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Safety risks from rotor wash at hospital helicopter landing sites

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Addendum

Page	Change	Date

Executive summary

Why the ATSB undertook this research

Following several helicopter rotor wash incidents at hospital helicopter landing sites (HLSs) that resulted in injuries to nearby pedestrians, the ATSB compiled a list of similar incidents in the preceding 5 years. Analysis of the specific occurrences was conducted to identify the common factors, existing regulatory guidelines, and ways to mitigate the effect of rotor wash.

What the ATSB found

Of the 18 helicopter downwash incidents reported in the last 5 years, 9 were reported to have occurred at hospital HLSs. Of these, 6 occurrences resulted in injuries to pedestrians that were located within approximately 30 m of the HLS. Flight crew were not aware of the presence of pedestrians in all cases, and most flight crew were not aware of the incident at the time. Most, and possibly all of the injuries were sustained by pedestrians over the age of 75 after being exposed to rotor wash. All incidents involved AgustaWestland AW139 helicopters. If the recommended rotor wash exclusion area had been applied at each HLS, it would have reduced the risk of the pedestrians being injured.

Key factors contributing to the effects of rotor downwash include the weight of the helicopter, the main rotor size, disc loading, prevailing wind, and the flightpath. There were no reported occurrences of rotor wash related injuries at hospital HLS prior to the significant increase in the utilisation of AW139 for medical transport operations from 2017.

As part of Civil Aviation Safety Regulations Part 133 (*Australian air transport operations rotorcraft*), helicopter operators are required to determine information about aerodromes and determine procedures for safe operations at aerodromes. The Civil Aviation Safety Authority does not currently regulate the design and operation of heliports, including hospital HLSs, where they are not an integral part of an aerodrome certified under Civil Aviation Safety Regulations Part 139 (*Aerodromes*). This means that the Civil Aviation Safety Authority does not provide any formal approval for, or assurance of, HLS operational standards. The Civil Aviation Safety Authority has produced guidance material for the operators of HLSs to design, maintain, and operate their facility to the standards of certified aerodromes.

What has been done as a result

Helicopter operators involved in these incidents reported taking corrective actions to mitigate the dangers of rotor wash, which included:

- immediate cessation of operations to the HLS
- selection of an alternate landing area
- removal of hazards in the vicinity of the HLS
- operational restrictions including the number of helicopters permitted on the HLS at one time and restrictions on flightpaths used during approach and departure
- marshallers put in place for arrival and departure times.

The ATSB has issued the following Safety Advisory Notice (AD-2022-001-SAN-001) with this report:

> The Australian Transport Safety Bureau strongly encourages operators of hospital helicopter landing sites, and helicopter medical transport operators using those landing sites, work together to review the adequacy of existing risk controls to ensure pedestrians are adequately protected from the increased rotor wash associated with larger helicopters.

Safety message

From the identified common factors associated with rotor wash incidents, the flightpath is the only element that can be managed by the pilot in accordance with the operator's procedures. However, pilots may be unaware of the presence of pedestrians in the vicinity of a hospital HLS. To enable the continued safe use of these facilities, hospital HLS owners and helicopter operators should ensure pedestrians are not affected by rotor wash by implementing appropriate risk controls for their HLS in addition to the helicopter operating procedures. Controls may include physical barriers, warning devices such as sirens, lights, high visibility warning signs, painted lines on nearby public thoroughfare to alert pedestrians to the rotor wash danger area, an inspection schedule for the HLS facility and surrounding area, and establishing a closed-loop reporting system.

Data and analysis

Following several incidents at hospital helicopter landing sites (HLSs) involving injuries to nearby pedestrians from helicopter rotor wash, the ATSB initiated a review of the number and type of helicopter downwash occurrences from 2018 to 2022. The following analysis of the specific occurrences was conducted to identify the common factors, existing regulatory guidelines, and ways to mitigate the effects of rotor wash.

Rotor wash

Rotor wash is comprised of downwash, which is the vertical component of rotor wash produced by the main rotor blades that supports the helicopter in flight, and sidewash, which is the horizontal component of rotor wash. It is influenced by environmental conditions such as air density, temperature, and altitude. However, the key factors that determine the strength of rotor wash include:

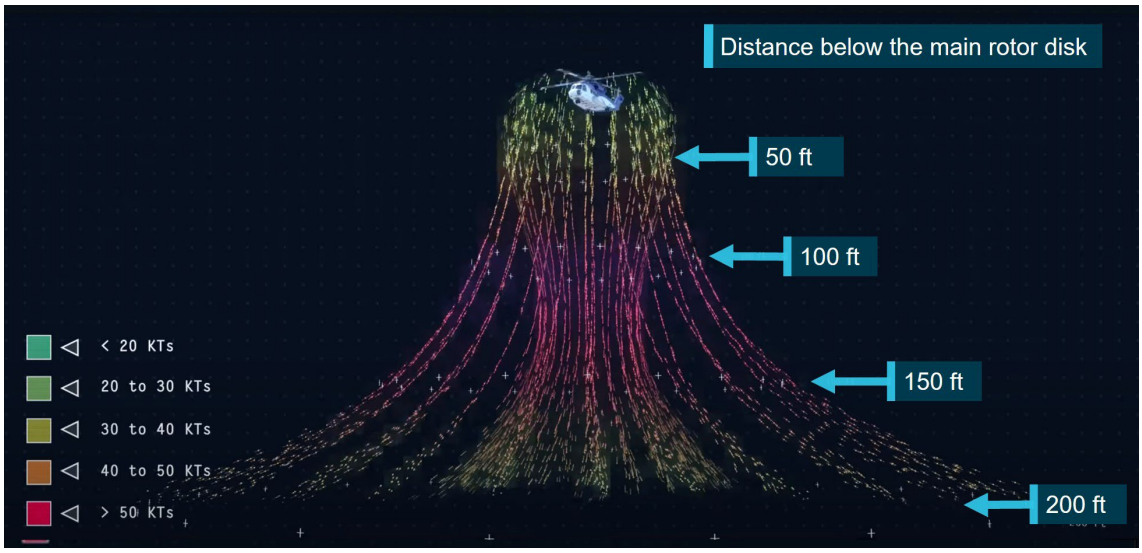
- weight of the helicopter – a heavier helicopter generally produces higher downwash speeds
- main rotor size – a larger rotor disc area will lower the downwash speed but a larger rotor disc is usually associated with heavier helicopters that produce higher downwash speeds
- disc loading – how much weight is being carried per unit area of the rotor blades
- wind – the relative wind influences the movement of the rotor wash (Figure 1)
- flightpath – rotor wash is concentrated underneath the helicopter as illustrated in Figure 1.

