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FINAL REPORT

**ON SERIOUS INCIDENT OF THE AIRCRAFT PIPER PA-44,
REGISTRATION OM-ARC**

**28 MAY 2021,
EN ROUTE LZKZ-LDRI**



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OCCURENCE INFORMATION

Type of the occurrence:	Serious incident
Date:	28 May 2021
Local time:	13:35
Place:	On route LZKZ-LDRI
Type of the aircraft:	Aeroplane
Manufacturer / model:	Piper Aircraft/PA-44-180
Registration:	OM-ARC
Owner:	Termaltech s.r.o
Operator:	Rera Air s.r.o
Number of persons on board:	Three
Injuries:	No injuries
Damage to the aircraft:	Minor material damage

INVESTIGATION

The Air, Maritime and Railway Traffic Accident Investigation Agency received information about a serious incident on the same day from the MUP OCCZ (Ministry of the Interior - Civil Protection Operations Centre) and Rijeka Airport. AIA investigators performed a technical inspection of the aircraft.

Upon completion of the investigation in question, the Air, Maritime, and Railway Traffic Accident Investigation Agency issued this Final Report.

SUMMARY

On 28 May 2021, on the route LZKZ (Košice, Slovakia) - LDRI (Rijeka, Croatia), there was a complete loss of electrical power on the aircraft. The aircraft landed on Rijeka Airport with retracted landing gear. There were three people on board, a pilot and two passengers. No injuries were sustained in the serious incident in question. Minor material damage occurred to the aircraft.

The investigation determined that this serious incident was caused by a human factor.

AIA issued safety recommendations to the Slovakian Aviation Authority and maintenance mechanic.

1. FACTS AND INFORMATION

1.1. FLIGHT INFORMATION

On 28 May 2021, at 10:30, the pilot and two passengers took off with PA-44-180 aircraft, registration mark OM-ARC, in accordance with the flight plan LZKZ-KEKED-KOPRY-KULEN-LDRI and IFR rules (Instrument Flight Rules). The take-off and flight to Croatia proceeded without problems at an altitude of 12,000 feet. Above the area of the City of Zagreb, the air-traffic controller asked the pilot to check the operation of the transponder. At this point, the pilot noticed that the voltage of both alternators was outside the normal range, i.e. that the alternators did not produce electricity.



The pilot reported the mentioned problem to the controller and continued towards Rijeka Airport and he tried to eliminate the technical problem along the way.

He informed the controller that due to the degradation of the navigation devices, he would continue towards the KULEN point, reduce the altitude to 7000 ft., and that he would make a visual approach to Rijeka Airport. The pilot gradually switched off electricity consumers; light, ADF (Automatic Direction Finder), and left on both GARMIN (GPS/NAV/COM) devices and transponder. Several times he tried to turn on the alternators but without success. During the preparation for landing on Rijeka Airport he lowered the landing gear lever, the landing gear did not extend. He then tried to lower the landing gear using the emergency extension however he could not pull the lever.

On several occasions the pilot flew over Rijeka Airport to check the position of the landing gear. Considering that at the current altitude the signal from mobile operators was available, he contacted a mechanic in Slovakia to try to get advice on the said technical issues.

He also contacted Rijeka Airport tower controllers by phone to check if they see the condition of the landing gear. He was informed that the landing gear was not visible in the extended position and was granted permission to land. The aircraft landed on Rijeka Airport, runway direction 32, without extended landing gear at around 13:35 LT.

1.2. INJURIES

Injuries	Crew	Passengers	Others
fatal	0	0	0
serious	0	0	0
minor / none	1	2	0

1.3. DAMAGE TO THE AIRCRAFT

At Rijeka Airport, the aircraft was inspected by AIA investigators during which the following damages common to landing without a landing gear extended were determined. The stringers on the underside of the fuselage and both propeller blades on both engines were damaged.



Picture 1 – Damage to the tip of the propeller blade



Picture 2 – Damage to stringers of the fuselage



Picture 2 – Aircraft OM-ARC at the site of the serious incident

1.4. OTHER DAMAGE

During the serious incident no other damage occurred, other than those to the aircraft in question.

