

Accident

Aircraft Type and Registration:	Grumman FM2, Wildcat, G-KINL
No & Type of Engines:	1 Wright Aeronautical Corp CT7-9B piston engine
Year of Manufacture:	1942 (Serial no: 5744)
Date & Time (UTC):	6 July 2023 at 1615 hrs
Location:	Heveningham Hall, Suffolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Windscreen and canopy broken, propeller, fin and rudder disrupted
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	4,238 hours (of which 2 were on type) Last 90 days - 28 hours Last 28 days - 17 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was attending an annual public event at a private estate. During the landing on a grass runway, at an unlicensed private airstrip, the aircraft nosed over and came to rest inverted. The pilot was seriously injured. It is believed the surface of the runway had a solid crust on top of a softer sub-soil that the aircraft dug into which caused it to nose over.

The event organisers are planning to implement additional operational coordination and risk management measures for future events.

History of the flight

Background information

G-KINL, a Grumman FM2 (also known as a Wildcat), was one of 13 historic aircraft that were part of a fly-in and static display at a concours¹ of aircraft, which was part of the annual Heveningham Country Fair (HCF), held at Heveningham Hall (HH) Estate, near Walpole, Suffolk. This was the twenty fifth fair held at HH and was attended by about 35,000 members of the public over two days.

Footnote

¹ An exhibition of vintage or classic aircraft in which prizes may be awarded for those in the best or most original condition.

There were three grass runways at HH, orientated 03/21, 06/24 and 15/33 (Figure 1). Runway 03/21 was for the sole use of visitors to the fair that were flying in. In previous years there have been about 70 visiting aircraft. Runway 06/24 was for the sole use of the aircraft taking part in the concours fly-in and a flying display. Those that used Runway 06/24 were generally vintage aircraft. Runway 15/33 was not routinely used during the HCF.

The pilot had operated G-KINL from a grass runway at Duxford Airfield², Cambridgeshire, where it was based, after its restoration. Prior to departing for the HCF he flew it from a grass runway, on a local flight, as a familiarisation and to confirm it was serviceable.

To assist the pilot of G-KINL in manoeuvring the aircraft to its parking position at HH, and to take the pilot back to Duxford, a Rallye Minerva³, with two ground crew, flew to HH ahead of G-KINL.

The accident flight

The pilot stated that the aircraft left Duxford at about 1530 hrs, with 102 US gallons of fuel. After an uneventful transit to HH, at about 1,500 ft amsl, G-KINL arrived in the area at about 1600 hrs; as did the Minerva. Prior to the arrival of G-KINL and the Minerva, a Waco UPF7⁴ and a Focke Wulf FW44J⁵ landed on Runway 24 without incident.

The pilot of G-KINL advised the pilot of the Minerva that he would let him land first. The Minerva pilot made an uneventful landing on Runway 24 and reported that the runway was fine.

The pilot of G-KINL then flew down Runway 24, to orientate himself to the runway direction, assess the approach over some trees in the undershoot and the proximity of trees on the sides of the runway, before positioning downwind to land. On the downwind leg he completed the landing checks and left the canopy closed. At this point there was about 80 US gallons of fuel remaining.

The pilot then positioned the aircraft on the final approach at a V_{APP} of 85 kt. The aircraft landed in a 3-point attitude, with the tail wheel about one foot off the ground, just before the runway threshold. The pilot added that, during the initial part of the landing roll, the aircraft was going straight and in full control, with the throttle closed. As he could see the ground crew at the end of the runway, he started thinking ahead about taxiing off the runway to the parking position. At this point he became aware of the aircraft's tail coming up. To counter this, he immediately applied full back stick, but the tail continued to rise. He then put both hands on the control column and looked inside to check the position of his feet, which were on the floor, so was not applying braking. Not understanding what was going on, he knew he could not stop the tail from rising, as it was happening so quickly, and that the aircraft would go on its nose as the aircraft was still doing a reasonable speed. As a result, he braced for the impact.

Footnote

² Duxford Airfield is licensed by the UK Civil Aviation Authority (CAA).

³ The Minerva had a maximum landing weight of 2,425 lb.

⁴ The MTOW of the UPF-7 was about 2,550 lb.

⁵ The MTOW of the FW44J was about 1,985 lb.

The aircraft went onto its nose, but immediately went further over and came to rest inverted about 96 m from the point of touchdown. As it did so, the pilot leaned his head forward and braced himself as low as possible in the cockpit. The impact crushed the cockpit into him and forced his head and shoulders to the right of the cockpit.

