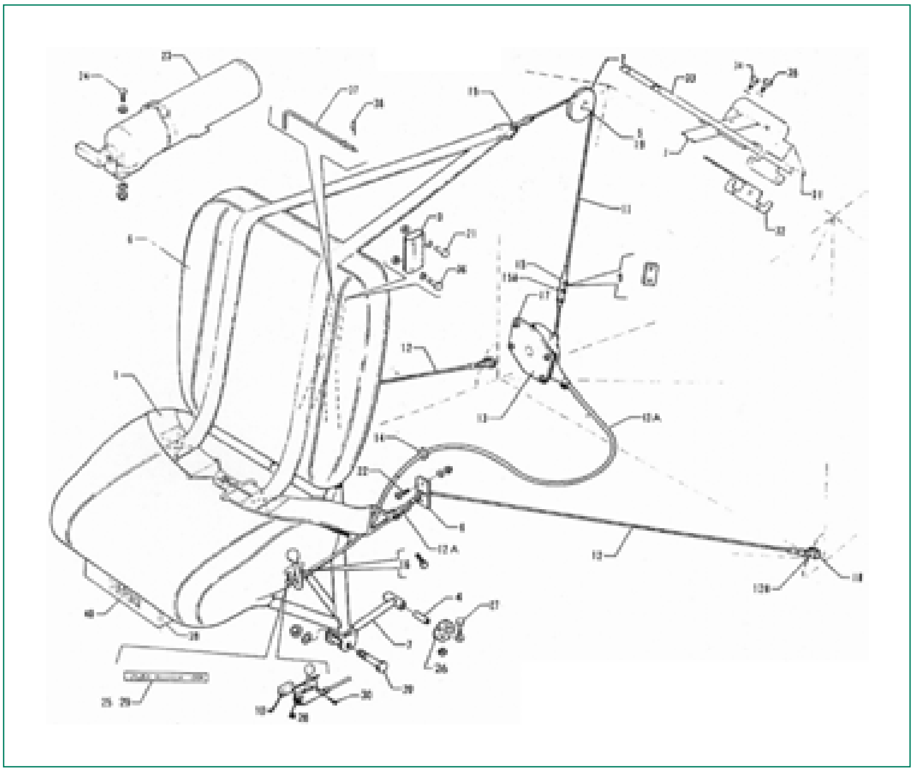
2.3. Evaluation of survival factors

As has already been stated, during the impact the two upper chest semi-straps of the safety harness were torn, allowing the upper body of the pilot to be thrust forward until impacting, mainly his head, against the instrument panel, causing serious injuries to his face.

2.3.1. *Safety harness properties*

The entire safety harness unit (see diagram) is composed of the following parts:

— Safety harness lap belt which is divided into two parts that are joined to each other through a buckle and that are attached to the structure of the aircraft. Sewn to the safety harness lap belt are two chest straps, one on each part, that make up the lower part of the shoulder straps.



— The upper part of the harness is formed by a single item that has each end joined to each one of the lower shoulder straps through a fitting that also adjusts the length of the strap. In the upper part it passes through the buckle that joins to a tightening cable so that when it folds over it forms the two upper chest semi-straps. This upper chest strap is sewn onto itself in the area next to the buckle.

This last component (upper semi-straps of the safety harness unit) which was torn during the impact with the terrain, could not be recovered. However, the rest of the components that make up the harness were found, that is, the lower part of the safety belt. Therefore, the lower part of the shoulder straps was obtained. Identification marks were not found on the lower part of safety belt recovered.

These components were sent to the National Institute of Aerospace Technology (Instituto Nacional de Técnica Aerospacial, INTA) for analysing.

2.3.2. *Technical specifications applicable to safety harnesses*

The aircraft PA-36-300 has a Type Certificate number A10SO issued by Aeronautical Authority of USA on date 19th December 1974, like Restricted Category aircraft and a MTOW of 4.800 pounds (2177 Kp). According to this Type Certificate, the airworthiness regulations for certification wasd FAR 23, effective February 1st, 1965; and including amendments 23-1 through 23-6 dated August 1st, 1967; with a few exceptions based on its operational limitations because of its Restricted Category.