1.5. PERSONAL INFORMATION

1.5.1. Pilot

Male person, Slovak citizen born in 1967. The person in the serious incident in question was in the function of the pilot of the aircraft and was sitting in the front left seat. He possesses a valid CPL(A) pilot license with CRI (ME), towing, SEP(land), FI(A), IR-ME authorizations issued by the Slovak aviation authorities in 2018. He has been flying for 34 years, and until the time of the serious incident in question, he had 1,010 of flight hours, 20 of which on the PA-44 type in the last 90 days. He has been a flight instructor since 2018.

He possesses a valid Medical Certificate with a restriction “VNL Correction for defective near vision” (Correction for impaired myopia) issued on 6 November 2020.



1.5.2. Passengers

Two passengers, Slovak citizens, were on board during the serious incident in question. Both passengers have experience in flying the aircraft.

1.6. AIRCRAFT INFORMATION

Piper PA 44-180 / Piper Seminole

Manufacturer / model: Piper Aircraft/PA 44-180, Seminole
MTOW: 1156 kg

Piper PA-44 aircraft is a low-wing twin piston engine aircraft of metal construction. The fuselage of the aircraft is not pressurized. The landing gear is retractable, type tricycle. The aircraft fuselage has one door on the right for entry of the crew and passengers. This model of the aircraft has four seats. The purpose of this aircraft is multiple. Therefore, this aircraft can be used by private users to transport passengers and luggage, then by school pilot training centres as well as for other sports purposes.

Piper PA 44-180 / Piper Aircraft, registration OM-ARC

Registration:	OM-ARC
Year of manufacture:	1981
Aircraft serial number:	44-8095018
Engine 1&2 type:	Lycoming O-360-E1A6D/LO-360-E1A6D
Propeller 1&2 type:	Hartzell HC-2CYR-2CEUF/HC-2CYR-2CLEUF
Total flight hours:	4450.35
Total number of cycles:	1309 (since 2008)
Owner/Operator:	Termaltech s.r.o

The Aircraft Registration Certificate was issued on 22.05.2014, and the Airworthiness Certificate was issued on 26.11.2008. Both certificates were issued by the Slovak aviation authorities. The Airworthiness Review Certificate was issued on 30.04.2021 by CAMO organization SK.MG.022. The last maintenance of the aircraft was performed by a certified aircraft mechanic, on 23.04.2021, and a valid Certificate of Release to Service in accordance with the regulation Part ML, EU 1321/2014 was issued.

1.7. METEOROLOGICAL DATA

At the time of the serious incident on 28 May 2021 around 15:00 LT, the meteorological conditions were favourable for flying the aircraft in question.

On the day of serious incident in period from 08:00 UTC until 11:00 UTC, METAR reports for LDZA airport were as following:

SA 28/05/2021 11:00->
METAR LDZA 281100Z VRB01KT 9999 FEW042 20/11 Q1020 NOSIG=



SA 28/05/2021 10:30->
METAR LDZA 281030Z VRB02KT 9999 FEW035 SCT045 19/10 Q1020 NOSIG=
SA 28/05/2021 10:00->
METAR LDZA 281000Z VRB03KT 9999 SCT038 18/10 Q1020 NOSIG=
SA 28/05/2021 09:30->
METAR LDZA 280930Z VRB03KT 9999 FEW027 SCT035 18/10 Q1021 NOSIG=
SA 28/05/2021 09:00->
METAR LDZA 280900Z VRB01KT 9999 FEW023 SCT035 18/11 Q1021 NOSIG=
SA 28/05/2021 08:30->
METAR LDZA 280830Z VRB04KT 9999 FEW023 17/11 Q1021 NOSIG=
SA 28/05/2021 08:00->
METAR LDZA 280800Z VRB02KT 9999 FEW018 17/11 Q1021 NOSIG=

1.8. COMMUNICATION

During the flight in question, and after entering the Croatian airspace, the pilot communicated with the competent controller via radio, on the corresponding frequencies. By the time the electrical system failure occurred to the aircraft, communication had become intermittent and unclear. After the electrical system failure, and near Rijeka Airport, the pilot contacted Rijeka Airport tower with his mobile phone to coordinate the landing. He also used a mobile phone to communicate with a mechanic in Slovakia to try to rectify the mechanical failure of the landing gear.