Once the aircraft had come to rest, the pilot found himself suspended in the straps, with his helmet and left shoulder in contact with the ground, and with his head pushed onto his right shoulder. He noticed a small gap in the Perspex canopy between the ground and the cockpit's left side and realised that would be the only place to exit the aircraft. Fuel then started leaking down into the cockpit. Realising there was no point in turning the fuel cock off as the fuel would have been coming out of the filler caps and knowing that the electrical relays were in the rear of the fuselage, he knew it would be safe to turn the electrics off, which he did. He then removed his protective helmet and used it to break through some of the canopy's Perspex to make the hole larger.

By this time, the ground crew from the Minerva had arrived at the aircraft. The pilot of G-KINL was still in the aircraft so the ground crew helped remove the pilot's helmet and clear away broken canopy parts, and other debris, away from the aircraft. The pilot then released his parachute harness before carefully releasing his aircraft four-point harness. Once he was able to stretch both his arms out of the hole he was pulled out of the aircraft before being taken a distance away from the aircraft, where some additional people gave him first aid.

At about this time paramedics arrived as did the local Rescue and Fire Fighting Services (RFFS) and an air ambulance. The pilot was subsequently taken to hospital by the air ambulance. The pilot stated that he remained conscious throughout the event.

Landings on other runways

The following day, two Spitfires landed uneventfully on Runway 15, in preparation for a flying display over the weekend. This other runway was used because Runway 03/21 was too short, and Runway 06/24 was not available as a result of the accident. One was flown by the Airborne Flying Display Director (AFDD). The Spitfires weighed about 2,990 kg with main gear tyre pressures of about 55 psi.

The AFDD had also landed in a Minerva, on the same runway, the previous day, after the Wildcat's accident, leaving no indentations in the grass. The surface appeared to be solid and would not leave any indentations when the heel of a shoe was dug into the surface.

Pilot's comments

The pilot was a very experienced pilot of vintage aircraft; he held a Display Authorisation and was a Display Authorisation Evaluator. He had flown over 110 different types and, of his 4,238 total flying hours, had over 1,800 hours on Spitfires and similar aircraft types.

The pilot commented that this was the first time he had landed at the HCF in a Wildcat but, having landed there before in other vintage aircraft in preceding years, he was familiar with the general layout of Runway 06/24. The other aircraft included a ME 109 (Buchon), which had 13 cm wide tyres, with a pressure of 66 psi and a Maximum Takeoff Weight (MTOW) of 2,850 kg.

He added that he had landed various marks of Spitfires at the HCF before. These had either 10½ inch (26.7 cm) or 12-inch (30.5 cm) radius main wheels, which had tyre pressures of 55 psi and 62 psi respectively. The pilot commented that the 12-inch wheels were more likely to penetrate the top surface of a grass runway compared to the 10½ inch ones. The Wildcat's mainwheel tyres are "not very wide" and were inflated to about 100 psi. However, having landed without event in a ME 109, he did not consider the Wildcat's narrow tyres to be a problem on the HCF runway. The pilot stated that, had the runway been described to him as being potentially soft, then he would have considered this factor. However, there was no mention of the runway being potentially soft when, prior to departing, he spoke to a representative from HH who informed him that the runway had been driven and was serviceable.

Witnesses

One witness landed on Runway 24 in a Waco UPF-7 about 10 minutes before the Wildcat and watched it land. He stated that its touchdown was a "lovely 3-pointer". However, after a ground roll of about 75-100 m, the tail of the aircraft lifted, and the aircraft continued to pitch over quickly before coming to rest inverted.

The AFDD commented that he thought it was noteworthy that the first relatively heavy aircraft to land on Runway 24 for the 2023 concours fly-in, was the Wildcat, with its relatively higher Centre of Gravity (CG) and firmer tyres when compared to a Spitfire. He felt that had a Spitfire been the first heavy aircraft to land, it would have done so without any problems, but the pilot would have noticed the softer ground.

Meteorology

An aftercast obtained from the Met Office showed the rainfall recorded in the local area in the previous four weeks. Whilst the exact rainfall was not recorded at HH, rainfall totals recorded within a 30 nm radius throughout June ranged between 16.6 mm and 35.4 mm. The first week of July showed an increased rainfall rate, with 34.4 mm recorded at Tibenham, Norfolk, 15 nm north-west, of which 30.0 mm fell between 1800 hrs on 4 July 2023 to 0800 hrs on 5 July 2023. No further rainfall was recorded on 6 July 2023.