At that moment, the main paragraphs applying to the conditions of the safety harnesses into FAR 23 were 23-561, 23-785 and 23-1413. Basically, the aircrafts certified under FAR 23 on Normal Category must be able to support 3 g´s upward and 9 g´s forward. The attachement points to the structure must be able to support these loads multiplied by a fitting factor of 1.33.

It is remarkable that FAR 23 does not point out that the seatings or restraint systems must be «approved», as it is point out by FAR 25 («approved» is considered like carry out with corresponding TSO). Nevertheless though it is not explicit asked, the normal way is that the safety harnesses carry out with corresponding TSO. In the case of PA-36, it would be the TSO C-22-f of 1972. On the straps of safety harnesses recovered we did not found marks or stamps of branch and certification, well due to they had been loss, as they would be on straps did not recover.

The FAA Technical Standard Order TSO C-22-f defined the minimum performance standards for seat bealts and required that they meet the standards set out in National Aircraft Standards (NAS) Specification 802, with some exceptions. One of this exceptions is that NAS 802 requirede a minimum rated strength for a belt assembly of 3000 pounds, and however the TSO C-22-f specified that this be reduced to 1500 pounds

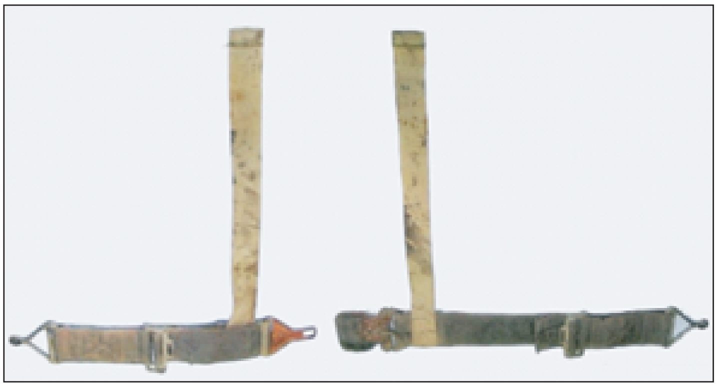
(680 kp) (6674 Nw). It also is specified that minimum breaking strength of the webbing shall be at least the 150% of the assembly rated minimum strength, ie 2250 pounds (1020 kp) (10012 Nw).

Also are defined the conditions under testing to check the strength should be carried out, whether for web straps as for restraint system. Both cases by tensioning the loads over the samples at a maximum rate of 4 inch by second (10,16 cm/sg).

According to these airworthiness regulations and thecnical requirements that are suitable to this safety harness, we must suppose that the web straps had in origin an ultimate strength included into 1500 and 2250 pounds (from 680 kp to 1020 kp) (from 6674 Nw to 10012 Nw).

2.3.3. *Visual inspection of safety harness*

At the point where the chest strap is sewn to the lap strap, a hand-made stitch can be observed. A marked discoloration is also observed in the lower chest straps if, once the lap straps have been unsewn, the areas that have been exposed to the sun are compared to those that have not been. This discoloration suggests deterioration in the shoulder straps caused by ultraviolet radiation, although the deterioration is difficult to quantify based only on this fact.



In this regard, it must be taken into account that in addition to atmospheric agents, seat harnesses are also exposed to the chemical substances present in the treatment products used which could modify their properties without significantly altering their appearance.

2.3.4. *Testing of safety harnesses*

A tensile test was carried out on two samples obtained from one of the chest straps, which had previously been unsewn from the lap strap. The second strap has been set aside in case another type of testing is needed under different conditions or according to some regulation that has yet to be found. It is assumed, however, that both shoulder straps are in similar conditions.

The following results were obtained for the ultimate strength prior to tearing:

— Sample #1: 129 Kp (1265 Nw).
— Sample #2: 120 Kp (1176 Nw).

In both cases, the fraying began at about half the maximum load. The speed of load applied to the sample was 0,166 cm/sg, below the maximum tensioning rate specified by TSO C-22-f.

It is considered definitive the fact that the results obtained were significantly lower than those stated in the aforementioned regulations, lead one to believe that the properties of the shoulder straps did not withstand the stresses to which they were designed.

The upper semi-straps that tore during the accident could have had a lower load to failure than that of the semi-straps tested (lower) because that is where the failure took place and that has to be the weakest point.

On the other hand, there is a prior case of an accident involving another aircraft of a similar model whose harness showed apparent signs of severe deterioration. This harness was submitted at the time to the same type of tensile testing as in the aircraft in this accident, resulting in an average load to failure of 697 Kp (6.832 Nw).

Comparing the results obtained in both tests, it can be seen that the loads to failure of the harness of the aircraft involved in this report are around 5 times lower than those corresponding to the other aircraft. This leads one to conclude that its deterioration was extremely severe, despite the fact that its appearance was better.

Lastly, results are available from a tensile test done to a harness from another kind of aircraft, specifically a glider model Schleicher Ka-6-BR, registration marks PH-1204, that suffered an accident in Spain (reference A-037/2002) 24th of June 2002, even though in this case the sample tested was from the waist harness instead of the chest straps. In this test the load to failure was about 2.750 Kp (26.968 Nw). This harness, considered to be in good condition, supported loads twenty times greater than the sample analysed in this report.

2.3.5. *Other background information*

Two reports have been found, one from the UK Aircraft Accident Investigation Branch (AAIB) (Ref. EW/C96/8/12. Bulletin n° 2/97) and the other from the US National Transportation Safety Board (NTSB), (Ident. SEA97LA104. Cessna T188C, N3152J) that deal with cases very similar to the present one with respect to the tearing of the safety harnesses.

In the first case, the harness straps had a design ultimate strength of 1100 lb. (499 Kp., 4.893 Nw) and the tests resulted in loads to failure between 256 and 518 lb. (116

Kp/1.139 Nw and 235 Kp/2.304 Nw). A safety recommendation was made to the Civil Aviation Authority to carry out an inspection programme for safety harnesses in order to determine their fitness for continued use and, if need be, to impose a life limitation on them.

The second case involved an aircraft of a restricted category (agricultural) whose harness, the one originally installed in the aircraft, had a single shoulder strap with significant deterioration due to ultraviolet radiation. The recommendations set forth by the NTSB lead the aircraft manufacturer to send out a service bulletin asking to replace the original safety harnesses of certain aircraft within a maximum time period of one year.

2.3.6. *Safety belt maintenance*

The aircraft's maintenance manual states that the safety harnesses should be replaced when they are cut, frayed or showing significant signs of deterioration. With regards to this, it should be noted that the harness parts recovered from the aircraft did not show any of the aforementioned signs of deterioration. The only thing that was observed was discoloration when the harnesses were unsewn and areas previously unexposed to the sun came into view.

The age of the harness has not been determined since neither the safety harness nor the aircraft documentation contained this information. The evidence found in this accident lead one to believe that safety harnesses with a considerable amount of deterioration may be currently in use.

3. CONCLUSIONS

3.1. Findings

The system of protection of the aircraft against the impact with electrical wires was damaged by the impact with the first of the wires. This damage made the second wire to be trapped with the rear fitting of the cable and to interfere with the fin.

After the loss of the vertical stabilizer, the pilot managed to reach the ground with the aircraft under control, although afterwards the aircraft became uncontrolled, possibly due to the loss of conscientiousness of the pilot.

The shoulder straps of the safety shoulder harness were found degraded and broke during impacts produced at the first stages of the event, leaving the pilot unprotected against the final and most violent impact of the aircraft.

3.2. Causes

The cause of the accident was the impact of the aircraft with power lines, which resulted in the detachment of the vertical empennage, which caused the pilot to lose the control of the aircraft and led to the aircraft violently impacting against the terrain. The reduced strength of the shoulder straps of the safety harness contributed to the pilot suffering injuries of a more serious nature.

4. SAFETY RECOMMENDATIONS

REC 04/04. Due to the fact that the safety harness was degraded and was still in service in accordance with its maintenance schedule «on condition», it is recommended that the aircraft manufacturer, The New Piper Aircraft, and the Type Certification Authority, the FAA, study and set up new maintenance criteria of the safety harnesses of aircraft of this type, even with the goal of limiting their service life.

REC 05/04. Faced with the possibility that the safety harnesses of a majority of the aircraft fleet dedicated to agricultural work are in severe conditions of deterioration similar to those of this aircraft, it is recommended that the Civil Aviation Authority (Dirección General de Aviación Civil) carry out an inspection programme amongst such aircraft, in order to assess the condition of the installed safety belts, to determine their fitness for continued use, and, depending on the results, to establish service life limits if needed.