1.9. AIRPORT INFORMATION

Rijeka Airport is registered for public domestic and international air traffic. It is located on the island of Krk in the municipality of Omišalj. The airport operator is the company Zračna luka Rijeka d.o.o. At the airport there is a runway with length of 2500 m, width of 45 m, of direction 14-32, and several taxiways and parking positions. The traffic in 2019 was 200,841 passengers, while 4942 air operations were performed. This turnover was mostly realized during the summer months.

1.10. FLIGHT DATA RECORDERS

The aircraft was not equipped with the Flight Data Recorder or the Cockpit Voice Recorder.

1.11. INFORMATION ON REMAINS AND ACCIDENT SITE

After landing, the aircraft stopped at the runway direction 32.

During the serious incident in question, the following damages occurred to the aircraft:

- Lower side of the fuselage and associated antennas.
- Both propeller strikes.

1.12. SEARCH AND RESCUE

Since the aircraft in question landed on the runway and there were no injuries of the participants during the serious incident, there was no need for a search and rescue operation. Prior to landing, all necessary airport services were on standby.

1.13. TESTING AND INVESTIGATION

1.13.1. Technical aircraft airworthiness

On Rijeka Airport the aircraft was inspected by an AIA investigator and a certified aircraft mechanic for the subject aircraft type engaged by AIA for the purposes of the investigation, and a check of the technical airworthiness of the aircraft and its components was performed.

The preliminary inspection established that battery state of charge is very low, and that the radio devices could not be started solely on that power source.

It was determined that there was a poor connection of all electrical conductors on the alternator no. 1, especially on the alternator field conductor. The presence of surface corrosion on the conductors themselves was also visible. In addition to the above on the alternator no. 2 there was a complete separation of the field wire from the terminal itself attached to the alternator.

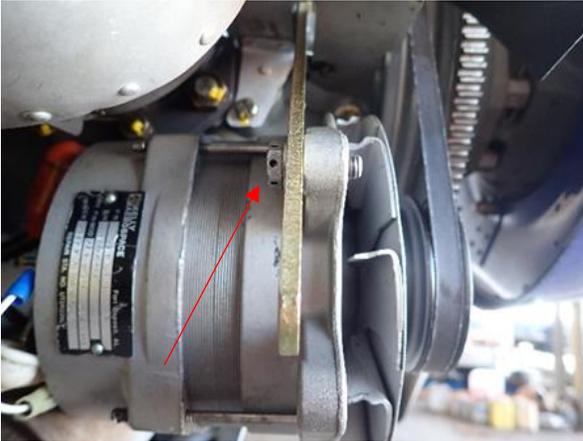


Picture 19 – Poor connection of field wire and contact



Picture 21 – Alternator field wire separated from contact

It was also determined that one of the bolts on the alternator no.1 belt tensioning lever was not secured with safety wire (Picture 20). The number of threads outside the nut on the alternator bracket bolt was out of the standard. One of the bolts on the alternator no. 2 bracket was completely missing the nut (Picture 22).



Picture 20 – Bolt without safety wire



Picture 22 – Bracket bolt without nut

No signs of malfunction were visible on other components of the electrical system.

The inspection of the landing gear and associated components determined that the steel cable of the emergency landing gear extension command was blocked inside the outer shield due to the presence of corrosion or mechanical damage and could not be moved. The plastic lever of the same control separated from it very easily. A metal fuse of the plastic lever was found on the floor under the pilot pedals. The emergency landing gear extension valve had a full deflection with no visible signs of malfunction. Furthermore, other components of the landing gear system were in good condition without visible mechanical damage.

1.14. ADDITIONAL INFORMATION

1.14.1. Statement of the pilot

In his statement, the pilot stated that he took off with aircraft around 10:30 from Košice (LZKZ) in accordance with the flight plan. There were three people on board. The flight took place at an altitude of 12,000 ft in the direction of the KOPRY point through Hungarian airspace. After entering Croatian airspace, the aircraft was moving in the direction of Zagreb. At the moment when they were above the City of Zagreb, the controller instructed him to check the operation of the transponder. At this point, the pilot noticed incorrect output current values on both alternators. He reported the failure on the Zagreb Info frequency and started looking for the cause of the failure of both alternators. He checked the fuses and reset the alternator switches.