Figure 1: Rotor wash profiles

Source: Japan Transport Safety Bureau

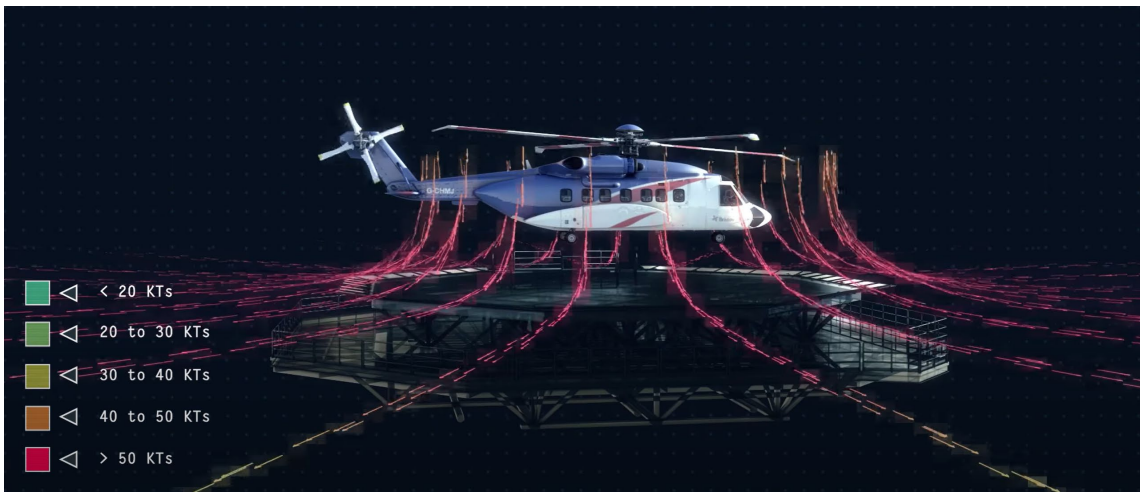
Mathematical modelling of rotor wash adjusted for the effects of open rotor flow from the main rotor blades by Airbus (2021) determined the highest velocity of this stream of air occurs from 1 to 3 rotor diameters below the rotor blades directly beneath the helicopter. Beyond this distance the high velocity airflow dissipates due to turbulence. Figure 2 is a British Petroleum model of the downwash velocities over a 200 ft vertical profile for a Sikorsky S92 helicopter. As the airflow comes under the influence of the terrain or a structure, there is a directional change and acceleration of the airflow as it transitions into sidewash as illustrated in Figure 3. Due to helicopter power requirements and the influence from the ground, rotor wash effects are most pronounced during hover, take-off, and landing where it can produce localised wind strengths greater than 100 km/h. The following figures show the rotor wash velocity in knots and a conversion table for km/h is provided at *Appendix 1: Conversion tables*.

Figure 2: Downwash profile of a Sikorsky S92 helicopter over 200 ft



Source: British Petroleum annotated by the ATSB

Figure 3: Sidewash profile of a Sikorsky S92 helicopter



Source: British Petroleum

Many HLSs are located inside airports at ground level, isolated from people and structures. However, hospital HLSs are often located in built-up areas or at existing hospital facilities where space permits. In Australia, they are built on the top of high-rise hospital buildings, in carparks, in public ovals and above public roads as illustrated at *Appendix 3: Area of consideration*. Therefore, a hospital HLS may be in an area that exposes the public to the risk of being struck by rotor wash or struck by objects propelled or dislodged by rotor wash.

The effect of rotor wash on people has been the subject of several studies, with most agreeing that 80 km/h winds represent conditions that are 'unsuitable for walking', and 60 km/h winds are at the 'threshold of danger' for the average population (Jordan and others 2008). Jordan and others (2008) also considered the effect of rotor wash on the more vulnerable groups of the population and found that in people over the age of 50, roughly half were displaced by a gust of 40 km/h. Consequently, the International Civil Aviation Organization (ICAO) heliport design work group

have been working on an amendment to Document 9261 – *Heliport Manual,* that will incorporate a 40 km/h rotor wash speed guidance into the document.[1]

Occurrence data

Introduction

A review of the ATSB National Aviation Occurrence Database found 18 helicopter rotor wash occurrences were reported between 2018 and 2022. Of these 18 occurrences, 9 were in the immediate vicinity of a hospital HLS. A summary of each of the 9 occurrences is provided in the following section and the occurrence data is available at *Appendix 2: Occurrence data.*

Of the 9 rotor wash occurrences at hospital HLS:

- 6 resulted in injuries, 3 resulted in serious injuries and 3 resulted in minor injuries
- 3 resulted in damage to third party property caused by debris.

Occurrences

ATSB occurrence OA2018-00396

On 8 January 2018 at about 1300 local time, an elderly pedestrian was walking along the footpath adjacent to the Alfred Hospital HLS, Victoria, as an AgustaWestland AW139 helicopter was on approach to land. The helicopter passed overhead the pedestrian and the rotor wash was reported to have blown the pedestrian across the path and into a wall. The pedestrian sustained minor injuries (bruising) and reported they were unaware of the possible strength of the rotor wash.

ATSB occurrence OA2018-05243

On 27 July 2018 at about 1100 local time, an AgustaWestland AW139 helicopter was on approach to land at the rooftop HLS at Bathurst hospital, New South Wales. As it passed over the corner of a carpark, a pedestrian was blown over sustaining minor injuries. This HLS was situated 4 stories above ground level. The height of the helicopter during the final approach would have been consistent with the height below the main rotor disc where the strongest downwash velocities would be experienced as described by Airbus Helicopters (2021) and illustrated with Figure 2.

ATSB occurrence OA2018-05244

On 27 July 2018 at about 2000 local time, the crew of an AgustaWestland AW139 was conducting a visual approach on night vision goggles to the Health Centre HLS in Warren, New South Wales. The crew conducted a straight in approach from the east, which involved overflying a nearby caravan park. As the helicopter approached the HLS, the crew detected a large flock of birds take-flight near the HLS and entered a hover. The crew maintained the hover at 200 ft above ground level for approximately 2 minutes to allow the birds to disperse. During this time, rotor wash was reported to have affected the trees in the caravan park below, with falling branches causing minor damage to caravan park buildings and equipment.

