Republic of the Philippines
CIVIL AVIATION AUTHORITY OF THE PHILIPPINES

AIRCRAFT ACCIDENT INVESTIGATION AND INQUIRY BOARD

FINAL REPORT

RP-R4456
AG CAT G-164A

OPERATOR: SOUTH PACIFIC AERIAL SPRAYING SERVICES (SPASS)

TYPE OF OPERATION: AGRICULTURAL SPRAYING

DATE OF OCCURRENCE: AUGUST 21, 2023

PLACE OF OCCURRENCE: BARANGAY ZENEBEN, LAMBAYONG, SULTAN KUDARAT, MAGUINDANAO, PHILIPPINES

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(RP-R4456, Ag Cat G-164A Final Report)

FOREWORD

This report was produced by the Aircraft Accident Investigation and Inquiry Board (AAIIB), Civil Aviation Authority of the Philippines, MIA Road, Pasay City, Philippines.

The report is based upon the investigation carried out by the AAIIB in accordance with Annex 13 to the Convention on International Civil Aviation, Republic Act 9497 Section 42, and Philippine Civil Aviation Regulation Part 13.

Readers are advised that the AAIIB investigates for the sole purpose of enhancing aviation safety. Consequently, AAIIB reports are confined to matters of safety significance and may be misleading if used for any other purpose. It should be noted that the information in AAIIB reports and recommendations is provided to promote aviation safety, and in no case is it intended to imply blame or liability.

Furthermore, no part of the AAIIB report or reports relating to any accident or investigation shall be admitted as evidence or used in any suit or action for damages arising out of any matter mentioned in such report or reports.

FINAL REPORT

TITLE: Accident involving an Ag Cat G-164A aircraft with Registry Number RP-R4456 that experienced loss of engine power upon take-off at Lambayong Airstrip, Lambayong, Sultan Kudarat, Maguindanao. Philippines, on August 21, 2023/ 0730H.

Notification of Occurrence to National Authority

The Notification of accident to AAIIB CAAP was relayed by the Operator of the aircraft at 1100H (LOCAL) on August 21, 2023.

Identification of the Investigation Authority

The Aircraft Accident Investigation and Inquiry Board (AAIIB), the mandated accident investigation organization within the Civil Aviation Authority of the Philippines (CAAP) as the state of Occurrence/Registry/ Operator conducted the investigation.

Organization of the Investigation

In accordance with provisions of Philippine Civil Aviation Regulation (PCAR) Part 13, an Investigator-In-Charge was appointed.

Authority Releasing the Report

The Final investigation report was released by Aircraft Accident Investigation and Inquiry Board (AAIIB) and published on the CAAP website on **06 January 2025**.

Synopsis:

On August 21, 2023, at about 0730H local time, an Ag Cat G-164A aircraft with Registry Number RP-R4456 sustained substantial damage following loss of engine power upon take-off at Lambayong Airstrip, Lambayong, Sultan Kudarat, Maguindanao, Philippines. The sole occupant of the aircraft operated by South Pacific Aerial Spraying Services sustained minor injury. A visual meteorological condition (VMC) prevailed at the time of the accident. The cause of the occurrence was attributed to the failure of the number three (3) cylinder resulting in a total loss of engine power.

LIST OF ACRONYMS AND ABBREVIATIONS

AAIIB	:	Aircraft Accident Investigation and Inquiry Board
AD	:	Airworthiness Directive
AMO	:	Approved Maintenance Organization
AAOC	:	Agricultural Aircraft Operator Certificate
CAAP	:	Civil Aviation Authority of the Philippines
CHT	:	Cylinder Head Temperature
ICAO	:	International Civil Aviation Organization
FAA	:	Federal Aviation Administrations
MC	:	Memorandum Circular
OFSAM	:	Office of the Flight Surgeon and Aviation Medicine
VFR	:	Visual Flight Rules
VMC	:	Visual Meteorological Condition

1. FACTUAL INFORMATION

Aircraft Registration No.	:	RP-R4456
Aircraft Type/Model	:	Agricultural Aircraft/Ag Cat G-164A
Operator	:	South Pacific Aerial Spraying Services (SPASS)
Address of Operator	:	Old Airport Rd, Sasa, Davao City, Philippines
Place of Occurrence	:	Barangay Zeneben, Lambayong, Sultan Kudarat, Maguindanao, Philippines
Date/Time of Occurrence	:	21 August 2023/ 0730H/2330 UTC
Type of Operation	:	Agricultural Spraying
Phase of Flight	:	Take-Off
Type of Occurrence	:	Reciprocating engine - mechanical failure

1.1 History of Flight

On August 21, 2023, at about 0730H local time, an Ag Cat G-164A aircraft with Registry Number RP-R4456 sustained substantial damage following loss of engine power upon take-off at Lambayong Airstrip, Lambayong, Sultan Kudarat, Maguindanao, Philippines. The sole occupant of the aircraft operated by South Pacific Aerial Spraying Services sustained minor injury. A visual meteorological condition (VMC) prevailed at the time of the accident.

It was during the initial climb of the fifth (5^{th}) load of chemicals for the swathing operation that the aircraft experienced engine vibration. A decrease in engine rpm ensued, leading to the eventual loss of engine power. The pilot was not able to dump the load of chemicals before the aircraft made a forced landing in an open area. The aircraft initially touched down on its main gears and swerved to the left as it continued to roll. It came to a complete stop in an inverted position after both wings collided with two (2) gimelina trees, with a final resting point of 291 degrees and grid coordinates of 6° 51’27” N; 124° 38’44” E (Figure 1).

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Figure 1 - RP-R4456 on its final resting point.

1.2 Injuries to Person (s)

Injuries	Crew	Passengers	Others	TOTAL
Fatal	0	0	0	0
Serious	0	0	0	0
Minor	0	0	0	0

1.3 Damage to Aircraft

The aircraft sustained substantial damage.

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1.4 Personnel Information

1.4.1 Pilot

Gender	:	Male
Date of Birth	:	June 13, 1984
Nationality	:	Filipino
License	:	CPL-104250
Valid up to	:	September 30, 2025
Type Rating	:	Airplane: Single Engine Land- AG CAT-G164A/ 164B
Medical Certificate	:	Class 1 valid up to October 01, 2023
Time on A/C type	:	7,000+00 Hours
Grand Total Time	:	7,927+55 Hours

1.5 Aircraft Information

1.5.1 Aircraft Data

Registration Mark	:	RP-R4456
Manufacturer	:	Allied Agcat Productions, Inc.
Type/Model	:	AG CAT G-164A
Operator	:	South Pacific Aerial Spraying Services
Serial No.	:	504-4025
Date of Manufacture	:	2015
Certificate of Airworthiness Valid up to	:	January 25, 2024
Certificate of Registration Valid up to	:	December 27, 2023

1.5.2 Engine Data

Manufacturer	:	Pratt & Whitney
Type/Model	:	R-1340 AN-1 HYD
Serial No.	:	22129
Engine Time Since New	:	9,639+01 Hours

1.5.3 Propeller Data

Manufacturer	:	Hamilton Standard
Serial Number	:	6054
Model	:	12D40-403
Propeller Time Since New	:	457+25 Hours

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1.6 Meteorological Information

Visual Meteorological Conditions (VMC) prevailed at the time of the accident.

1.7 Aids to Navigation

The flight was carried out under Visual Flight Rules (VFR). In using VFR, the pilot must be able to operate the aircraft with visual references to the ground and visually avoid obstructions and other aircraft.

1.8 Communications

Normal communications were carried out between the pilots and other aircraft operating in
the area.

1.9 Flight Recorders

The aircraft was not equipped with any flight recorders and existing CAAP regulation does not require it.

1.10 Wreckage and Impact Information

After initially landing on its main gears and swerving to the left, the aircraft sustained substantial damage. It came to a full stop in an inverted position after colliding with two gemilina trees with a final resting point of 291 degrees and grid coordinates of 6° 51’27” N; 124° 38’44” E.

1.11 Medical and Pathological Information

There was no medical impediment that hindered the pilot’s fitness to fly. His medical records also confirmed that he met the CAAP and ICAO Annex 1 Medical Standards for exercising the privileges of the license held.

1.12 Fire

There was no post-crash fire observed during on-site investigation.

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1.13 Search and Survival Aspects

A search was not conducted since the aircraft landed near the airstrip. The cockpit's integrity remained intact, making the event survivable. The seat and restraint remained intact after the accident.