The weather conditions on the day of the accident were generally fine with mainly light winds from the southwest at 5 to 10 kt and a daytime temperature of 21°C. No precipitation was recorded locally, and both cloud bases and visibilities remained good.

Local people also commented that Suffolk had significant rainfall two days prior to the accident with the following days being dry and sunny. The Wildcat pilot commented that at Duxford (50 nm west-south-west of HH), there was no rain in the week prior to the accident, giving him the impression that the locality, including HH, had not had any rain either. At Wattisham Airfield, 21 nm southwest of HH, temperatures were recorded up to 21°C and 26°C the day before and the day of the accident respectively.

Airstrip information

The field within the HH estate, where Runway 06/24 was located, is about 115 ft amsl. The runway orientation, and general layout of all three runways on the estate, is shown in Figure 1.



Figure 1

Approximate runway positions and orientation on the HH estate
© 2020 Google, Image © Landsat / Copernicus

The field in which Runway 06/24 was situated was normally used for pastoral farming, had about 6 inches of topsoil and a subsoil of heavy brown clay. Runway 06/24 was prepared every year for the sole use of the aircraft flying in for the concours. On around 8 June 2023, the grass was cut with a flail topper, with the cuttings being collected a couple of days later. It was then rolled with a 13-tonne vibrating roller, six times, at 1.2 km/hr to 1.5 km/hr. This is the same process as was used in preceding years. Thereafter, there was no activity on the runway until the aircraft arrived on 6 July 2023; the day of the accident. At the time of the accident the grass was approximately 3 to 4 inches (about 7.5 cm to 10 cm) long⁶. Whilst Runway 06/24 had been inspected each year by some of the pilots before an aircraft landed on it, the HCF had no evidence to suggest anyone had requested to do an in-person

Footnote

⁶ CAP 793 stated that 'It is recommended that grass be kept to a maximum of 10 cm'. See below for more information.

inspection before the event in 2023. However, several pilots, who were familiar with that runway, are believed to have been in contact with the HCF to check on the condition of the runway and to confirm that there were no significant changes to previous years.

Having been advised that the visiting aircraft would be landing at about 70 mph (60 kt), a 1,200 kg off-road buggy, with 20 psi tyres, was driven down the edge of the runway at about 50 to 60 mph in the days before the accident. This was to see if there were any uneven areas that caused the vehicle to bounce and could potentially do the same for aircraft if they were operating on it. However, none were identified. Additionally, prior to the first aircraft landing, a 2,675 kg road vehicle, with 38 psi tyres, was driven at various speeds up to 60 mph on multiple occasions by a representative from the HCF. No surface indentations were noticed after these. The organiser of the visitors' fly-in also drove along the runway in a 1,700 kg road vehicle, with 32 psi tyres, at speed of up to 70 mph. He commented that wheel marks were only made in the grass, not into the surface soil.

To coordinate aircraft movements to both runways, pilots communicated with an Air Ground Communications Service (AGCS) operator at the HCF via the 'SAFETYCOM' frequency, 135.480 MHz⁷, using the callsign 'Heveningham Radio'. The use of SAFETYCOM is discussed later in this report.

As the airstrips were not licensed, pilots only needed the landowner's permission and were landing at their own risk. There was no firefighting equipment or aircraft recovery provisions at the airstrip for the arrival of the concours aircraft, nor was there a requirement for there to be any. During the days the fair was open, there was firefighting equipment present for the visiting aircraft landing on Runway 03/21 and for the flying display. This comprised of five vehicles, including two fire tenders.

A representative from the HCF commented that whilst, during the preceding years, they had sought advice from the AFDD on operating from Runway 06/24, they had not sought any advice from the CAA to help prepare the runways, nor was there a requirement to do so. However, they had followed the advice in the CAA's Safety Sense 12 – Strip Flying⁸ which contains the following information of relevance.

'Assessing the site

...

Conditions on the ground

A ground visit is recommended...⁹

...

Footnote

⁷ SAFETYCOM is a common traffic advisory frequency for use at aerodromes that do not have an assigned frequency. Aircraft should announce their position and intentions at the normal points in the circuit.

⁸ The full version of the Safety Sense 12 can be found at https://www.caa.co.uk/media/cwjom2ph/safetysense_12-strip-flying.pdf [accessed 6 June 2024].

⁹ The CAA commented that a ground visit would be appropriate to assess the ground conditions if there had been infrequent flying activity.