ATSB occurrence OA2019-00659

On 24 January 2019 at about 1200 local time, an AgustaWestland AW139 was on approach to land at the Latrobe Regional Hospital, Victoria. Rotor wash from the helicopter blew a traffic barricade into the side of a vehicle parked nearby. The vehicle sustained minor damage.

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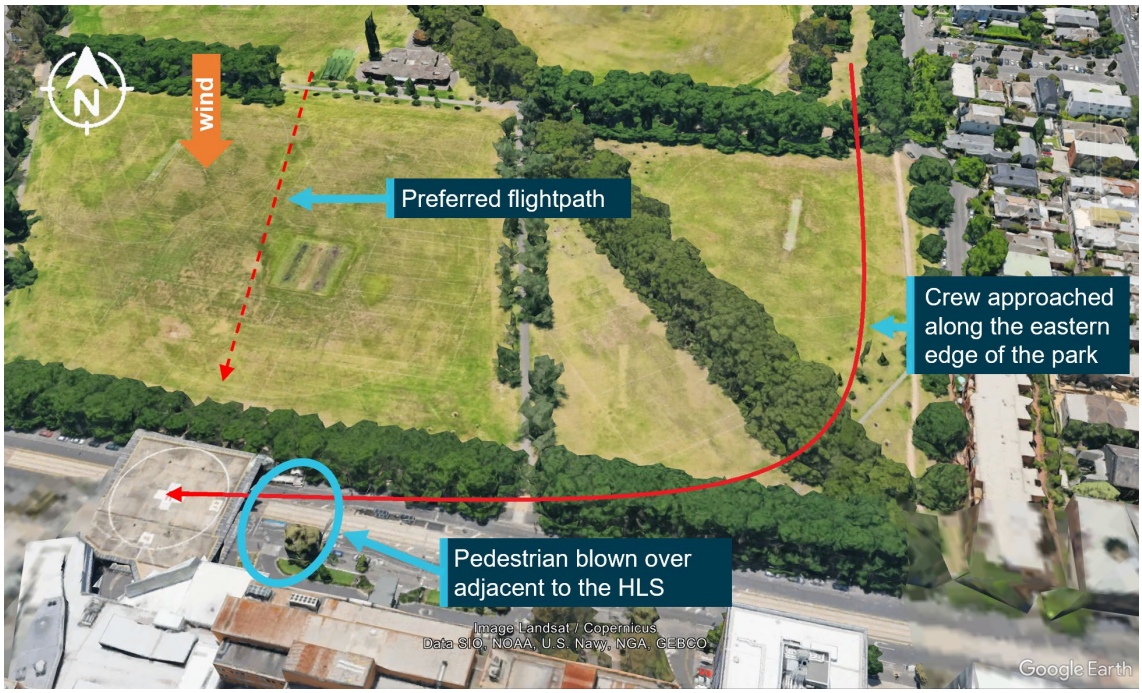
[1] International Civil Aviation Organization Heliport design work group virtual seminar on the design and operation of heliports to provide States with updated tools based on the new amendments to Annex 14 Vol. II, updated ICAO guidance documents; and awareness of new measures. *Doc 9261 Part II Onshore Heliport Manual*

ATSB occurrence OA2020-06455

On 27 December 2020 at about 1300 local time, a pedestrian was walking along the footpath adjacent to the Alfred Hospital HLS as an AgustaWestland AW139 helicopter was on approach to land. The crew altered their approach to account for the 35-knot wind on the day by tracking along the nearby park before turning towards the HLS on late final (Figure 4). As the helicopter approached the HLS, the pedestrian was blown over and sustained a broken sacrum.

Figure 4: Approximate flight path based on reported information



Source: Google Earth annotated by the ATSB

Occurrence Brief AB-2021-028 (OA2021-05170)

On 28 October 2021 at about 1550 local time, an AgustaWestland AW139 conducted an approach to land at the Alfred Hospital HLS. The crew approached the helipad from the west, using a steep approach profile aligned with Commercial Road. As the helicopter passed overhead a pedestrian walking on the footpath about 30 m west of the HLS,[2] the pedestrian was blown over by the rotor wash and sustained serious injuries (broken bones) (Occurrence Brief AB-2021-02).

ATSB occurrence OA2022-02001

On 24 May 2022 at about 0852 local time, an AgustaWestland AW139 was on approach to the Royal Prince Alfred Hospital, NSW. During approach to the elevated HLS, the doctor onboard observed a large piece of cloth blown up behind the helicopter. Further investigation revealed that multiple lengths of shade cloth, held in place by bricks, had been dislodged by the rotor wash. It was later discovered that some of the bricks used to retain the lengths of cloth had fallen 300 ft to the ground below, with one brick found in a café and another found in an area of the hospital grounds open to the public.

