

ACCIDENT

Aircraft Type and Registration:	1) P-51D Mustang (Commonwealth CA-18 Mk 22 NA), D-FBBD
	2) Douglas AD-4N Skyraider, F-AZDP
No & Type of Engines:	1) 1 Packard Motor Car Co Merlin V1650-7 piston engine
	2) 1 Wright R3350-268 piston engine
Year of Manufacture:	1) 1951
	2) 1960
Date & Time (UTC):	10 July 2011 at 1616 hrs
Location:	Near Duxford Aerodrome, Cambridgeshire
Type of Flight:	1) Private
	2) Private
Persons on Board:	1) Crew - 1 Passengers - None
	2) Crew - 1 Passengers - None
Injuries:	1) Crew - 1 (Minor) Passengers - N/A
	2) Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	1) Aircraft destroyed
	2) Outboard section of right wing detached
Commander's Licence:	1) Private Pilot's Licence
	2) Airline Transport Pilot's Licence
Commander's Age:	1) 64 years
	2) 64 years
Commander's Flying Experience:	1) 3,894 hours (of which 1,035 were on type) Last 90 days - 26 hours Last 28 days - 16 hours
	2) 25,920 hours (of which 15 were on type) Last 90 days - 76 hours Last 28 days - 30 hours
Information Source:	AAIB Field Investigation

Synopsis

The pilot of a P-51 Mustang was leading a 'Vic' (Vee) formation of three aircraft participating in an airshow at Duxford. On his left was a Douglas Skyraider and on his right was another P-51 Mustang. On a signal from the leader, the formation carried out a

'break' manoeuvre ¹ to the left. During the left turn the Skyraider and the leading Mustang collided. The

Footnote

¹ The 'break' manoeuvre is when each aircraft in the formation pulls up and turns, in this case, to the left in a set sequence at three second intervals. Each aircraft then positions behind the aircraft ahead at sufficient distance to perform the landing.

Mustang pilot was forced to abandon his aircraft and descended by parachute to a safe landing; the Skyraider pilot was able to land his aircraft at Duxford.

The accident occurred after the Skyraider pilot had lost sight of his leader and continued to make a tighter turn than his leader's aircraft, which had slowed down. This caused their respective flight paths to converge, resulting in the collision.

Background information

The Skyraider pilot was a French national who had not previously taken part in the weekend Duxford air display of historic aircraft, which is known as the 'Flying Legends'. For this reason he had to demonstrate his competence in meeting the UK display flying requirements and underwent a Display Authorisation (DA) evaluation which was conducted by a DA Examiner

(DAE). This involved flying an aerobatic sequence, both as an individual aircraft and in close formation with another aircraft. He successfully completed the test and his DA was issued by the UK CAA.

The accident occurred on the second day of the two-day, weekend event, during the finale of the display. This comprised a long formation of 27 aircraft in elements of two, three and four aircraft. This formation is known as the 'Balbo'². In order to land such a large number of aircraft, the formation makes three passes along the display line in front of the crowd and at the end of each pass, a specified number of elements break away from the crowd, in this case to the left, in a predetermined sequence. The aircraft involved in the accident were in the third element of the leading section. The order in which they were to carry out the Break manoeuvre is illustrated at Figure 1.

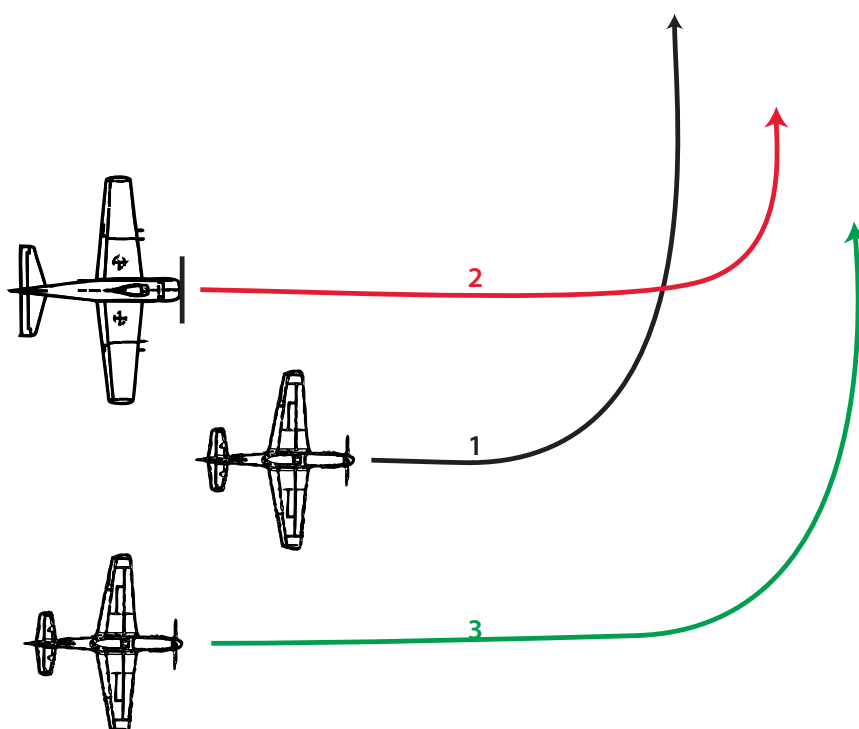


Figure 1

The sequence of the aircraft in the accident element carrying out their respective break manoeuvres

Footnote

² A term used to describe a large formation of aircraft named after the Marshal of the Italian Air Force, Italo Balbo.

The break sequence allows a manageable number of aircraft to position, in a specific order, suitably spaced, on the downwind leg of the circuit for landing. Both the accident aircraft had flown earlier in the display as part of other formations which had been briefed separately. These had also culminated in a break to land manoeuvre.

On the Saturday, the first day of the airshow, the break manoeuvre was uneventful and although the Skyraider pilot had lost sight of his leader as he climbed and turned his aircraft, which he considered normal, he quickly regained visual contact during the initial part of his break. At the post-flight debrief held between the three pilots in the element, there were no issues or concerns expressed and no changes to the break manoeuvre were made.

On the Sunday, the earlier formation flights involving the accident pilots were carried out without difficulty, and again no debrief points were raised.

History of the flight

After takeoff from Runway 24, the Balbo formation aircraft assembled into the pre-arranged elements. The weather conditions for the display were good and the weather was not a factor in the accident. At the end of the first pass in front of the crowd, the two aircraft at the rear of the Balbo carried out their break for landing. At the end of the second pass, the 12 aircraft in the second section carried out their break to land and on the third pass, the four elements of the leading section performed their respective breaks. On the next pass, following his hand signal to initiate the break, the lead Mustang aircraft broke upwards and turned to the left with an angle of bank of about 40°, turning towards the south as briefed. Three seconds later the Skyraider climbed and commenced a turn to the left, initially at an angle

of bank of 60° but this increased to 90° as the turn progressed. The Mustang pilot reduced power to reduce his airspeed to 170 mph and lowered the first stage of flap. The Skyraider pilot maintained the same engine power setting and looked to his left to try and regain visual contact with his leader, but despite scanning the area ahead, was unable to locate him. The lead Mustang suddenly appeared in his two o'clock high position and the Skyraider pilot attempted to initiate an avoiding manoeuvre but the two aircraft collided.

The Mustang pilot, who was wearing a parachute, considered making a forced landing in the open areas ahead of his aircraft, but faced with an abnormally aft control column position and severe airframe buffeting, he elected instead to abandon the aircraft and, after deploying his parachute, landed safely.

Immediately after the collision, the Skyraider aircraft made a 360° roll to the right, due to the loss of the outboard section of the right wing. Following the roll, the pilot was able to bring his aircraft under control. There was no airspeed indication due to the loss of the pitot tube which was located on the missing section of the right wing. The aircraft was landed using the normal landing flap setting.

Accident site details

The Mustang had crashed into a cereal crop approximately 2 km southwest of the airfield. The ground marks indicated that the aircraft struck the ground on a track of 185° (M), banked at almost 90° to the left and pitched steeply nose-down, with the nose leaving a shallow impact crater. This had resulted in a compact wreckage site, with the main wreckage lying some 16 to 18 m from the scar in the ground made by the left wingtip. The furthest flung item of debris was found approximately 50 m from the point of initial impact.

The engine had broken away from the airframe and was found a short distance from the impact crater. The propeller assembly had become detached from the engine; the individual blades displayed evidence of chordwise scoring but otherwise had not suffered major damage, suggesting a low power setting at impact.

The largest piece of wreckage consisted of the fuselage aft of the nose, together with much of the wing structure. The impact forces had resulted in the tail section being folded over on top of the fuselage centre section. Some light scrape marks were observed on the unpainted underside of the rear fuselage; the absence of earth adhering to this area of the wreckage suggested that these marks may have been associated with the airborne collision. In general however, it was considered that the severe airframe disruption that occurred at impact would have tended to obliterate much of the airborne contact marks. Despite the damage it was possible to confirm that the rudder and elevator operating cables had remained attached to their surfaces.

The fuel tanks, located in the wings, had been torn open during the impact, dissipating the fuel. There was no fire, although the Fire Service had blanketed the wreckage with foam after the accident.

The Mustang's canopy was found approximately 980 m due north of the impact site. The outboard portion of the Skyraider's right wing was found some 280 m north-east of the canopy and about 1 km south-east of the airfield. The section of wing was approximately 1.7 m in length, and bore evidence of a deep impact crease on the upper leading edge at the inboard end. The radius of the crease was sharp, which, following subsequent analysis of photographs taken of the event, suggested that the wing may have contacted the radiator cowling of the Mustang, which is located on the fuselage underside.

Photographic evidence

There was considerable video footage and still photography taken of the aircraft immediately before, during and after the collision. Figure 2 shows the aircraft virtually at the moment of impact, together with an enlarged portion that shows more detail.



Photo: Huw Hopkins



Figure 2

The moment of the collision, with enlargement showing damage to the Mustang's right tailplane

The enlarged image indicates that the Skyraider wing had passed beneath the Mustang's fuselage such that it contacted the leading edge of the right tailplane. This had resulted in a flap of tailplane skin protruding upwards into the airflow. It was not possible to determine the full extent of the damage due to the serious disruption to the tailplane structure during the subsequent ground impact. However, it is likely that the damage caused significant disturbance to the airflow over the tail, with an associated effect on the elevator controls. It can also be seen that the Skyraider's right aileron remained attached, despite the outboard portion being structurally unsupported.

Figure 3 shows a photograph of the Mustang immediately after abandonment by the pilot. It can be seen that the underside of the fuselage has sustained a significant amount of damage in the area that contained the engine coolant radiator. It is considered that this generated the crease in the leading edge of the Skyraider's wing, as noted earlier, and which resulted in its structural failure.



Photo: Huw Hopkins

Figure 3

View of Mustang showing damage to fuselage underside

Examination of the video footage indicated that the Mustang's canopy was jettisoned approximately 3.5 to 4 seconds after the collision, with the aircraft then adopting a level attitude on a gently descending flight path. The pilot was seen to exit the aircraft around 10 seconds later, following which the aircraft entered a steepening dive. It struck the ground approximately 3.5 seconds after the pilot baled out. The parachute deployment sequence could be seen in the video and, although the actual landing area was obscured by trees, it was estimated that 7 to 8 seconds elapsed between the canopy starting to inflate and the subsequent landing.

Display briefings

A flying display briefing was held at 0945 hrs daily and was given by the Flying Display Director. It was a comprehensive briefing for all the participating pilots and covered the day's activities and procedures to be adopted. A kneepad-sized aide-memoir was provided for each pilot and contained all the relevant information needed to take part in the display.

The Balbo formation was briefed by the Balbo leader after the main display briefing. A written 'Balbo Brief' was also provided for each pilot and contained all the information presented during the briefing.

The leader of each element in the Balbo briefed the pilots in their element on the formation and the break manoeuvre. Following the briefing, the pilots in the accident element walked through their display sequence, adopting the formation shape, and their individual positions within the formation. The leader was to run in at about 200 mph, signal the break with his left hand and then pull up rolling to the left using some 50° to 60° angle of bank, turning onto a southerly heading. The wingmen would then delay for three seconds before commencing their break in order to ensure separation.

Following the display any issues were discussed and any necessary changes made.

On the Saturday, the sequence of briefings was followed and no changes were required to be made to the display. On Sunday the three pilots in the accident element did not hold their briefing as the day before but the leader confirmed with his two wingmen that they were happy with the display.

Flight crew information

The Mustang pilot

The Mustang pilot started flying in 1967 and obtained a PPL 1988. He commenced flying historic aircraft in 1993 using a Harvard and acquired the accident aircraft in 1997. He had also flown other Mustangs. He had taken part in the Flying Legends and Balbo on 12 occasions. He had sold the aircraft in March 2011 but was asked by the new owner to display it during the Flying Legends weekend.

The Skyraider pilot

The Skyraider pilot had served initially as a fast jet pilot and instructor in the French Air Force and, as a fast jet pilot and instructor, he had taken part in and taught break manoeuvres which tended to be more dynamic than those briefed at Duxford. After leaving the Air Force he followed a career in commercial aviation as a pilot with his national airline and commenced historic aircraft flying in 2006. He had displayed historic aircraft throughout Europe since 1998 and had been a member of an aerobatic team since 2005.

Safety and survival

The Skyraider pilot, despite his difficulties in controlling his aircraft, was able to perform a successful landing. The Mustang pilot was forced to abandon his aircraft. He was wearing a set of flying overalls, boots, gloves

and a leather flying helmet³ with integral headphones. He also wore a Strong Para-Cushion Seat 304 parachute and was secured in the aircraft seat by a four point harness. He had frequently rehearsed the sequence of actions needed to be completed when abandoning the aircraft.

Following the collision the Mustang yawed to the right, the left wing dropped and the nose pitched down. The pilot heard the impact, and although he did not see the other aircraft, realised he had been in a mid-air collision. He regained control of his aircraft and confirmed the engine was still producing power. He then reduced power. He realised from the control column being aft of the normal position that the aircraft was damaged and jettisoned the canopy with his right hand. He attempted to trim the aircraft for the best glide speed in preparation for a belly landing in the farmland ahead. When he relaxed the back pressure on the control column, the aircraft nose pitched down and he could feel a buffeting through the control column and airframe. He decided to abandon the aircraft and released his seat restraint harness with his left hand and then placed that hand on the left side of the cockpit. He put both feet on the floor and moved his right hand to the right side of the cockpit at the same time pushing up to stand up in the cockpit. As he released the control column, the aircraft pitched nose down and the combined effect was that he exited the cockpit at a height of about 500 ft. He struck the tailplane, hitting his head, both arms and a shin. He immediately pulled the parachute deployment handle and saw the canopy deploy. He was surprised at the high rate of descent but landed in a cornfield, executing a parachute roll to absorb the impact. He was able to stand up, remove his parachute and awaited the arrival of the emergency services.

Footnote

³ The helmet was a modern, Kevlar, hard flying helmet, covered in leather to simulate a vintage leather flying helmet.

Discussion

The collision occurred due to the Skyraider continuing the turn without the pilot having sight of the lead aircraft. His turn was tighter and his speed greater than that of his leader, causing the flight paths of the aircraft to converge. The approximate relative tracks of the aircraft in the accident element are illustrated at Figure 4 below.

Whilst abandoning his aircraft, the Mustang pilot impacted the tail section. He was fortunate that his injuries did not prevent him from operating his parachute deployment mechanism. Had he been incapacitated, there was no automatic means, such as a static line, for deploying the parachute. The low height also meant that the parachute had to be deployed as soon as the pilot had cleared the aircraft structure. As a result, the following Safety Recommendation is made:

Safety Recommendation 2011-083
It is recommended that the Civil Aviation Authority considers, where a parachute is worn as safety equipment, whether the provision of an automatic means of operating the parachute would provide a safety benefit.

The Mustang pilot had frequently rehearsed the sequence of actions needed to be completed when abandoning the aircraft and was able to exit the aircraft very quickly; a factor which was significant in the successful outcome. Other pilots who wear parachutes may benefit from regular practice and rehearsal of aircraft abandonment drills.

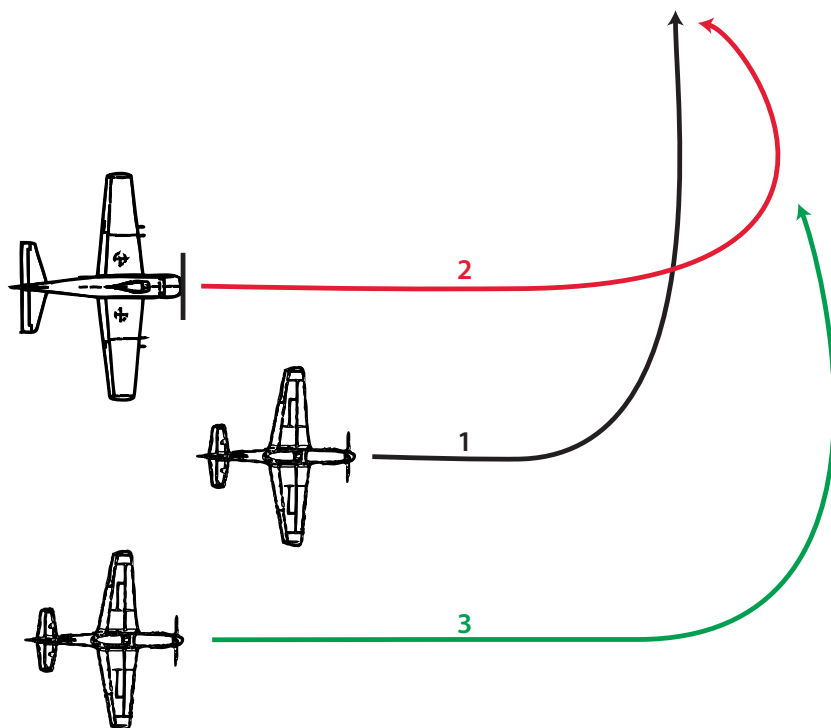


Figure 4

The approximate relative tracks adopted by the aircraft in the accident element