After checking the condition of the fuse and the switch, he reported on the frequency that he would continue the flight toward the KULEN point, and that he would try to find the cause of the failure. After trying to find the cause of the failure, he reported on the Zagreb Info frequency that he would continue towards the KULEN point, after which the controller informed him that the runway direction in use is 32. He gradually turned off the power sources, i.e., the lights and the ADF (Automatic Direction Finder). Initially, he left both Garmin GPS/NAV/COM radios on and tried to broadcast on both. From time to time, he could hear the controller trying to get in touch with him on the Zagreb



Info frequency, later on the Pula Info frequency. He also left turned on the transponder that operated occasionally as well as the autopilot that he turned off later before descending.

He could not turn on the alternators again, so after the KULEN point, he started descending to 7000 ft. During the approach, he lowered the landing gear extension lever however the landing gear did not extend, probably due to a loss of electricity. He heard a sound similar to the sound of a landing gear being extended but did not see the front landing gear in the control mirror. He then tried to pull the emergency landing gear extension lever but was not able to.

Considering that the landing gear did not extend, he tried to fly over near the Rijeka Airport tower on several occasions to check the status of the landing gear. As he was receiving a signal from a mobile phone device at that altitude, he also called a mechanic in Slovakia to get advice on what to do. He was trying to pull the emergency landing gear extension lever while the passenger in the front right seat was operating the aircraft. He also tried again to extend the landing gear electrically, but without success. These attempts lasted about 20 minutes. He tested the minimum landing speed. Then he got a green light for landing from the tower....

The pilot further stated that he contacted Rijeka Airport around 13:28 by phone at 00385 21205444 published in the AIP. The person who answered the call informed them that this was not the number of the tower number and that the tower would call them from 00385 51842272. At around 13:30 the controller from the tower called them and informed them that he did not see the extended landing gear and asked them how much fuel they have and number of passengers. Since the fuel gauge was not reliable, the pilot replied that he had fuel for another 20 minutes of flight. After landing, he established that there were another 100 litres of fuel in the aircraft, but previously he was not sure about the fuel consumption during the flight. After several test circles, he decided to land without the engine running. He went through the Emergency Landing Checklist, checked the passengers' belts, and landed with the flaps in position no. 2. He asked a passenger who has flight experience to turn off the fuel mixture and turn off the engines and cut off the fuel supply. The pilot turned off the magnets about 50 feet above the runway, before landing. At around 13:35 local time, he landed on runway 32 on the longitudinal reinforcements of the fuselage envisaged for landing without the extended landing gear. After landing, everyone left the aircraft.

1.14.2. Pilot comment on draft of the Final report

In his comment on the draft of the Final report pilot states how he planned flight according IFR rules due to weather forecast, in some parts of the flight there was no visual contact with the ground surface. Above Zagreb aircraft was above clouds with reduced IFR capability (due to electrical system failure). Based on the weather briefing, he knew that the weather around Rijeka airport will be VFR. In accordance with the radio communication loss procedures during IFR flight in IMC condition he continued the flight towards destination. In addition, pilot states how he also considered that in case of emergency landing (with landing gear retracted) at ZL. Zagreb he would cause a several hours delay since this airport is busy. Based on all information written above, and after discussion with the rest of the persons on board, which are all active pilots, he decided to continue the flight towards ZL. Rijeka.

In addition, he states that there is a toolbox on board of the aircraft which includes pliers. After few failed attempts to pull the emergency landing gear lever, he tried to pull it with pliers after which plastic lever separated from the steel cable.