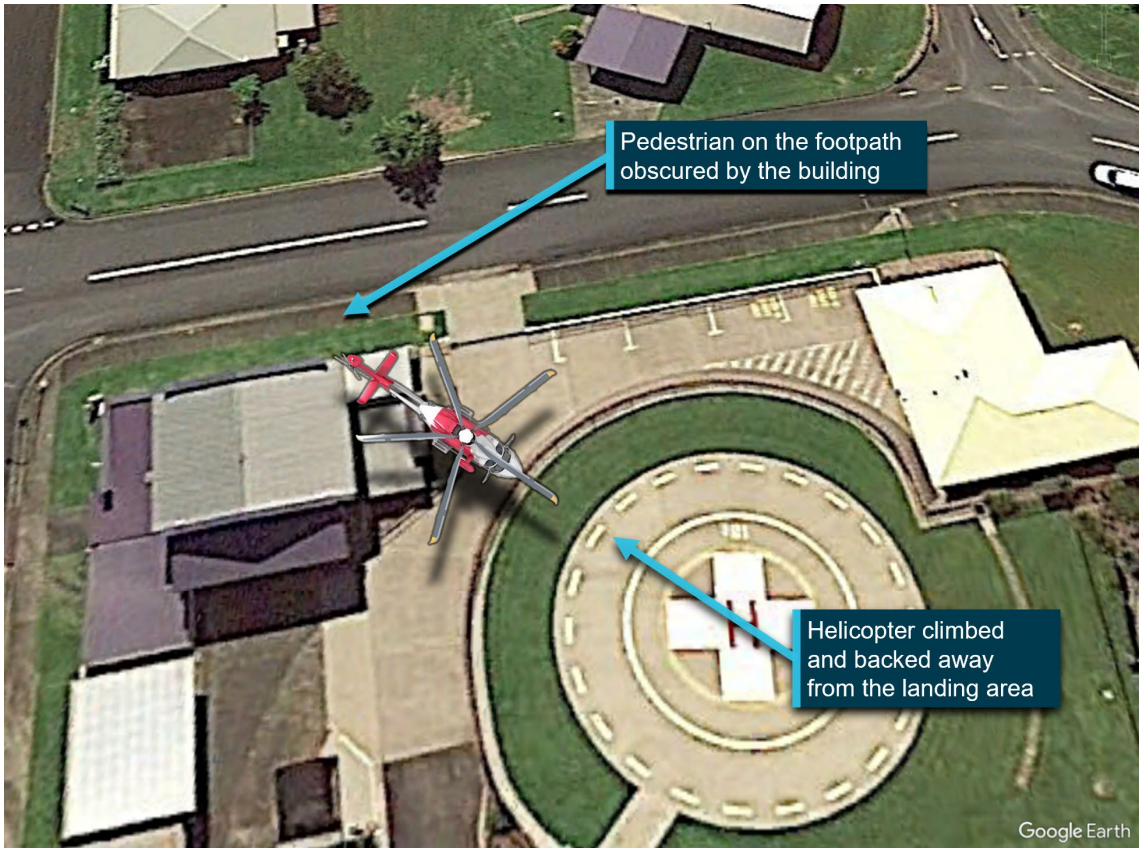
ATSB occurrence OA2022-02750

On 17 July 2022 at about 1708 local time, an AgustaWestland AW139 helicopter departed from the Innisfail Hospital HLS, Queensland. The standard departure required the helicopter to climb

[2] While AB-2021-028 reported this distance as 50 m west of the HLS, analysis of the details provided found that it was approximately 30 m from the HLS.

vertically and back away from the helipad slightly so the pilot could keep the landing area in sight in case of an abort before flying away (Figure 5). As the helicopter backed over the top of a hospital building towards the nearby roadway, a pedestrian walking on the adjacent footpath was blown over and sustained a serious head injury. The pedestrian was not visible to the crew from the helipad.

Figure 5: Approximate flight path based on operator report



Source: Google Earth annotated by the ATSB

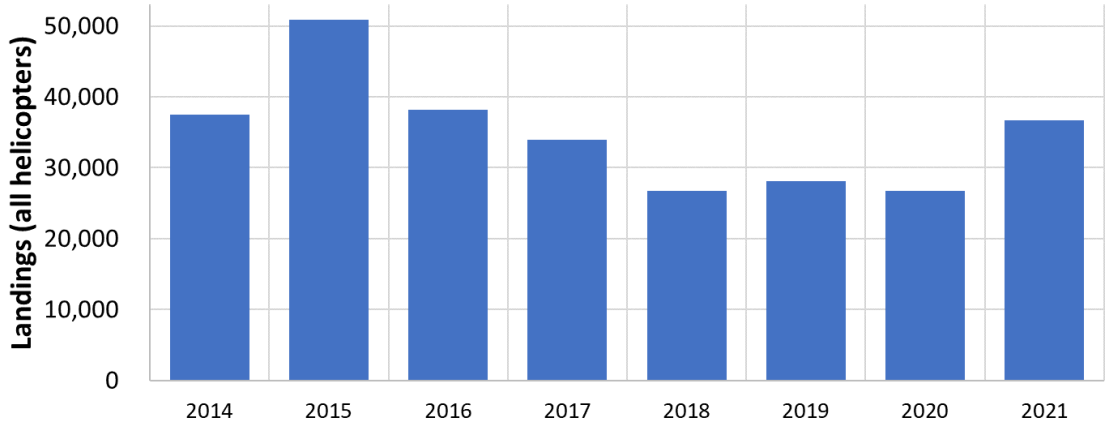
ATSB occurrence OA2022-04733

On 25 December 2022 at about 1500 local time, the crew of an AgustaWestland AW139 commenced a take-off from the Mareeba Hospital HLS, Queensland. An elderly patient of the hospital was walking in the hospital grounds at the time and as the aircraft lifted into a low-level hover, they were blown over by the rotor wash. The patient fell to the ground and sustained minor head injuries. The crew observed the patient fall and aborted the take-off.

Medical helicopter operations and size

Analysis of medical transport operations (MTO) helicopter movements, from data obtained from the Bureau of Infrastructure and Transport Research Economics, indicates that the number of landings per year (Figure 6) remained relatively constant from 2014 through to 2021.

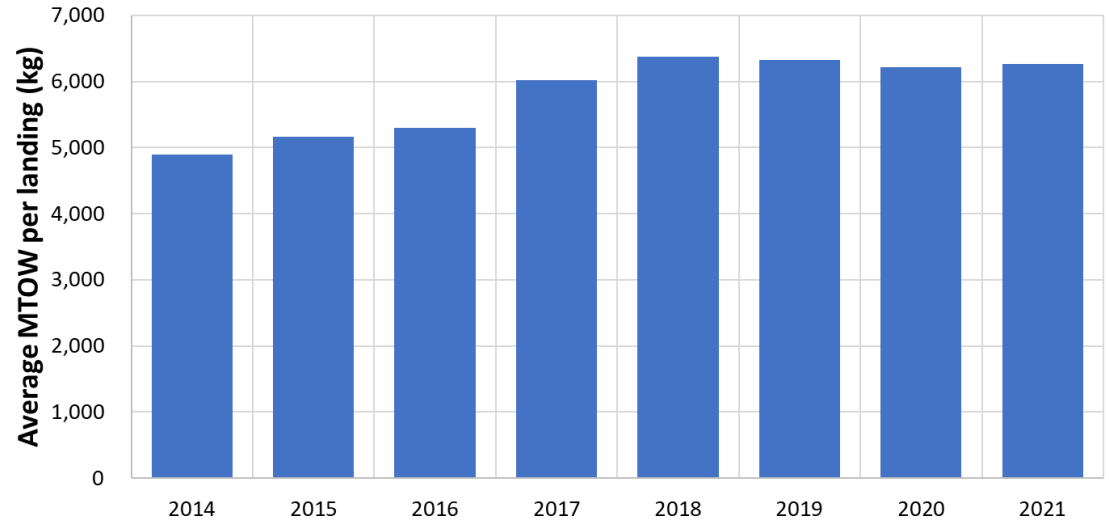
Figure 6: Number of medical transport landings 2014-21



Source: Bureau of Infrastructure and Transport Research Economics

However, there was a significant increase (around 30%) in the average maximum take-off weight (MTOW) per landing for helicopters conducting medical transport operations (Figure 7) from 2014 to 2018 which remained relatively constant to 2021.