*One way of assessing the **general condition of the surface** is to drive a car at approximately 30 mph and note the ride quality, if it is reasonably smooth, it should be suitable. Grass height should be not more than 30% of the diameter of the aircraft's main wheels¹⁰ and ideally shorter.'*

Aircraft performance

Runway 06/24 had a landing distance available of about 850 m and the Wildcat, from the aircraft's performance data, required a factored landing distance of about 680 m.

Weight and balance

During the aircraft restoration a check weigh was carried out. The aircraft basic weight was found to be 5,396 lbs (2,538.3 kg) with its CG within limits. The aircraft contained 756 lbs of fuel at takeoff on the day of the accident and used approximately 233 lbs during the flight from Duxford to HH. The aircraft basic weight, fuel, pilot and his flying kit meant the aircraft's landing weight was approximately 5,999 lbs (about 2,720 kg). The weight on each mainwheel was therefore 2,999.5 lbs (1,360 kg) per wheel by calculation this results in a ground pressure of 100 psi on the soil.

The thrust line, and therefore vertical centre of mass of the Wildcat, acts approximately 2.0 m above the centre of the mainwheels when the aircraft is in a horizontal attitude. The Spitfire that landed the following day weighed about 6,585 lb (2,987 kg) and had a thrust line of approximately 1.5 m above the centre of the mainwheels when in a horizontal attitude.

Recorded information

The aircraft was fitted with a transponder and the pilot stated that he had switched it on for the flight to the HCF. However, no secondary radar was able to be recovered by NATS.

Accident site

The aircraft touched down at approximately 85 kt on the grass runway and evidence on both tyres show an initial wheel run up slippage but also show the tyres penetrated the ground to a depth of 3.3 cm. Marks made by both tyres were pronounced over most of the 96 m landing run until the aircraft nosed over (Figure 2). Deepening propeller blade slash marks had been made at the end of the landing run followed by a deep hole made by the propeller boss.

Footnote

¹⁰ 30% of the diameter of the Wildcat's mainwheels is 13.5 cm.



Figure 2

Accident site with ground marks

The aircraft had nosed over on to its back and come to rest in line with its landing run. Fuel had spilt from wing tanks through the filler caps. The rudder was heavily distorted and had detached, and the fin was buckled and had been compressed. The windscreen, canopy transparency and frame parts had detached and were lying beneath the cockpit area. The left wingtip had also struck the ground and was distorted. The right mainwheel could be turned by hand with a small amount of binding. The left mainwheel was stiff to turn by hand. Although one witness described a '3-point' touchdown, no tailwheel marks were found on the runway.

The first responders had turned the fuel cock off and disconnected the battery to make the aircraft safe as far as possible.

Apart from the marks left by this aircraft, there were no other identifiable marks on the runway surface. A subjective test the day after the accident was carried out using a steel spike (part of an electric fence pole) to penetrate the runway surface and found it had a hard turf surface crust approximately 2 cm thick on top of a softer substrate. It was noted that when the test was done, the daytime temperature reached 28°C by midday¹¹, which was much warmer and sunnier than the day of the accident. This would have had the effect of drying the crust and making it slightly harder when this test was carried out.

Aircraft description

The aircraft was a World War Two carrier-borne fighter. It is an all-metal midwing monoplane powered by a nine-cylinder, single row supercharged radial engine. Its airframe, landing gear and braking systems are designed for all weather aircraft carrier deck operations. The main landing gear is a parallelogram frame assembly which retracts into the undersides of the fuselage giving it a narrow track when compared to other carrier aircraft of the era. To fit neatly into the fuselage, it was fitted with relatively narrow wheels and tyres. The wheel and tyres were approximately 45 cm in diameter and 13 cm wide. This size of tyre was required to support an aircraft which had a maximum weight of approximately 7,400 lb (3,356 kg) and required a pressure of 103 psi (7.1 bar) which would give a tyre contact surface area of approximately 180 cm².

Both mainwheels are fitted with drum brakes with an upper and lower lined brake shoe. The drum is an integral part of the inner half hub. Both rudder pedals are fitted with an articulated foot pad which acts on a sealed master cylinder and fluid reservoir on each pedal. When the brakes are applied, hydraulic pressure is felt on a double acting slave cylinder which pushes the shoes outwards against the drum to achieve the desired braking effect. When the pedals are released the brake shoe are pulled away from the drums by a spring. To ensure that the brake shoes require the minimum slave cylinder piston travel and to allow for friction material wear, they are fitted with threaded adjusters. The brakes are adjusted to achieve maximum clearance¹² between the friction material and drum. A correctly adjusted brake will exhibit a small amount of drag when the wheel is rotated by hand. Figure 3 shows the brake assembly.