Now, after this emergency is behind him, he thinks that the procedure for the emergency condition should state: *“Put down undercarriage immediately after complete electricity supply is lost, till you have enough electricity in battery.”*

1.14.3. Pilot operating handbook, Piper PA-44-180

Paragraph 3.5n of the POH (Pilot operating handbook) prescribes the procedure in case of loss of power source from both alternators which contain the following steps:

- Confirm failure
- Reduce electrical load to a minimum
- Reset the alternator switches and fuses

Furthermore, if no alternator can be reset:

- Switch off both alternators, and continue the flight with reduced electrical load only with the battery as the source of electricity
- Land as soon as possible
- Expect complete loss of electricity
- Battery life depends on its previous condition and current load
- The magnetic compass error can exceed 10 degrees
- If the battery is completely discharged, the landing gear should be lowered using the emergency landing gear extension lever.

1.14.4. Aircraft PA-44-180 landing gear system

The type of aircraft in question has a built-in landing gear type tricycle, hydraulically driven. The main components of this system are levers, actuators, hydraulic lines and a hydraulic pump. The hydraulic pump is driven by an electric motor. For normal operation of this system, electricity is required to start the hydraulic pump, and for the correctness of the hydraulic system.

In the event of an emergency, i.e. in the event of a hydraulic or electrical system failure, the landing gear can be lowered by the emergency landing gear extension lever. By pulling the said lever, a valve lever is moved through a steel cable, which connects the return hydraulic line with the hydraulic line under pressure. This completely equalizes the pressure inside the hydraulic system, and the landing gear is extended by gravity.

1.14.5. Aircraft PA-44-180 electrical system

The voltage of the electrical system is 12 V. The main components of the electrical system of the aircraft in question are battery, two alternators (60A), two voltage regulators, and two relays in case of over-voltage. In the event of a malfunction of both alternators, the electricity will be completely drawn from the battery. Battery life will depend on current power consumption and previous battery capacity.

1.14.6. Recording of the radio communication between the controller and the pilot of the subject aircraft

During the listening of the radio communication recording between the pilot of the aircraft and the competent controller, it was established that the pilot made the decision to continue the flight to the destination when he was above the city of Zagreb.



1.14.7. Aircraft maintenance

By the inspection of the aircraft's technical documentation, it was determined that at the last 100-hour / annual inspection of the aircraft in the list of maintenance works, items 47 and 48 in Chapter B were marked with the signature of the mechanic. Item 47 refers to checking the tension of the alternator belt, while item 48 refers to checking the condition and securing of the alternator bracket. In the same chapter, item 56 was also marked by signature, which refers to the inspection of electrical lines on the engine. In Chapter I, item 4, which refers to the operational check of the alternator operation, i.e., the check of the alternator output, is marked with the signature of the mechanic.

In Chapter G, item 23 refers to the operational check of the landing gear operation, which was signed by the mechanic.

From the issuance of the last Certificate of Release to Service until the day of the serious incident, the aircraft flew for 5 hours and 40 minutes. All the listed tasks on the list of maintenance tasks as well as the Certificate of Release to Service were signed by one person, the mechanic.

Commission Regulation (EU) no. 1321/2014 of 26 November 2014 on the continuing airworthiness of aircraft and aeronautical products, parts, and appliances, and on the approval of organisations and personnel involved in these tasks, ED Decision 2020/002/R, AMC1 ML.A.402(b)(8), describes procedures applied in case of critical maintenance works and maintenance works performed by only one person. The said chapter states that when one person performs maintenance works, methods are used that reduce the possibility of error. Some of these methods are to perform a double or independent inspection of the works.

2. ANALYSIS

2.1. ANALYSIS OF THE COURSE OF EVENTS

The analysis of the course of the event in question established that the aircraft in question was located above the area of the City of Zagreb when the controller informed the pilot to check the operation of the transponder. At that point, the pilot noticed that the power outputs on both alternators were zero. In this case, all the electricity required to operate the consumers (lights and radio devices) was drawn from the battery. It is not known how long such condition existed before the pilot noticed it.

After a brief attempt to determine the cause of the malfunction, the pilot decided to continue the flight to the destination of Rijeka Airport without rectifying the failure. Before continuation of the flight pilot also consulted passengers on board due to their flying experience. Since at that point aircraft was above few, scattered clouds, and aircraft IFR capability was degraded, pilot continued toward destination where he knew that better meteorological conditions are present. The procedure described in the Pilot operating handbook states that in the event of a failure of both alternators, it is necessary to land as soon as possible, and that a complete loss of electricity can be expected. During the continuation of the flight, the pilot could not reset the alternators, i.e., the battery was still the only source of electricity. Until the approach to Rijeka Airport the battery voltage was so low that it was not possible to start the electric motor of the hydraulic pump.



The pilot's attempt to pull out the landing gear using the emergency landing gear extension lever was unsuccessful because the control cable was blocked, and the lever detached from the control itself.

At that moment, the pilot could only land with the retracted landing gear on Rijeka Airport.

2.2. ANALYSIS OF TECHNICAL AIRWORTHINESS OF THE AIRCRAFT

During the safety investigation, a check of the technical airworthiness of the subject aircraft was performed, during which a direct connection of the established technical deficiencies with the event in question was determined.

The inspection determined that the loss of power supply occurred due to poor connections of electrical installations on alternator no. 1, and a completely interrupted connection of the excitation of alternator no. 2. Such technical condition is not sufficient to supply the electrical system with electricity. Furthermore, the voltage of the main battery during the technical inspection was at a low level, insufficient to start the radio devices or the hydraulic pump of the landing gear, which is a significantly higher consumer. Also it was determined that both alternator belt tension lever bolts were not properly installed.

On the landing gear system, a technical malfunction of the control cable of the emergency landing gear extension command has been determined. Namely, it was found blocked, most likely due to mechanical damage or corrosion caused between the cable itself and the outer protective shield. Such condition does not allow the command to move. If the lever is pulled with greater force, it separates from the command itself.

The abovesaid confirms the inability of the pilot to extend the landing gear in the normal way or via emergency landing gear extension lever.

2.3. AIRCRAFT MAINTENANCE ANALYSIS

By the analysis of the available aircraft maintenance documentation, it was established that the last 100-hour / annual inspection was performed by one person, a certified mechanic. Such approach to aircraft maintenance increases the possibility of error during the performance of work since there is no organizational system that would establish the procedures in case of one person performing the task. To reduce the possibility of error, it is necessary to use one of the methods listed in Decision 2020/002 / R, AMC1 ML.A.402 (b) (8).

3. CONCLUSION

3.1. FINDINGS

- The pilot of the aircraft possessed a valid Flight Crew License issued by the Slovak Civil Aviation Authorities and a Certificate of Medical Ability with VNL Correction for defective near vision
- For the aircraft a valid Certificate of Release to Service was issued by the aircraft mechanic and the Airworthiness Review Certificate was issued by the organization "Slovensky narodni aeroklub"



- The technical malfunction of the electrical connections on both alternators has been established
- Technical malfunction of the cable for the control of emergency landing gear extension command has been established
- The pilot did not follow the procedures described in the Pilot operating handbook in case of failure of both alternators
- Meteorological conditions above Zagreb airport area during the time subject aircraft overflew it – few and scattered clouds with its base at 3500 ft and rising

3.2. IMMEDIATE CAUSE

After the conducted safety investigation, it is concluded that the immediate cause of the serious incident was the inability to extend the aircraft landing gear, which was preceded by a complete loss of electricity on the aircraft, and malfunction of the emergency landing gear extension system.

3.3. CONTRIBUTING FACTORS

Contributing factors that preceded the serious incident are:

- Non-compliance with the standards and methods described in the applicable regulations during aircraft maintenance
- Continuation of the flight towards the destination at the moment electrical system failure occurred

4. SAFETY RECOMMENDATIONS

Considering the collected information during this Safety investigation, AIA issued the following safety recommendations to the aircraft pilot and the aircraft mechanic:

AIN04-SR-05/2021

The Slovak civil aviation authorities should, during their supervision, support the maintenance mechanic in introducing the procedures and methods for reducing errors in performing the maintenance work by one person, described in Decision 2020/002 / R, AMC1 ML.A.402 (b) (8).

AIN04-SR-06/2021

During the maintenance of the aircraft, the mechanic of the aircraft in question should establish procedures and methods for reducing errors in performing the maintenance work by one person, described in Decision 2020/002 / R, AMC1 ML.A.402 (b) (8).

Investigator in charge

Dejan Ćurik