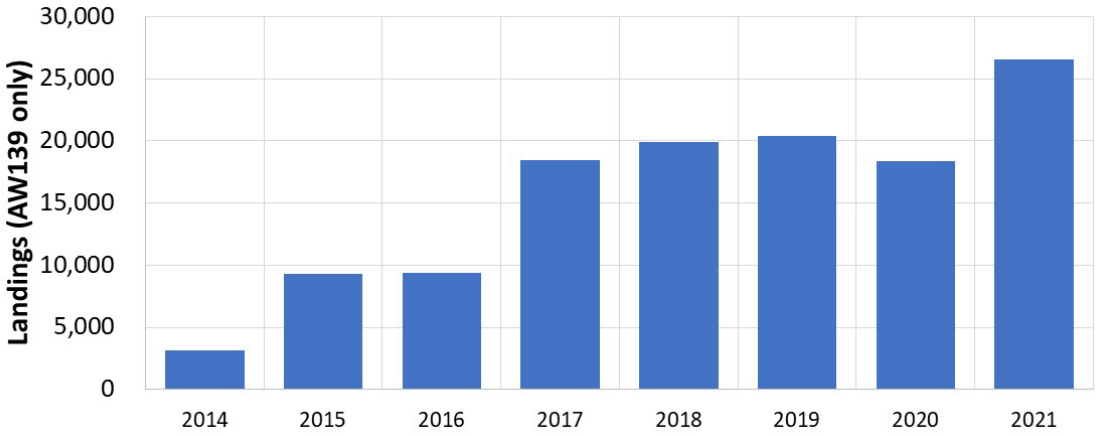
Figure 7: Average maximum take-off weight per landing for medical transport helicopters 2014-2021



Source: Bureau of Infrastructure and Transport Research Economics

This increase is consistent with the significant increase (approximate doubling), in the use of AW139 for medical transport observed between 2016 – 2017 (Figure 8).

Figure 8: Number of AW139 medical transport landing 2014-21



Source: Bureau of Infrastructure and Transport Research Economics

Common factors

Helicopter emergency medical service operations often involve time critical missions that require the crew to utilise landing areas within the grounds of hospitals. Analysis of the 9 identified occurrences found the following common factors:

- all occurrences involved the AgustaWestland AW139 helicopter type and there were no reports of downwash related injuries at hospital HLSs prior to the significant increase in the utilisation of AW139 for medical transport operations from 2017.
- most incident crews were unaware of the incident at the time of occurrence
- there were no references to established rotor wash danger or exclusion areas[3]
- in 5 out of the 6 injury-related events, the pedestrians age was reported to be 75 or greater, and in the 6th event, the pedestrian was reported to be using a walker
- where the locations of injured pedestrians were reported, they were outside the HLS perimeter fence but within 30 m of the final approach and take-off area (FATO).[4]

In addition to the increase in helicopter mass, the capability of the AW139 permitted a greater number of vertical, backup, or lateral transition take-off and approach and landing options to the flight crew. The different ways the aircraft could be flown may have also been a contributing factor to the increase in rotor wash occurrences but could not be determined from the occurrence database.

Regulatory oversight and guidance

Australia

The Civil Aviation Safety Authority (CASA) does not regulate the design or operation of HLSs if they are not an integral element of an aerodrome certified under Part 139 of the Civil Aviation Safety Regulations (CASR) 1998. As hospital HLSs are not located at Part 139 certified aerodromes, CASA does not regulate their design or operation. In accordance with CASA Advisory Circular (AC) 139.R-01 v1.0 – *Guidelines for Heliports – design and operation*, a HLS is an aerodrome intended to be used wholly or in part for the arrival, departure, and surface

[3] Exclusion area: Term used to refer to an area from which non-essential personnel should be kept clear in accordance with AC 91-29 v1.1 and AC 139.R-01 v1.0.

[4] FATO: Final approach and take-off area. For the operation of a rotorcraft, means the area of the aerodrome:
a. from which a take-off is commenced or
b. over which the final phase of the approach to hover is completed.

movement of helicopters and therefore, references to an aerodrome in this section below includes hospital HLSs.

Helicopters operating into and out of hospitals are generally medical transport operations. Medical transport operations (MTO) fall into the air transport rule set under CASR Part 133 – Australian air transport operations–rotorcraft. CASA advised the ATSB:

> Part 133 requires the MTO operators to include in their exposition via regulation 133.170 of CASR procedures to determine information about aerodromes and via regulation 133.175 of CASR procedures for safety at aerodromes.

CASR 133.170 requires the MTO operator's exposition to include information on the final approach and take-off area (FATO) dimensions and directions for the pilot-in-command. This includes any limitations, special procedures, and restrictions the operator requires the flight crew to use at the aerodrome.

CASR 133.175 stated an operator's procedures must include measures to ensure the safety of persons in the vicinity of the rotorcraft. The requirement to consider the effects of rotor wash is mentioned in part (b):

> (b) procedures to determine the minimum distance that a person, animal or thing must be kept from the following to ensure the safety of the person, animal or thing:
>
> (i) the rotorcraft while it is on the ground at an aerodrome with its rotors turning;
>
> (ii) the movement area of an aerodrome while the rotorcraft is landing or taking off;
>
> (iii) a hazard created by the downwash of the rotorcraft at an aerodrome.

In reference to CASR 133.175, CASA stated:

> The assumption is these procedures and distances would also be communicated to any person responsible at a HLS location for third party person and property risk control measures, otherwise the operator would not be able to operate to the location and comply with their exposition.

CASA AC 91-29 v1.1 – *Guidance for helicopters – suitable places to take-off and land*[5] provided the following recommended considerations for pilots and operators:

- the FATO and touchdown and lift-off area (TLOF)[6] are clear of all objects and animals likely to be a hazard to the helicopter, other than objects essential to the helicopter operation
- no person is within 30 m of the closest point of a hovering or taxiing helicopter, other than persons who are essential to the safe conduct of the operation or the specific nature of the task and who are trained and competent in helicopter operational safety procedures
- appropriate information from the owners and authorities is obtained to confirm the suitability of the HLS for the proposed operation.

Data on rotor wash speeds has been incorporated into CASA AC 139.R-01 v1.0 (Figure 9) and shows the distance from the centre of the helipad that rotor wash velocities of 40, 60 and 80 km/h can be expected for common helicopter types. The data is expressed both as a distance in metres, and as multiples of the main rotor disc radius. Figure 9 indicates that the associated strength of rotor wash increases with increased helicopter weight (MTOW). The AgustaWestland AW139, involved in all 9 rotor wash incidents described above, is highlighted and shows that beyond the recommended 30 m non-essential person exclusion area, rotor wash velocities can be expected to be between 60 and 80 km/h.

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[5] AC 91-29 v1.1: Supports the new Civil Aviation Safety Regulations and replaces operational information previously found in CAAP 92-2(2) and is referred to in AC139.R-01 v1.0. An advisory circular provides advice and guidance to illustrate a means, and not necessarily the only means, of complying with regulations.

[6] TLOF: Touchdown and lift-off area is the surface over which the touchdown and lift-off is conducted.

Figure 9: Helicopter rotor wash data

Helicopter Data				Peak Wind Velocity					
Type	MTOW	Rotor Diameter	Disc Loading	Radius @ 40 km/h		Radius @ 60 km/h		Radius @ 80 km/h	
	(kg)	(m)	(kg/m2)	(radii)	(m)	(radii)	(m)	(radii)	(m)
AW101	15600	18.6	57.47	7.0	65	5.5	51	4.1	38
S92	12565	17.2	54.27	6.8	58	5.4	46	4.1	35
H225	11200	16.2	54.34	6.8	55	5.4	44	4.1	33
B525	9299	16.6	42.91	6.0	50	4.8	40	3.7	31
AW189	8300	14.6	49.58	6.5	47	5.2	38	3.9	29
H175	7800	14.8	45.34	6.2	46	5.0	37	3.8	28
AW139	6800	13.8	45.46	6.2	43	5.0	34	3.8	26
H160	6050	13.4	42.90	6.0	40	4.8	32	3.7	25
Bell 412	5398	14.0	34.97	5.5	38	4.1	29	3.5	25
S76	5306	13.4	37.57	5.6	38	4.4	29	3.6	24
AW169	4800	12.1	41.61	5.9	36	4.7	29	3.7	22
H145	3800	11.0	39.99	5.8	32	4.6	25	3.7	20
Bell 429	3175	11.0	33.41	5.3	29	4.0	22	3.5	19
EC135	2980	10.4	35.08	5.5	28	4.2	22	3.5	18

Source: CASA AC 139.R-01 v1.0

Foreign jurisdictions

The ATSB contacted several foreign regulatory bodies to determine the oversight of hospital HLSs outside Australia. Responses were received from the United Kingdom Civil Aviation Authority (UK CAA) and Transport Canada. In addition, the guidance from the United States Federal Aviation Administration was reviewed. At the time of drafting this report the UK Air Accidents Investigation Branch had an active investigation into a fatality at the Derriford Hospital HLS, Plymouth, from a Sikorsky S92 helicopter rotor wash.

United Kingdom Civil Aviation Authority

The UK CAA advised the ATSB that every helicopter operator is responsible for approving a HLS and principal oversight by the CAA is through the review and acceptance of each operator's operations manual landing site directory. They reported that where an elevated helipad is intended for use at night, a check flight will be conducted with the primary operator and thereafter cleared for other operators who will include it in their own landing site directory.

Hospital HLSs are not currently licensed in the UK and, with the emphasis in the Air Navigation Order (ANO) on licensing heliports only where scheduled public transport operations occur, there are only a handful of licensed heliports in the UK. New hospital HLS builds in the UK, since 2016, have been designed to the standards of UK Civil Aviation Publication (CAP) 1264 – *Standards for helicopter landing areas at hospitals*, which incorporates sections on downwash guidance. Several recent new build HLSs, to meet a condition of their local planning authority process, have incorporated a downwash study at the pre-application stage, which takes account of the impact of rotor downwash on persons and property. However, this has been adopted by some projects as a good practice rather than as a regulatory requirement. At the time of publishing this report, it was

reported that the UK CAA was poised for a further review of CAP 1264, including downwash guidance, pending the release of a final investigation report into a fatality at Derriford Hospital due to main rotor downwash from a helicopter arriving at the hospital HLS.

Utilising consultancy arrangements via their subsidiary organisation CAA International Limited, UK CAA offers a service to provide support to Hospital HLS new builds and refurbishments by undertaking feasibility studies and providing advice and support to National Health Service Trusts and their sub-contractors. CAA is currently rolling out Hospital Helipad Training Aviation Awareness courses for the benefit of Hospital HLS operational staff.

Transport Canada

Transport Canada advised that the requirement for certification is predicated in most cases on the location of the heliport being within the built-up area of a city or town, as mandated under Part 305 of the Canadian Aviation Regulations 1996. Hospital HLSs may or may not meet this requirement. HLSs which are not required to be certified and whose operators wish to have the aerodrome registered and the information published in the *Canada Flight Supplement,* will fall under Canadian Aviation Regulation Part 301, with respect to the location, markings, lighting, use and operation of the aerodrome. This differed from the available Australian guidance in that Canadian hospital HLS operators, who elected to comply with the Canadian Aviation Regulations, were required to ensure that certain minimum safety considerations were met.

Canadian Aviation Regulation 301.03(2) stated:

> The Minister may refuse to register an aerodrome where the operator of the aerodrome does not meet the requirements of sections 301.05 to 301.09 [concerning warning notices, wind direction indicator, lighting, prohibitions, fire preventions] or where using the aerodrome is likely to be hazardous to aviation safety and, in such a case, shall not publish information with respect to that aerodrome.

Canadian Aviation Regulation 301.05 identified the following HLS operator responsibilities with regards to warning notices:

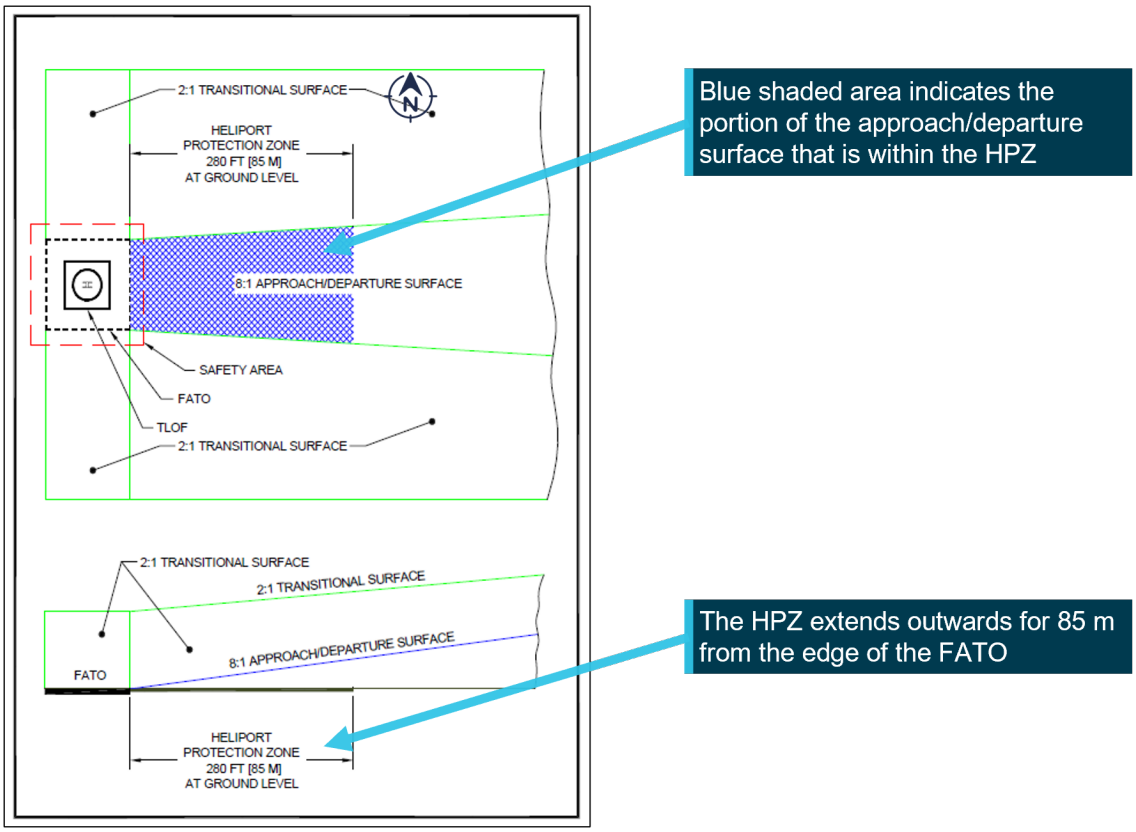
> Where low-flying or taxiing aircraft at or in the vicinity of an aerodrome are likely to be hazardous to pedestrian or vehicular traffic, the operator of the aerodrome shall immediately:
>
> (a) post notices warning of the hazard on any public way that is adjacent to the manoeuvring area; or
>
> (b) where such a public way is not owned or controlled by the operator, inform the authorities responsible for placing markings on the public way that there is a hazard.

United States Federal Aviation Administration

In the United States, the Federal Aviation Administration AC 150/5390-2D for heliport design recommended the establishment of a heliport protection zone (HPZ) for each approach/departure surface as illustrated in Figure 10. Starting at the edge of the FATO, the HPZ extends outwards underneath the flight path for 280 ft (85 m).

> The HPZ is intended to enhance protection of people and property on the ground. This is achieved through heliport owner control over the HPZ. Such control includes clearing HPZ areas (and maintaining them clear) of incompatible objects and activities.

Figure 10: Heliport Protection Zone



Source: United States Federal Aviation Administration

Managing the risk of rotor downwash at hospital HLS

Introduction

The recent increase in rotor wash incidents does not suggest that hospital HLSs are more dangerous now than they were previously, rather, the risk mitigation measures employed for previous generations of MTO helicopters are likely inadequate in managing the rotor wash hazard produced by the current generation of heavier MTO helicopters. The regulatory standards and guidance published by CASA indicate there is a shared responsibility between the HLS operator, the MTO operator, and the pilot-in-command for the safe conduct of operations to a hospital HLS.

Areas where the strength of rotor wash should be considered by hospital HLS operators, who want to comply with the Part 139 standards, should include:

- public areas where pedestrians are likely to be walking
- public roads and vehicle access areas
- areas that contain unrestrained objects that could be propelled by rotor wash
- buildings and other structures that may cause channelling and turbulence of the rotor wash.

CASA have defined acceptable limits in Part 139 Manual of Standards Chapter 6, Division 5 for certified aerodromes.

Where the specifications cannot be met, CASA AC 139.R-01 recommends a risk assessment is conducted to identify any alternative mitigation measures to achieve an acceptable level of safety of helicopter operations at the HLS.

Understanding the risk

Where the locations of injured pedestrians were reported, they were outside the HLS perimeter fence but within 30 m of the FATO and inside the area CASA AC 91-29 recommended be kept

clear of non-essential pedestrians. If the recommended rotor wash exclusion area had been applied at each HLS, it would have reduced the risk of the pedestrians being injured. However, based on the latest guidance published by CASA in AC 139.R-01 v1.0, and the research by Jordan and others (2008), the hazards associated with rotor wash at a hospital HLS should be considered further than 30 m, out to the 40 km/h rotor wash radius, to prevent injury to the elderly and vulnerable. For a HLS constructed at surface level, the distances published by CASA indicate the danger area[7]. However, for an elevated HLS, or HLS in the vicinity of structures, a rotor wash analysis should be considered to understand the nature of the risk. This can be explored with anemometers and wind vanes or with computational fluid dynamics to produce a plot of the HLS rotor wash danger area in accordance with the approach and departure flight paths for the design helicopter.[8]

Risk controls

While it is the responsibility of the HLS operator and MTO operator to identify what controls are necessary for safe operations, some generic risk controls for consideration may include an exclusion area, physical barriers, active controls, passive controls, MTO operating procedures, inspections, and a hazard reporting and tracking system as follows:

- A HLS exclusion area should be in accordance with the danger area for the design helicopter as published in AC 139.R-01 v1.0, or as determined by a plot of the HLS rotor wash danger area. If this is not feasible, then an alternative strategy may need to be evaluated. Examples of hospital HLS sites in *Appendix 3: Area of consideration* are based on the guidance for an AgustaWestland AW139 as per Figure 11 below, which recommends an exclusion area based on a 66 m radius.
- Physical barriers, such as fences and covered walkways, designed as safety barriers and/or security barriers to prevent inadvertent entry to the HLS, can provide protection to pedestrians and property from rotor wash.
- Active controls can be used during helicopter operations to alert pedestrians in or near the danger area with warning lights and alarms as per Figure 12. Marshallers can be employed to restrict pedestrian access during helicopter operations.
- Passive controls should include warning signs and painted/marked paths to indicate the helicopter operations danger area to the public (Transportation Research Board, 2013).
- An inspection schedule can identify and secure or remove loose objects and verify the condition and serviceability of the other controls, such as the signs and barriers.
- Operating procedures in accordance with CASR 133.170, should include the approved approach and departure flight paths, alternate landing sites, and the location of the danger areas for pedestrians, so flight crew can make informed decisions.
- A closed-loop reporting system should be available for flight crew to alert the MTO operator and HLS operator to hazards for tracking through to closure, including any temporary or permanent controls implemented to reduce the risk.

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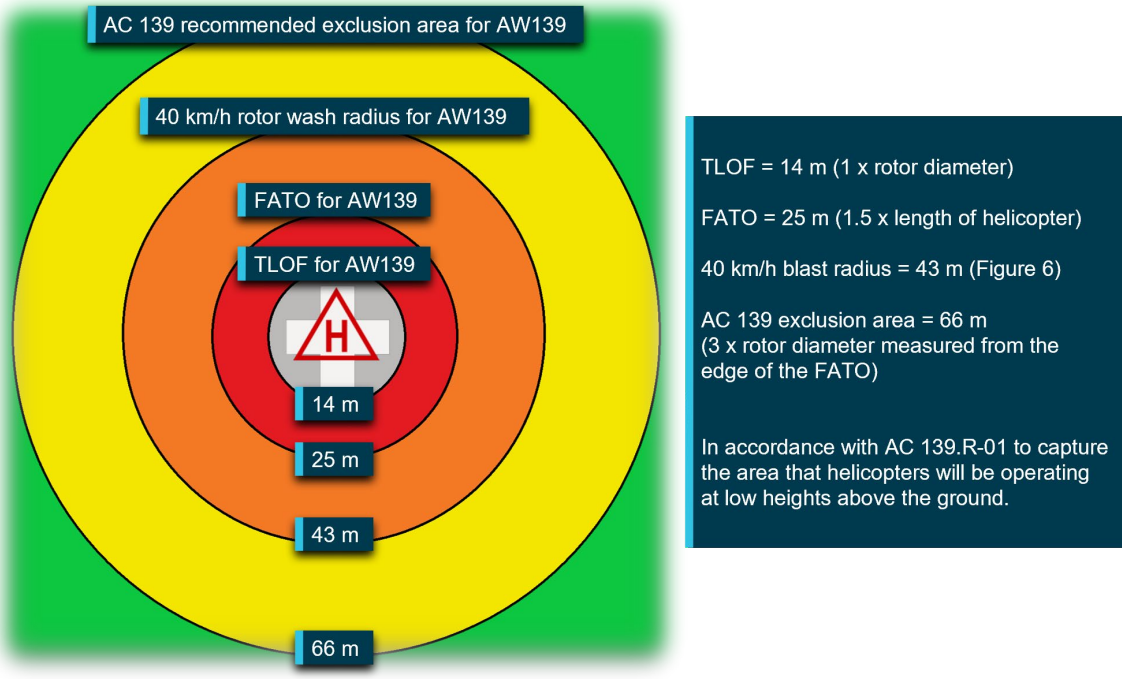
[7] Danger area: Term used to refer to an area where rotor wash velocities can be expected at or above speeds that may displace a person. (See section titled *Rotor wash* and Figure 9).

[8] From AC 139.R-01 v1.0: The design helicopter is a helicopter having the most demanding set of dimensions, the greatest maximum take-off weight and the most critical obstacle avoidance criteria. It may not be a single helicopter type but rather a combination of critical aspects from numerous helicopters that the heliport intends to serve.

Figure 11: HLS rotor wash regions of consideration for an AgustaWestland AW139[9]



Source: ATSB

Figure 12: HLS warning device (left) and sign (right)

Source: alamy.com

[9] Touchdown and lift-off area (TLOF) is the surface over which the touchdown and lift-off is conducted. Final approach and take-off area (FATO) for a rotorcraft, means the area of the aerodrome from which take-off is commenced; or, over which the final phase of the approach to hover is completed.

Safety action

Safety advisory notice to helicopter medical transport operators and hospital helicopter landing site operators

SAN number:	AD-2022-001-SAN-001

The Australian Transport Safety Bureau strongly encourages operators of hospital helicopter landing sites, and helicopter medical transport operators using those landing sites, work together to review the adequacy of existing risk controls to ensure pedestrians are adequately protected from the increased rotor wash associated with larger helicopters.

Sources and submissions

Sources

- Civil Aviation Safety Authority
- Transport Canada
- United Kingdom Civil Aviation Authority

References

Airbus Helicopters (2021). *Safety Promotion Notice No. 3684-P-00 Noise and downwash considerations for ground operators.* Airbus Helicopters

Civil Aviation Safety Authority (2022). *Advisory Circular AC 91-29 v1.1 Guidance for helicopters – suitable places to take-off and land.* Civil Aviation Safety Authority.

Civil Aviation Safety Authority (2022). *Advisory Circular AC 139.R-01 v1.0 Guideline for heliports – design and operation.* Civil Aviation Safety Authority.

Civil Aviation Safety Authority (2019). *Part 139 (Aerodromes) Manual of Standards.* Australian Government.

Federal Aviation Administration (2012). *Advisory Circular AC 150/5390-2C – Heliport design* