Australian Government
Australian Transport Safety Bureau

Collision with terrain involving Lockheed EC130Q, N134CG

50 km north-east of Cooma-Snowy Mountains Airport (near Peak View), NSW, on 23 January 2020

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Addendum

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The occurrence

This interim report details factual information established in the investigation's evidence collection phase and has been prepared to provide timely information to the industry and public. Interim reports contain no analysis or findings, which will be detailed in the investigation's final report. The information contained in this interim report is released in accordance with section 26 of the *Transport Safety Investigation Act 2003*.

Fire situation in the Snowy Mountains region

On 23 January 2020, the Snowy Mountains region in New South Wales (NSW) had a severe fire danger rating,[1] due to high temperatures, strong winds and forecast thunderstorms. This region included the Adaminaby and Good Good fire-grounds, which were both under the control of the Cooma Fire Control Centre (FCC).

At about 1100 Eastern Daylight-saving Time,[2] the Cooma FCC incident commander made a call to the NSW Rural Fire Service (RFS) State Operations Centre, to discuss the escalating fire danger at the Adaminaby fire-ground. During that call, it was noted that the smaller firefighting aircraft were not flying in the area due to strong winds and poor visibility. Consequently, a birddog[3] and two large air tankers (LAT) were tasked by the State Operations Centre to the Adaminaby fire-ground: a Rockwell International 690-B aircraft; a Boeing 737 aircraft, registered N137CG, call sign 'Bomber 137' (B137); and a Lockheed EC130Q[4] aircraft, registered N134CG, call sign 'Bomber 134' (B134). All three aircraft were based at Richmond Royal Australian Air Force (RAAF) Base, NSW, about 316 km north-east of the Adaminaby fire-ground.

'B137' tasking to Adaminaby

At about 1121, B137 had commenced taxiing at Richmond for a task when the crew were re-tasked to the Adaminaby fire-ground. The aircraft subsequently departed at 1127, with the crew having been notified by the Richmond airbase manager[5] that there was no birddog in the area, and that it 'is very windy down there'.

The birddog pilot had experienced moderate to severe turbulence in the Snowy Mountains region about 2 weeks prior to the day of the accident. On receipt of the tasking to Adaminaby, the birddog pilot reviewed the weather and concluded that the conditions were forecast to be worse than previously experienced, and therefore declined the task. In addition, as B137 was already en route to Adaminaby, the crew of that aircraft would be able to provide a report to the birddog pilot and other crews of the actual conditions.

At about 1155, B137 arrived overhead the Adaminaby fire-ground. At interview, the pilot in command (PIC) of B137 reported the wind speed at the Adaminaby fire-ground was 50 kt[6] at 800 ft above ground level (AGL), and about 37 kt at the retardant drop height of 200 ft AGL. While

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1 The NSW Rural Fire Service fire danger ratings provide an indication of the possible consequences of a fire and are based on predicted conditions including but not limited to temperature, humidity, wind and the dryness of the landscape.

2 Eastern Daylight-saving Time (EDT): Coordinated Universal Time (UTC) + 11 hours.

3 Birddog aircraft are used to lead air tankers and provide guidance on the release of the fire retardant. The RFS procedures stipulated that an air tanker with an initial attack certified crew (refer to section titled *Pilot in command*) were able to conduct operations without a birddog.

4 The aircraft was initially built as an EC130Q, however, all specialised military equipment had been removed, and it was considered to be the equivalent of a C130H. Throughout the report, the aircraft is referred to as a C130.

5 The airbase manager is responsible for the supervision and co-ordination of airbase personnel, and the layout and operation of an airbase

6 1 kt equals 1.852 km/h.

assessing the conditions in the Adaminaby area, the crew reported experiencing uncommanded aircraft rolls up to 45° angle of bank (due to wind) and a windshear[7] warning from the aircraft on-board systems. The PIC of B137 elected to operate on the upwind side of the hills to avoid lee-side mechanical turbulence.[8] At about 1225, B137 departed the Adaminaby fire-ground, having successfully deployed a retardant load.

After completing the retardant drop, the B137 crew sent a text message to the birddog pilot assigned to the Adaminaby fire-ground indicating that the conditions were 'horrible down there. Don't send anybody and we're not going back'. They also reported to the Cooma FCC that the conditions were unsuitable for firebombing operations. During B137's return flight to Richmond, the Richmond air base manager requested that they reload the aircraft in Canberra and return to Adaminaby. The PIC replied that they would not be returning to Adaminaby due to the weather conditions.

'B134' tasking at Adaminaby

While B137 was still at the fire-ground, at about 1205, B134 departed Richmond with the PIC, co-pilot and flight engineer on board.

At about 1235, the PIC of B137 had a conversation with the PIC of B134 on their designated operating frequency, to inform them of the actual conditions, and that they would not be returning to Adaminaby. At that time, B134 was about 112 km north-east of Adaminaby, en route to the Adaminaby fire-ground.

At about 1242, the crew of B134 contacted air traffic control (ATC), advising them of the co-ordinates they would be working at, provided an 'ops normal'[9] call time, and confirmed there was no reported instrument flight rules[10] traffic in the area. About 5 minutes later, the Richmond air base manager also attempted to contact B134 to confirm 'ops normal', firstly by radio, and then by text to the PIC's mobile phone, but did not receive a response.

The automatic dependent surveillance broadcast (ADS-B) data showed that after arriving at the Adaminaby fire-ground (Figure 1), the crew of B134 completed several circuits at about 2,000 ft AGL.[11] At about 1255, the crew contacted the air operations officer at the Cooma FCC by radio and advised them that it was too smoky and windy to complete a retardant drop at that location. The Cooma air operations officer then provided the crew with the location details (co-ordinates) of the Good Good fire, about 58 km to the east of Adaminaby, with the objective of conducting structure and property protection near Peak View.

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7 Windshear is defined as a wind direction and/or speed change over a vertical or horizontal distance.

8 Mechanical turbulence results from airflow over or around irregular terrain or man-made objects.

9 'Ops normal' call time provides the next expected transmission time from this aircraft to indicate operations are normal.

10 Instrument flight rules (IFR): a set of regulations that permit the pilot to operate an aircraft in instrument meteorological conditions (IMC), which have much lower weather minimums than visual flight rules (VFR). Procedures and training are significantly more complex as a pilot must demonstrate competency in IMC conditions while controlling the aircraft solely by reference to instruments. IFR-capable aircraft have greater equipment and maintenance requirements.

11 When conducting initial attack operations, crews complete several circuits to assess hazards and drop conditions.

Figure 1: Flight path overview (in white), including the times and locations of where the crew of B134 was in communication with others

Source: Google earth and ADS-B data, annotated by the ATSB

'B134' tasking at the Good Good fire-ground

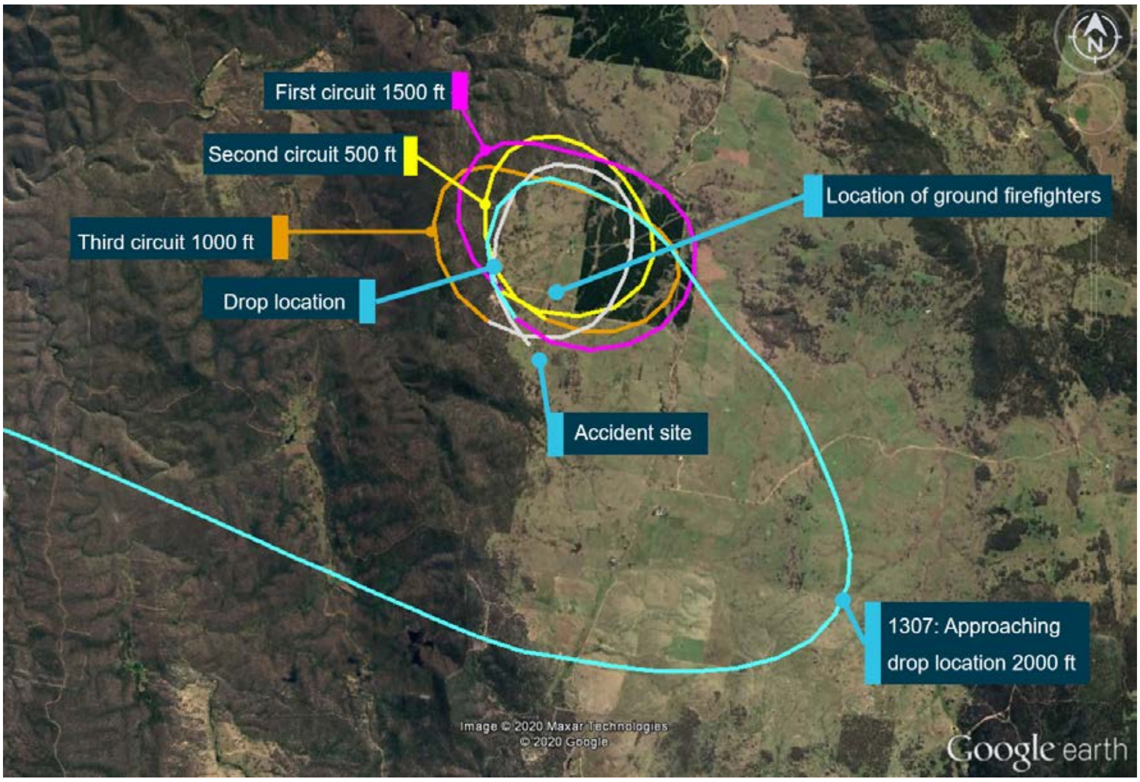
At 1259, the crew of B134 contacted ATC, to advise them that they had been re-tasked to the Good Good fire-ground for a retardant drop, and provided the updated co-ordinates. At about the same time, the RFS ground firefighters at the Good Good fire-ground, near Feeney's Road in Peak View, contacted the Cooma FCC and requested additional assets for property protection. They were advised that a LAT would be passing overhead in about 10 minutes. The firefighters acknowledged the intention of a LAT drop, and advised the Cooma FCC they would wait in open country on Feeney's Road, clear of the properties targeted for protection.

At about 1307, B134 arrived overhead the drop area (Figure 2). From the aircraft's recorded tracking data, the crew conducted three left circuits, at about 1,500 ft, 500 ft and 1,000 ft AGL respectively, prior to commencing the drop circuit.

At 1315:15,[12] the retardant drop was conducted on a heading of about 190° and at about 190 ft AGL (3,595 above mean sea level (AMSL)) with a drop time of about 2 seconds. During the drop, about 1,200 US gallons (4,500 L) of fire retardant was released. Witness video footage and images showed that at the commencement of the drop, the aircraft was at an approximate bank angle of 10°, with the flaps set at 100 per cent. A ground speed of 144 kt was recorded at the time of the drop.

[12] All times in the report are referenced to the ADS-B data, with adjustments based on the recorded locations.

Figure 2: B134's approach and circuits overhead the drop location, and the position of the firefighters



Source: Google earth and Skytrac data, annotated by the ATSB

The ATSB's analysis of the witness videos found that, at the completion of the drop at 1315:17, the aircraft was observed to be banked about 17° to the left (Figure 3). About 4 seconds after the drop at 1315:21, the aircraft had a pitch-up attitude of about 12°, with an increase to about 30° angle of bank. Over the next 1.5 seconds, the aircraft's angle of bank and pitch attitude reduced to about 22° and 10° respectively. The aircraft then became obscured by smoke.[13]

While being intermittently obscured by smoke, a positive rate of climb was achieved for about 10 seconds, with the aircraft climbing to about 330 ft AGL (3,770 ft AMSL) at 1315:27. Just prior to this, from about 1315:25, a right roll was observed on the video. The video captured the aircraft at about an 18° left angle of bank at 13:15:25, and then at about a 6° right angle of bank at 13:15:27. At the same time, the aircraft pitch attitude had decreased to about 6°. Following this, the aircraft was then observed descending. A further 7 seconds after this, at 1315:34, the aircraft was seen at a very low height above the ground, in a left bank. Throughout this period, the recorded groundspeed increased slightly to a maximum of 151 kt.

Shortly after, at about 1315:37, the aircraft collided with terrain and a post-impact fuel-fed fire ensued. The three crew were fatally injured and the aircraft destroyed.

A review of the Airservices Australia audio recording of the applicable air traffic control frequency found no distress calls were received by ATC prior to the impact.

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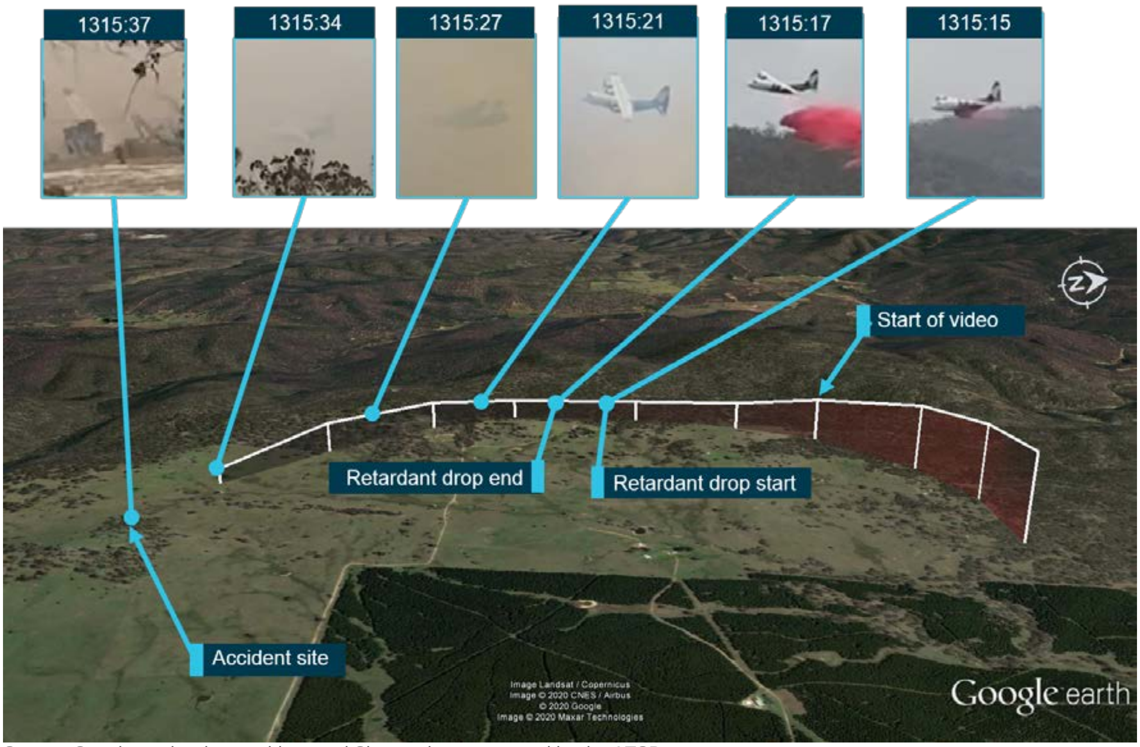
13 From the witness video, it was unclear if the aircraft flew behind the smoke or entered the smoke.

Figure 3: Aircraft attitude and approximate flight path at key times



Source: Google earth, witness videos and Skytrac data, annotated by the ATSB

Context

Operator

Coulson Aviation are a USA (US) based operator, with US registered aircraft and US licensed crew contracted to Australia for the 2019/2020 fire season through the National Aerial Firefighting Centre. At the time of the accident, Coulson Aviation had a fixed wing fleet in Australia consisting of two C130 aircraft, and one Boeing 737 aircraft. They also provided flight crews for the NSW RFS Boeing 737 which had previously been purchased from Coulson Aviation in 2019.

The RFS subsequently contracted one C130 and one 737 from Coulson Aviation via a service agreement subject to the National Aerial Firefighting Centre contract. Following the Australian fire season, the aircraft and crews then return to North America for heavy maintenance and recurrent training prior to the US fire season.

Crew information

Pilot in command

Qualifications and experience

The PIC was initially trained as a navigator and pilot in the United States Air National Guard. During this time, the PIC gained experience in firefighting operations through the modular airborne firefighting system (MAFFS)[14] program. The PIC subsequently joined the operator in 2015 on a part-time basis, before being employed full-time in 2017.

The PIC's logbook, combined with the operator's records for the accident aircraft showed that the pilot had a total flying experience of about 4,010 hours, which included 3,010.3 hours in the C130 aircraft, and 994 air tanker drops. The PIC had also accrued a further 1,616.8 hours as a flight navigator.

The PIC held a current airline transport pilot certificate with ratings for multi-engine land aircraft including the EC130Q, issued by the US Federal Aviation Administration (FAA) on 13 October 2017. The PIC's most recent flight instructor certificate with ratings for multi-engine and instrument aircraft was issued by the FAA on 6 April 2019. On 18 April 2019, the PIC's latest airplane pilot qualification card was issued from the US Department of Agriculture, Forest Service,[15] for the C130 aircraft, which included the authorised missions of: *Low level* (below 500 ft above ground level); *Mountainous terrain*; and *Airtanker Initial Attack*. An air tanker initial attack qualification allows a pilot to conduct fire retardant drops without the supervision of a birddog or air tactical supervisor.

The PIC's most recent first-class medical examination was on 5 September 2019, with the certificate issued with a limitation to wear corrective lenses.

Training

The PIC's training with the operator in March and April 2019[16] included annual C130 simulator training, controlled flight into terrain awareness, and crew resource management. In addition, the PIC completed two assessed training flights with the operator in the C130 on 14-15 April 2019.

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14 MAFFS are portable fire retardant delivery systems that can be inserted in C130 aircraft without major structural modifications to convert them to air tankers when needed.

15 When operating in the US as an air tanker, the aircraft is considered a public use asset, and the US Department of Agriculture Forest Service assumes the regulatory role, and defines and issues initial attack qualifications.

16 This was the operator's spring training period in preparation for the North American fire season.

The training flight on 14 April included approach to stalls in the circuit (50 per cent flap) and drop (100 per cent flap) configurations, and go-arounds with a full load. The flight on 15 April included drop planning (hazards, tactics, ingress, egress and dry run) and an emergency on the drop run. The drop run emergency was a simulated 'down air' [downdraught] with the comment 'Jettison for down air'. All the assessed sequences, which included jettison of the load during an emergency condition,[17] were recorded as satisfactory.

Co-pilot

The co-pilot had joined the operator in September 2019, after 20 years in the military, including experience flying the C130. This was the co-pilot's first fire season. The co-pilot's logbook combined with the operator's records showed a total flying experience of about 1,744 hours, of which about 1,364 were on the C130. The co-pilot held a current airline transport pilot certificate and ratings for multi-engine land aircraft, including the EC130Q (second-in-command privileges only), issued by the FAA on 7 November 2019. The co-pilot also held a flight instructor certificate with ratings for single, multi-engine and instrument aircraft, issued by the FAA on 14 August 2019. The co-pilot's most recent first-class medical examination was issued on 17 July 2019 with no limitations.

The co-pilot's check flight with the operator was completed on the C130 on 12 September 2019, and was assessed as satisfactory against the qualification standards for second-in-command. On 13 September 2019, the co-pilot completed the operator's crew resource management and controlled flight into terrain awareness courses, and reviewed the US Department of Agriculture Forest Service's air tanker pilot training video.

On 16 September 2019, the co-pilot was issued with an airplane pilot qualification card from the US Department of Agriculture Forest Service for the C130 aircraft, which included the authorised missions of: *Low level* (below 500 ft above ground level); *Mountainous terrain*; and *Airtanker SIC* (second-in-command).

Flight engineer

The flight engineer joined the operator in November 2019, after about 25 years in the US military. This was the flight engineer's first fire season. The flight engineer held a flight engineer certificate with a rating for turbo-propeller powered aircraft, issued by the FAA on 20 November 2019. On the flight engineer application form, the flight engineer reported accruing 4,050 hours on the C130 aircraft. The flight engineer also held a mechanic certificate with ratings for airframe and powerplant, issued by the FAA on 2 June 2019. The flight engineer's most recent second-class medical examination was issued on 27 August 2019 with no limitations.

The flight engineer's check flight was completed with the operator on 20 November 2019. In addition to this check flight, the FE completed two air tanker drops with a supervising flight engineer in Australia on 12 January 2020.

72 hour prior history

The PIC and co-pilot commenced work in Australia on 1 December 2019 and the flight engineer on 13 January 2020. Each crew member's roster cycle was 14 duty days followed by two rest days. The operator's records show they signed on between 0800 and 1000, and signed off between 1700 and 2100, with their duty times varied between 7.5 and 12 hours per day.

The accident flight occurred on the PIC's 9th day, and the co-pilot's and flight engineer's 11th day of their respective current duty periods.

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[17] Although the emergency condition for the jettison was a simulated scenario, the pilot was still required to perform a live jettison of the load (water) in this training sequence.

Table 1, based on the operator's records, details the crew's sign on and sign off times for the 3 days before the accident. On 23 January 2020, the crew signed on at 0900.

Table 1: B134 crew working hours

	20 January	21 January	22 January
Sign on	1000	0800	1000
Sign off	1800	1700	1900

Information from the crew's telephones and hotel records, in addition to work and flying duties, were used to determine their activities in the previous days. There were no indications of fatigue for the three crew members. However, there was insufficient information available to the ATSB about their sleep and non-duty activities to estimate fatigue levels with confidence.

Aircraft information

General information

The C130 is predominantly an all-metal, high-wing aircraft, designed for military operations. The accident aircraft (Figure 4) was manufactured in 1981 and was powered by four Allison T56-A-15 turboprop engines, fitted with Hamilton Sundstrand 54-H60-91 four blade propellers. The T56-A-15 is a constant speed engine, with a variable pitch propeller.

Previously owned by the US Navy, the aircraft was transferred to the US National Aeronautics and Space Agency (NASA) in 1992 and later placed in storage. It was removed from storage, re-purposed for firefighting activities by the operator and registered in the restricted category.[18] Initially registered as N130CG in 2018, its registration was later changed to N134CG in April 2019. The modifications included the installation of an avionics package and firefighting tank system, known as the Retardant Aerial Delivery System XXL (RADS).

Figure 4: N134CG

Source: Coulson Aviation

18 Restricted category in this instance refers to a type that has been manufactured in accordance with the requirements of, and accepted for use by, an Armed Force of the US and has been later modified for a special purpose.

Maintenance history

The aircraft had a total time-in-service of 11,888 hours and had accrued 683 hours of firefighting operations since the tanker conversion in 2018.

N134CG arrived in Australia in November 2019. The aircraft had a current certificate of airworthiness, and was maintained in accordance with an FAA approved program. The last daily inspection conducted on 22 January 2020, at the end of the day's flying activities the day before the accident, identified the propeller anti-icing system on engine number 2 was unserviceable, and rectification had been deferred in accordance with the minimum equipment list.[19]

In addition to a maintenance requirement to perform engine power efficiency checks at 150-hour intervals, the operator reported pilots were required to perform power checks before every take off, with operations only permitted if a minimum performance requirement of 95 per cent was met.

Retardant Aerial Delivery System XXL

The Retardant Aerial Delivery system (RADS) included a 4,000 US gallon (15,000 L) tank system located within the aircraft's fuselage. The system could deliver discrete quantities of retardant, dependant on the duration that the doors remained open. It was controlled from the cockpit, with drop controls located on both the PIC and co-pilot yokes.

The drop quantity could be controlled either as a pre-set percentage by the crew, or alternatively, if selected at 100 per cent, the crew could control the amount of retardant released by holding the button until the desired amount was dispensed. The RADS system was designed that, if less than 100 per cent volume was selected, the system would disarm after a partial load drop, and the crew would need to re-arm the system to complete further releases. It was reported that the crew on B134 normally selected 100 per cent volume and released the drop button once the desired amount had been dispensed.

The system also included a guarded emergency dump switch, located in reach of all three crew members, which would fully open the doors and jettison the load in a period of about 2 seconds. Following an emergency dump, the doors would remain open until the RADS was reset by the crew.

Weight and balance

The last weight and balance report for the aircraft, in April 2019, showed its basic empty weight was 75,794 lb (35,380 kg) and according to the RADS flight manual supplement, the maximum take-off weight was 150,718 lb (68,365 kg). The aircraft flight and maintenance log entry for 22 January 2020 indicated the PIC had the aircraft refuelled to a total of 34,000 lb (15,422 kg) at the completion of flying the previous day. The operational load monitoring system[20] indicated there was 35,514 lb (16,109 kg) of retardant on board prior to the drop, in addition to which the aircraft carried a 2,000 lb (907 kg) pallet of gel. This resulted in a take-off weight of about 147,253 lb (66,826 kg) and centre of gravity at the aft limit.

Using the operator's reported fuel consumption for air tanker drop missions of 5,000 lb/h (2,268 kg/h) for a 70 minute flight, and the retardant drop of 10,764 lb (4,882 kg), the estimated post-drop weight was 130,656 lb (59,265 kg). The centre of gravity remained close to the aft limit, which was consistent with the reports from the operator's other crews that the location of the

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[19] A minimum equipment list is a list that identifies items, subject to specific conditions, which may be unserviceable at the commencement of a flight, and is approved by the FAA.

[20] The operational load monitoring system transmitted various parameters in-flight, including the status of the RADS tank at the start and completion of the drop.

RADS tank in the aircraft meant there was no appreciable change in the centre of gravity following a retardant drop.

Meteorological information

Bureau of Meteorology forecasts

A Bureau of Meteorology graphical area forecast was issued at 0924 and was valid for the time of the flight. It forecast moderate mountain wave activity[21] above 3,000 ft AMSL and severe turbulence below 8,000 ft AMSL in the area of operation from Richmond to Cooma. This included the Adaminaby and Good Good fire-grounds. In addition, a SIGMET[22] issued at 0947, and valid for the flight, forecast severe turbulence[23] below 10,000 ft AMSL for the area.

The aerodrome forecast for the Cooma-Snowy Mountains Airport,[24] located 50 km south-west of the accident site was amended at 0948. It indicated wind speeds of 25 kt, gusting to 48 kt, with a mean wind direction of 300° from 1100 and visibility reduced to 8,000 m in light showers. Severe turbulence below 5,000 ft AGL was forecast from 0900-1500, and a PROB30[25] for visibility reduced to 2,000 m in blowing dust and a broken[26] layer of cloud at 1,000 ft AGL was forecast for the period 1100–1700.

At 1012, the Richmond air base manager sent a text message to the air tanker and birddog pilots to advise them of an airport warning for wind gusts in excess of 35 kt between 1000 and 1700 at the Richmond base.

Observations of the weather in the area

Other fire control aircraft

On the day of the accident, several fire-control aircraft, primarily consisting of fixed-wing Air Tractors and Bell 206 helicopters, were operating from the Polo Flat airstrip, located 33 km south-west of the accident site. The Cooma FCC received reports of strong winds in the area from the fire-control pilots in the early morning. This included winds of 30-40 kt at 0839, 40-50 kt at 0902, and 52 kt at 0937. All fire-control aircraft had departed the area or landed by 1030.

Additionally, the flight crew of B137 reported that the wind conditions at Adaminaby at about 1200 were 50 kt at 800 ft AGL, and about 37 kt at 200 ft AGL.

Witness reports

Following the accident, the ATSB received multiple witness reports of the weather conditions at Peak View. They all consistently reported very strong winds from the north-west, with gusts up to 43 kt recorded at ground level. One resident noted that, although the prevailing wind was from the

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21 Mountain waves form above and downwind of topographic barriers when strong winds blow with a significant vector component perpendicular to the barrier in a stable environment. If air is being forced over terrain, it will move downward along the lee slopes, then oscillate in a series of waves as it moves downstream, sometimes propagating long distances downwind.

22 Significant meteorological information (SIGMET): a weather advisory service that provides the location, extent, expected movement and change in intensity of potentially hazardous (significant) or extreme meteorological conditions that are dangerous to most aircraft, such as thunderstorms or severe turbulence.

23 Severe turbulence can result in large abrupt changes to an aircraft's attitude and/or altitude, and potentially a momentary loss of control.

24 The Cooma-Snowy Mountains Airport has an elevation of 3,106 ft AMSL.

25 PROB30 means 30 per cent chance of forecast conditions occurring.

26 Cloud cover: in aviation, cloud cover is reported using words that denote the extent of the cover – broken indicates that more than half to almost all the sky is covered.

north-west, the direction and strength at ground level were also being influenced by the local terrain.

Weather station recorded conditions

About 12 minutes prior to the accident, the Cooma-Snowy Mountains Airport weather station indicated a wind speed of 25 kt, gusting to 39 kt, from a direction of 320°. The visibility was 6,000 m, with a QNH[27] of 1002 hPa and temperature of 26 °C.

A personal weather station at Peak View, located about 1.3 km from both the drop and accident sites (Figure 5) recorded the conditions twice per hour. At about 1309 (7 minutes prior to the accident), the station recorded a mean wind of 15 kt from the west and a peak gust of 32 kt from the north.[28] At about 1330 (14 minutes after the accident), the station recorded a mean wind of 16 kt from the west and a peak gust of 42 kt from the north-west.

Figure 5: Accident circuit with predominant wind direction and terrain

Source: Google earth and SkyTrac data, annotated by the ATSB

Bureau of Meteorology analysis

The Bureau of Meteorology analysed the conditions on the day and indicated that a cold front was approaching the accident location, with hot and strong north to north-westerly winds ahead of the front. High resolution weather model data indicated the winds at 5,000 ft AMSL were about 45 kt from the north-west, increasing in strength with height up to 80 kt from the north-west at 10,000 ft AMSL. They reported that their analysis of the weather conditions in the accident area was consistent with what was forecast on the day.

The Bureau of Meteorology considered the conditions on the day were favourable for mountain wave development, and satellite imagery of cloud formations confirmed their presence in the

[27] QNH: the altimeter barometric pressure subscale setting used to indicate the height above mean sea level.

[28] This is the average and peak speed recorded for the previous 10 minutes.

general area of the accident. However, they were unable to determine the severity of the mountain wave activity from the data available.

Recorded information

Cockpit voice recorder

Cockpit voice recorders (CVR) are designed on an endless loop principle, where the oldest audio is continuously overwritten by the most recent audio. The CVR fitted to the aircraft was a Universal Avionics Model CVR-30B, part number 1603-02-03 (Figure 6). This solid-state memory CVR recorded crew and cockpit audio for a recording duration of at least 30 minutes. While the aircraft was not required to be fitted with a CVR under US or Australian regulations, it was required under contract requirements in the US.

Figure 6: N134CG cockpit voice recorder

Source: ATSB

The CVR was recovered from the aircraft and transported to the ATSB's technical facility in Canberra, Australian Capital Territory, on 25 January 2020 for examination and download. The CVR was successfully downloaded, and the recording downloaded contained 31 minutes of audio. However, the audio was from a previous flight when the aircraft was operating in the US. No audio from the accident flight was recorded on the CVR.

Inertia switch

The power supply for the CVR was fitted with an inertia switch. Inertia switches are designed to stop the recording function by removing power to the CVR when a pre-set deceleration force is detected. The recovered audio was of crew training flights undertaken on 7 May 2019 near Sacramento McClellan Airport, California. The audio included four landings conducted as part of the training in the aircraft on that day. The recording ceased immediately after the fourth landing, and the post-landing taxi and engine shutdowns were not recorded. It was likely that the inertia switch was activated during this landing and consequently disconnected power to the CVR.

Pre-flight testing

Following a CVR installation in an aircraft, supplemental material related to the operation of the CVR must be attached to the approved airplane flight manual. The supplement for the aircraft indicated the CVR conducted a self-test at power up, and the status of the CVR would be presented to the crew on the CVR control unit, located on the co-pilot side console. A CVR system check was not included in any of the operator's checklists, and none of the operator's flight crew were aware of the need to check this system status prior to flight.

Flight data

The aircraft was not fitted with a flight data recorder, nor was it required to be by Australian or US regulations. However, contracting requirements in the US required the aircraft be fitted with an operational load monitoring system, which was located behind the centre wing section in the fuselage. This recording device had no impact or fire protection, and was destroyed in the accident sequence.

The aircraft was also fitted with SkyTrac, a tracking system that can transmit the aircraft's position in real-time. This system was able to be monitored by the NSW RFS, and generally had an update rate of about 1 minute. The SkyTrac unit was recovered from the wreckage and transported to the ATSB's technical facility for examination and download. The SkyTrac unit recorded data at 5 second intervals.

Data broadcast by the ADS-B equipment fitted to the aircraft for ATC purposes was also obtained from various providers. ADS-B data is transmitted nominally every 0.5 seconds; not all transmission were available, with gaps of up to 5 seconds during the accident flight. Table 2 shows the parameters recorded by SkyTrac and ADS-B.

Table 2: SkyTrac and ADS-B recorded parameters

SkyTrac	ADS-B
• time	• time
• latitude and longitude	• latitude and longitude
• groundspeed (GPS)	• groundspeed
• altitude (GPS)	• pressure altitude
• track (GPS course)	• track
	• vertical rate of climb/descent

A detailed review of the available recorded data is ongoing and will be included in the ATSB's final investigation report.

Witness video

Two firefighters were located on Feeney's Road (800 m from the accident site), and videoed the aircraft during the retardant drop and subsequent accident. Overall, the video footage had a duration of 37 seconds. It captured the aircraft from 10 seconds prior to the drop, the drop, and 4 seconds after the drop, when the aircraft became obscured by smoke, and was only intermittently visible. Eleven seconds after being obscured by the smoke, the aircraft was seen at low level, followed by a collision with terrain and post-impact fire. The ATSB's analysis of this footage is continuing and will be included in the final investigation report.

Wreckage and impact information

Accident site

The accident site was located on slightly sloping, partially wooded terrain, near Peak View, 50 km north-east of Cooma-Snowy Mountains Airport. The wreckage trail (Figure 7) was approximately on a heading of 100°, with the initial impact at an elevation of about 3,440 ft AMSL. The debris trail began at the lower end of the slope, with the wreckage distributed linearly over about 180 m.

Figure 7: Accident site overview showing the wreckage trail

Source: ATSB

Wreckage examination

The ATSB's on-site examination of the wreckage, damage to the surrounding vegetation, and ground markings, indicated that the aircraft initially impacted a tree in a left wing down attitude, of about 55°, before colliding with the ground. An intense post-impact fuel-fed fire destroyed the aircraft. The ATSB's on-site examination (Figure 8) also found:

- no pre-existing airframe issues
- all major sections of the aircraft's structure were identified and there was no evidence of an in-flight break-up or pre-impact structural damage[29]
- the cockpit and associated avionics were identified about two-thirds of the way along the wreckage trail
- the cockpit and forward section of the airframe had separated from the fuselage, was inverted, and had been destroyed in the impact and subsequent fire
- sections of the wing skin, leading edge spar, wing tips and portions of the wings were identified along the wreckage trail, having fragmented during the impact sequence, and sustained further damage during the resultant fire

29 In July 2018, the aircraft manufacturer published service bulletin 382-57-97 to address accelerated structural fatigue for C130 aircraft performing air tanker operations.

- all flight control surfaces were identified, however, due to the impact and fire, flight control continuity could not be established
- the four engines and 16 propeller blades were located on-site and some of the propeller blades remained attached to the propeller hubs, while others had detached through impact forces
- there were varying degrees of damage observed across the four engines, likely due to the impact sequence of each engine, with the damage indicating the engines were rotating at impact.

The RADS tank remained upright (Figure 8), along with the aft section of the fuselage, with the vertical and horizontal stabilisers attached. There was no retardant identified between the drop area and the initial impact location, however, a large amount of retardant was located in the wreckage near the tank. The system was badly damaged, with the doors fragmented throughout the wreckage, and its operational state could not be established.

Figure 8: Main aircraft wreckage components

Source: ATSB

Aircraft configuration

The aircraft was equipped with four trailing edge flaps. All flaps had separated from the aircraft during the impact sequence. On-site measurements of the flap screw jacks indicated the flaps were set at 50 per cent at impact. This was consistent with the expected setting following a retardant drop. Due to the extent of damage, the elevator, aileron and rudder trim settings could not be established.

Fuel testing

Fuel samples were retained from the two fuel tankers that last serviced the aircraft and from the refuelling storage tank at Richmond. The fuel samples were independently tested by a commercial fuel company for correct specifications, with nil abnormal indications found. In addition, there were no reports of fuel quality concerns with any other aircraft using the same fuel source.

Engine and propeller examinations

With the assistance of the Australian Army, the engines, partial remnants of the reduction gearboxes, propeller assemblies and blades were transported to a secure hangar at Richmond RAAF Base for further examination.

The engine manufacturer attended the engine inspections, where it was confirmed that all engines were rotating at impact, and there were no noted pre-existing issues. As power changes are controlled by changes to the propeller blade pitch while maintaining a constant engine speed, the engine power levels were determined from the blade pitch angle at impact.

During the propeller hub assembly inspection, measurements of the internal components were recorded. The ATSB consulted the propeller manufacturer to determine the propeller blade angles at impact, and establish engine power levels. The propeller manufacturer concluded the following:

> The calculations indicate that, based on the operating conditions estimated by the ATSB, all the propellers were absorbing power from their respective engines and were producing positive thrust. The horsepower computed for each of the four engines are within the normal operating range for the T56 engine installed on this aircraft.

Safety action

Whether or not the ATSB identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk.

The ATSB has been advised of the following proactive safety action taken by Coulson Aviation in response to this accident:

- The Retardant Aerial Delivery system (RADS) software was reprogrammed so that the system will not require re-arming between partial load drops where less than 100 per cent volume is selected.
- Updated their pre-flight procedures to incorporate a cockpit voice recorder system check before each flight.

Ongoing investigation

To-date, the ATSB has interviewed Coulson Aviation pilots and key personnel, NSW RFS personnel involved in the large air tanker and aviation operations, witnesses, C130 and other aerial firefighting pilots, and key personnel in overseas aerial firefighting operations. In addition, the ATSB has conducted a detailed examination of the aircraft, engines and propellers; reviewed recorded RFS radio calls; and engaged C130 subject matter experts.

The investigation is continuing and will include consideration of the following:

- ongoing analysis of recorded data, including the on-board systems and witness videos
- aircraft performance and handling characteristics
- review and analysis of environmental influences
- operating policies and procedures
- aircraft maintenance history
- cockpit instruments examination
- crew health and medical history
- similar occurrences.

Should a critical safety issue be identified during the course of the investigation, the ATSB will immediately notify relevant parties so appropriate and timely safety action can be taken.

A final report will be released at the conclusion of the investigation.

General details

Occurrence details

Date and time:	23 January 2020, 1316 EDT	
Occurrence category:	Accident	
Primary occurrence type:	Collision with terrain	
Location:	50 km north-east of Cooma-Snowy Mountains Airport, New South Wales	
	Latitude: 36º 0.3' S	Longitude: 149º 23.0580' E

Aircraft details

Manufacturer and model:	Lockheed Aircraft Corp C130	
Registration:	N134CG	
Operator:	Coulson Aviation	
Serial number:	382-4904	
Type of operation:	Aerial work – fire control	
Persons on board:	Crew – 3	Passengers – 0
Injuries:	Crew – 3 (fatal)	Passengers – 0
Aircraft damage:	Destroyed	