1.14 Test and Research

A post-accident site examination revealed that the aircraft cylinder head number three (3) had visible cracks near where the spark plug is located. On August 25, 2023, the engine was removed from the crash site and was brought to the SPASS hangar. A tear-down inspection by the Operator's AMO and witnessed by an AAIIB investigator was conducted on RP-R4456 in determining the cause of the crack and failure.

1.15 Organizational and Management Information

The aircraft, RP-R4456 was operated by South Pacific Aerial Spraying Services (SPASS), with an address of Old Airport Rd, Sasa, Davao City. South Pacific Aerial Spraying Services is a holder of Agricultural Aircraft Operator Certificate (AAOC) number 11-201009 valid to operate up until March 23, 2025. It is authorized to perform restricted operations that provides agricultural aerial spraying services to the agricultural industries.

The maintenance function of RP-R4456 is being undertaken by South Pacific Aerial Spraying Services, Approved Maintenance Organization (AMO) with a current Certificate number 110-12 with facility located at BTC Hangar, Gen. Aviation Area, Old Airport, Sasa, Davao City.

2. ANALYSIS

2.1 General

On or about 0730H local time, August 21, 2023, during the initial climb, the aircraft experienced engine vibration. It was followed by a decrease in engine rpm, and eventually the engine lost power. The pilot was not able to dump the fifth (5^{th}) load of chemicals for the swathing operation as he elected to make a forced landing in an open area. The aircraft initially touched down on its main gears and swerved to the left. However, it came to a complete stop in an inverted position after both wings collided with two (2) gimelina trees.

The site investigation revealed a crack near the spark plug on engine cylinder number three (3) (Figure 2). The engine was removed from the crash site and was brought to the

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company's hangar for further examination. The tear-down inspection revealed that the cylinder head was completely separated from the barrel between the cooling fins. The separation was due to pre-ignition or detonation stresses, which no longer allowed the pushrods to operate the valves. This resulted in a loss of engine power during the initial climb after take-off (Figures 3, 4, and 5). Pre-ignition is the ignition of the air-fuel charge while the piston is still compressing the charge. A cracked spark plug tip, carbon or lead deposits in the combustion chamber, or a burned exhaust valve can act as a glow plug, causing the ignition source to ignite the charge prematurely. Detonation is an explosion of the fuel-air mixture inside the cylinder. It occurs after the compression stroke, either near or after the top dead center. During detonation, the fuel/air charge explodes rather than burning smoothly. Because of this explosion, the charge exerts a much higher force on the piston and cylinder, leading to increased noise, vibration, and cylinder head temperatures.

Figure 2 - Crack seen at Cylinder Number 3.

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Figure 3 - Separation of the cylinder head from the barrel.

Figure 4- Close up view of Cylinder Nos. 3 barrel.

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Figure 5- Close up view of cylinder head Nos. 3.

Aside from inspecting the remaining cylinders, a cylinder compression test was also conducted for any leaks or cracks, however it showed no relation that could contribute to the loss of engine power (Figure 6).

Figure 6 - Cylinder Compression Test

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For the time being, R-985 cylinders were not subjected to an overhaul time limit, and the tracking of cylinder life and overhaul cycles were not monitored. Overhauling of this cylinder is performed during engine overhaul or when the cylinders were removed prematurely in case of a cylinder problem. During the overhaul, the cylinders are subjected to an inspection that includes liquid penetrant inspection of the head area and, in some cases, ultrasonic testing of the barrel threads. These cylinders were then marked in the cylinder skirt with the overhaul date and serial number on the valve ear for tracking purposes distinct to the overhauling facility.

During the tear-down inspection, it also revealed that cylinder nos. three (3) was subjected to an ultrasonic test based on the markings of the 3499 stamp on the head near the intake port (Figure 7). The markings on the head were consistent with the markings required by FAA Airworthiness Directive 78-08-07 which denote that an ultrasonic inspection was conducted during the overhaul. Inspection of the cylinder assembly by visual and ultrasonic inspection were required to detect and replace cracked cylinders that exceed specified limits.

Figure 7 - Cylinder Nos. 5 with markings 3499 stamp.

On the other hand, Transport Canada's "in-service review" found that cylinder head to cylinder barrel separation was the most common defect, failure, and malfunction associated with the R-985 engine. It was established that cylinder heads usually fail when the tensile strength of their material has been lowered by excessive heat. Usually, discoloration that initially appears as a casting mark in the cylinder itself highlights cracks, necessitates a thorough visual inspection. A recurring FAA Airworthiness Directive (AD) applicable to the accident aircraft requires operators to conduct visual inspection to prevent cylinder head cracking. The pilots and crew must complete a walk-around inspection before and after the flight to comply with the directive.

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According to the documents submitted during the investigation, the pilot and crew performed pre-flight and post-flight inspections. However, the visual inspection checklist review does not include inspection of the cylinder head cooling fins for discoloration or casting marks that might indicate a crack was developing. Had the pre- and post-flight visual inspection of the cylinders been included, any evidence or indication of a crack developing could be identified. The required visual inspection of R-985 cylinders was therefore recommended to be included in the pre-flight and post-flight inspections.

The RP-R4456 has a Cylinder Head Temperature (CHT) gauge installed inside the aircraft (Figure 8). Through the CHT gauge, the pilot and crew can monitor and take necessary preventive measures in case there is an increase in cylinder head temperature and excessive manifold pressure. However, during the interview, the pilot was not familiar with the operating limitations of R-985 engines. Hence, putting a placard with the temperature limitation of the cylinder head in the cockpit is the safest way to perform a task like aerial spray. Although there is no guarantee that it will prevent accidents, such operational limitations increase the possibility for pilots to be aware of risks and how to manage them.

Figure 8 - RP-R4456 Cylinder Head Temperature (CHT) gauge

As a result of the AAIIB investigation into previous cylinder separations involving R-985 engines, a Memorandum Circular (MC) No. 28-18 dated October l, 2018 was issued by CAAP. The MC was addressed to all agricultural air operators that operate aircraft with R-985 engines for them to strictly comply with the General Operating

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Instructions (GOI). The GOI prescribes the specific temperature limitations during ground testing, take-off, climb, cruise, and shutdown. It also requires proper engine warming-up and cooling-down before and after every flight to minimize engine distress. Therefore, operators of aircraft with R-985 engines must ensure adequate warming up, particularly before increasing power. Adherence to the specific temperature limitations will reduce, if not eliminate, the issues related to cylinder head separation.

3. CONCLUSION

3.1 Findings

a. The Pilot has a valid license and medical certificate issued by the Licensing and Certification Department (LCD) and Office of Flight Surgeon and Aviation Medicine (OFSAM), CAAP, respectively.

b. Visual meteorological condition prevailed at the time of the accident.

c. The aircraft was released for flight without any discrepancies noted on its logbook.

d. The aircraft has a current aircraft registration and certificates of airworthiness.

e. The number three (3) cylinder head was separated from the cylinder barrel between cooling fins near the spark plug was located.

f. A cylinder compression test was conducted for any leaks or cracks but showed negative findings that contributed to the loss of power.

3.2 Probable Cause

3.2.1 Primary Cause

a. Failure of the number three (3) cylinder, resulting in a total loss of engine power.

3.2.2 Contributory Cause

a. Non-adherence to the specific temperature limitation of the R-985 engine.

b. Non-inclusion in the pre- and post-flight visual inspection of the cylinder head cooling fins for discoloration or casting marks as an indication that a crack was developing.

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4. SAFETY RECOMMENDATION

As a result of the safety investigation, the AAIIB proposes the following safety recommendations:

4.1 CAAP-FSIS to ensure that the Operator, South Pacific Aerial Spraying Services (SPASS):

a. Include in the pre- and post-flight checklist the inspection of the cylinder head cooling fins for discoloration or casting marks, for exhaust emissions stains and exhaust carbon deposits as an indication that a crack was developing.

b. Strictly complies with the CAAP-issued Memorandum Circular (MC) No. 28-18 dated October l, 2018 addressed to all Agricultural Air Operators that operates with R-985 engines aircraft.

c. Include in the refresher training and regular safety meetings of pilots and maintenance personnel the specific temperature limitations to be observed while operating aircraft with R-985 engines.

d. Place a placard with the temperature limitation of the cylinder head in the cockpit of aircraft with R-985 engines.

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