Footnote

¹¹ As shown on the outside air temperature monitor of one of the AAIB vehicles at the accident site.

¹² As this was an aircraft designed and built in the USA, all the settings are in imperial measurements. Of note, this aircraft had a comprehensive and detailed operation and maintenance manual which was adhered to during its restoration. Both brakes were adjusted using this manual to the required maximum clearance of 0.007 inch ('7 thou').

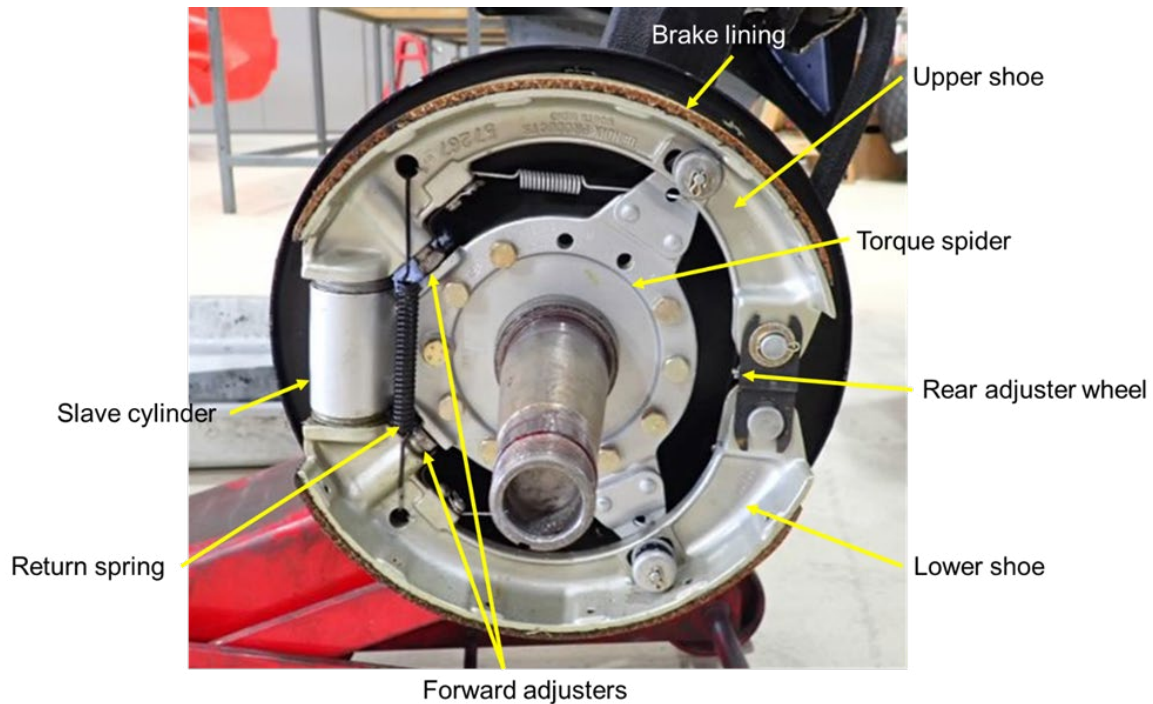


Figure 3

Wheel brake assembly (left side, drum removed)

Aircraft maintenance history

This aircraft had undergone a full restoration which had brought it back to the factory standard as far as possible. The brakes had been restored with new brake linings. The left wheel hub with integral drum was new 'old stock' whilst the right wheel was more original to the aircraft. Both had been repainted externally to leave a smooth bare metal running surface for the brake shoes. The aircraft was fitted with a modern but unobtrusive radio and transponder so as not to detract from the original cockpit layout. Post-restoration test flying had been carried out at Duxford and the first flight took place in October 2022. Since then, there had been seven flights/landings with a total of 5 hours and 40 minutes flying time. This included a short flight in the morning of 6 July 2023 before the accident. This flight and three other previous flights had taken off and landed on the grass runway at Duxford.

Aircraft examination

The aircraft was righted and placed on its undamaged landing gear. Engine lubricating oil started to leak from the underside of the engine cowling. This was found to be because of a slight distortion on the engine mounting frame which led to an oil pipe fracture. To minimise the environmental impact the oil reservoir was drained into a suitable container. The propeller blades were also damaged when they struck the ground.

The aircraft braking system was examined and there were no obvious signs of damage or malfunction. However, the left brake pedal was firmer when compared to the right. The double acting slave cylinders and shoes can be seen with the wheel hub cover removed. The left and right wheel brake shoes could be seen moving on and off although the left set appear to move to a lesser extent than the right.

Despite this the aircraft could be rolled backwards and forwards with ease. It was observed that whilst doing this the aircraft left distinct wheel tracks in the runway surface. The aircraft was then moved to an unprepared safe area at the side of the runway for later recovery to a maintenance facility.

After recovery, the aircraft braking system was examined. The left brake drum and shoe linings had started to bed in with evidence of high spots¹³ on the surfaces. Experience has found that the combination of a new drum and linings bed in slightly more slowly than an older, used drum with new linings. The right brake drum and shoe linings had bedded in commensurate with the number of aircraft landings since restoration. The resultant level of binding on each wheel was considered normal by the experienced aircraft restoration engineers present during the examination.

Organisational information

Anyone organising or participating in an event should take certain precautions to plan for unexpected circumstances. These could be in the form of risk assessments (RAs) and, although there is no requirement to follow it, the CAA provides a lot of guidance information and recommendations in various publications. Those of relevance to this event are discussed further in this report.

The HCF was open to the public on the Saturday and Sunday for which there was an *Event Management Plan* (EMP) and an *Emergency Plan*. The EMP covered the fair, the visitors' fly-in, concours fly-in and flying display, for the two days, and included a generic section about RA for the HCF. It stated that '*Risk Assessments relating to the content of specific attractions at the event are covered both by generic risk assessments and specific assessments by the providers of the attraction.*'

The flying display, that took place during the HCF and had planned to use Runway 06/24, had a RA that was produced by the AFDD and was signed by him and the HCF Event Organiser. The CAA permission (ADOC-2182) issued for the flying display was for an off-airfield display on the two public days.

The visitors' fly-in, that used Runway 03/21, was organised by the AGCS operator. The organiser stated that there was a RA for the visitors' fly-in. The HCF had requested a copy of the RA, prior to the 2023 fly-in, but they commented that the document "never materialised". The AGCS operator commented that this was an oversight on his part. However, they did have some documentation pertaining to the 2018 fly-in. The 2023 RA for the visitors' fly-in was made available to the AAIB during the course of this investigation.

The provider of the fire cover for the visitors' fly-in had a RA.

There was no RA for operations of concours aircraft to and from Runway 06/24, nor was there required to be one.

Footnote

¹³ The new linings were of a uniform thickness at manufacture, but when they were bonded to the shoe, high spots of a few thousandths of an inch can develop. These can manifest themselves as slightly darker areas early in the bedding in process but eventually disappear.

Issue 1 of Civil Aviation Publication (CAP) 793 – *Safe Operating Practices at Unlicensed Aerodromes*¹⁴ stated in Chapter 1, that the contents of this CAP ‘are not mandatory.’ It also states the following:

‘Whether an unlicensed aerodrome is a “farm strip”, a helicopter landing site or a hard runway equipped airfield, the physical characteristics and operating standards should provide a safe operational environment. This publication provides guidance to the owners of, and those who operate or fly from, unlicensed aerodromes to enable safe operating practices to be met.

Chapter 4 Aerodrome Physical Characteristics

3.4 ...It is recommended that grass be kept to a maximum of 10 cm (4 in.) high.

Chapter 5 Flying Operations

...

3. A visual inspection of the airfield including checking the runway...should be conducted each day before the start of flying...

5. ...The surface of a grass runway can be considered smooth enough if a car can be driven over it at 30 mph without undue discomfort...

Chapter 8 Emergency Services

1 ...At larger unlicensed aerodromes greater provision would be prudent,...

2 In developing emergency procedures the following should be considered:

- A competent person should conduct an assessment of the hazards and risks.

...

- Ensuring suitable first aid and fire-fighting equipment is available and can be transported to an accident or incident which occurs up to the aerodrome boundary.’

Consultant’s review of HH runways

In March 2019, a consultant met with representatives from the HCF and drove/walked Runways 03/21 and 06/24. He did not look at Runway 15/33 as it was not routinely used during the HCF. In his report he mentioned CAP 793 and CAP 403 – *Flying Displays and Special Events: Safety and Administrative Requirements and Guidance*¹⁵. He commented that ‘a Duty of Care is placed upon an Event Organiser to ensure that any event which is open to the public (including fly-ins) shall be risk assessed and managed to ensure that

Footnote

¹⁴ CAP 793 can be found here: <https://www.caa.co.uk/publication/download/13965> [accessed 6 June 2024].

¹⁵ CAP 403 can be found here: <https://www.caa.co.uk/publication/download/12154> [accessed 6 June 2024].

any risk is as low as reasonably practicable (ALARP).¹⁶ He also mentioned Appendix A to CAP 403, *Risk Assessment* which, whilst it is principally for flying displays and special events, he stated it 'is equally applicable to fly-ins.'

SAFETYCOM

The UK Aeronautical Information Publication states the following in *Communication and Navigation Services*:

'3.2.4 Common VHF Channel for Use at Aerodromes having no notified Ground Radio Channel

- a. *At aerodromes having no notified ground radio facilities a VHF channel is available to assist pilots to avoid potential collisions between arriving and departing aircraft. Pilots may use this channel to broadcast their intentions for safety purposes.*
- b. *The channel assigned is 135.480 and is known as 'SAFETYCOM'.*
- c. *The conditions of use are:*
 - ...
 - iii. *SAFETYCOM shall only be used to transmit information regarding the pilot's intentions, and there should be no response, except where the pilot of another aircraft also needs to transmit his intentions or, exceptionally, has information critical to the safety of an aircraft in a condition of distress or urgency.*
 - ...
 - vii. *No air traffic service is associated with SAFETYCOM...*

SAFETYCOM was used at the HCF to provide an AGCS. This is contrary to the conditions of use stated in the Aeronautical Information Publication (AIP). If an AGCS is required, organisers are to initially apply to Ofcom¹⁷, who would share the application with the CAA.

Analysis

G-KINL examination

On initial examination, with the aircraft on its back, the left wheel was very stiff to turn. The right wheel was free to rotate, albeit with slight brake shoe drag. After the aircraft had been righted with its full weight on the wheels, the left and right wheels rotated normally. Later examination of the brakes showed that the lining condition was as would be expected.

Footnote

¹⁶ CAP 760 defines a risk as being ALARP when it is low enough that attempting to make it lower, or the cost of assessing the improvement gained in an attempted risk reduction, would actually be more costly than any cost likely to come from the risk itself. CAP 760 can be accessed here: <https://www.caa.co.uk/publication/download/13108> [accessed 6 June 2024].

¹⁷ Applications to Ofcom are to be made via this form: https://www.ofcom.org.uk/_data/assets/pdf_file/0026/125369/OfW586a-Aeronautical-radio-ground-station-licence-application-form.pdf [accessed 6 June 2024].

The right brake had bedded in more than the left brake with its newer drum, but this was considered unremarkable by experienced engineers. This explains why there appeared to be slightly less movement of the left brake shoes when observed at the accident site. The operation of the braking system was not a factor in this accident.

Effect of the runway surface

A closer examination of the marks made by both mainwheels, their effect on the blades of grass and soil in the tyre tracks, show that compression of the surface was the prominent factor rather than skidding. Calculations show the static ground pressure from each wheel to be 1,360 kg over an area of 180 cm² and that the tyre pressure of 103 psi presents a stiff running face of the tyre. In practice, this loading would be less at initial touchdown but would rise to this magnitude as the wing lift reduces. No marks attributable to the tailwheel were found on the runway.

Met Office aftercast showed significant rainfall in the eastern counties in the preceding days which gave way to warm sunshine on the day of the accident. The day after the accident was hot and sunny. The penetrative examination of the runway showed that a hard surface crust had formed on top of a softer layer. It is likely that this surface had been softer on the day of the accident and that the crust was thicker and slightly harder as a result of the much warmer conditions on the following day and at the time the penetrative examination was carried out.

As the aircraft touched down, the hardness of the tyres and the weight of the aircraft compressed the surface crust. The leading rolling faces of the tyres continued to compress the surface as they rolled along which created a considerable drag effect. This was very similar to the effect of landing in soft sand or icy slush. This rapidly decelerated the aircraft from approximately 85 kt (43.72 m/s) to a stop over a distance of about 96 m. As this was happening, the mass of the engine, which was no longer producing thrust, as the throttle was closed, created a 2.0 m moment arm couple rotating the CG about the axis of the mainwheels. This tipped the aircraft forward and caused the propeller to strike the ground leaving deepening cut marks. Eventually the aircraft nosed completely over and came to rest on its back. This was despite the pilot's attempts to lower the tail by pulling back on the control stick.

Airstrip preparation

The preparations for Runway 06/24 seemed appropriate and were no different to previous years during which there were no known incidents. The grass was at an appropriate length and several different vehicles were driven along on Runway 06/24, prior to the first movements, as suggested by the CAA's Safety Sense 12 and CAP 793. However, the tyre footprints, and hence ground pressures, were lower than those of the Wildcat.

CAP 793 stated that the runway should be visually inspected each day before flying started and the runway was assessed for uneven areas using road vehicles by HCF. Safety Sense 12 also recommended that a ground visit be conducted. However, it seems reasonable to assume the recommendation to conduct a ground visit is directed towards

pilots who have not flown into a particular airstrip before or whose condition is unknown due to the absence of personnel on the ground to inspect it prior to a pilot's arrival.

Conduct of the flight

The pilot had flown the Wildcat from a grass runway at Duxford, several times before, including prior to departing for the HCF, with Duxford being a licensed airfield that had runways that were in regular use. Whilst he had landed at HH in previous years in different aircraft types, he did not consider the Wildcat's narrow tyres to be a problem on the HCF runway but, had he been informed that the runway was potentially soft, he would have taken this into account.

Even though some other aircraft did land before the Wildcat, they were lighter aircraft with a weight of about a third of the Wildcat and had softer tyres. The AFDD believed that had a Spitfire landed before the Wildcat, it would have done so without event. However, the soft sub-soil may have been noticed and this could then have been passed on to the Wildcat pilot.

It appears that, given the Wildcat's relatively high CG, once the narrow, high-pressure tyres broke through the surface crust and started to dig into the softer sub-soil, the tail started to lift and there was not much the pilot could have done to stop it from pitching forward onto its nose before coming to rest inverted. This was despite him applying full back stick to try to counteract this.

Once the aircraft came to rest, the trapped pilot was then exposed to leaking fuel. He was subsequently extracted, with assistance, through a small hole, as attempts to lift the tail of the aircraft were unsuccessful given its weight and the lack of aircraft recovery equipment close to hand.

There was also no firefighting equipment in the vicinity of the runway. Whilst neither of these were a requirement for an unlicensed airstrip, given the number of aircraft movements expected, it may have been prudent to have fire and rescue facilities available during all flying activities.

Risk Assessments

The HCF, flying display, visitors' fly-in and the associated firefighting provider each had an RA. However, there was no RA for operations using Runway 06/24 which was used by the aircraft involved in the concours and the display aircraft. This is despite the consultant highlighting some relevant parts of CAP 403 that could be equally applicable to the fly-ins, and that any event, including all fly-ins, should be risk assessed and managed to ensure that any risk is as ALARP.

Whilst the guidance in the CAPs was not mandatory, had an RA been conducted it is likely that more consideration would have been given to what may occur during aircraft operations and any potential risk, like an aircraft accident, reduced to ALARP by having appropriate provisions to cater for such an event, as suggested in CAP 793.

The RA for the visitors' fly-in for 2023 was not made available by the organiser of the fly-in to the HCF before or after the event and was only passed to the AAIB towards the end of the AAIB investigation. HCF only had a copy of the RA from 2018. This did not give the HCF the opportunity to review any changes made to the RA to ensure that the provisions put in place prior to the 2023 event were adequate, and thus ensure that risks were ALARP.

Survivability

The correctly adjusted and worn harness and protective helmet afforded protection to the pilot. This, along with his ability to anticipate what was about to happen and crouch down as far as possible, prevented a more serious outcome.

Conclusion

The aircraft systems and controls were functioning normally during the accident. The weight of the aircraft caused its narrow, high-pressure mainwheel tyres to sink into the soft runway surface and created a rolling resistance which rapidly decelerated the aircraft. The high CG resulted in large rotating moment about the axis of the mainwheels which led to the aircraft toppling forwards, the propeller blades striking the ground, and the aircraft then tipping over on to its back.

The crusty surface of the runway, on top of the soft sub-surface, was probably a result of the wet weather conditions in the weeks prior to the event, followed by warm dry weather in the days prior to the accident. This was undetected, despite the runway being checked in accordance with the guidance available.

The event organisers are planning to implement the following additional measures for future events:

- An RA for the visitors fly-in will be obtained and reviewed in advance of the HCF.
- A risk assessment will be conducted for the operation of Runway 06/24, that is used for the concours and flying display aircraft.
- There will be a nominated suitably qualified and experienced person to coordinate all the aviation operations.
- Firefighting and lifting equipment will be available at Runway 06/24 for movements in the days prior to the country fair.

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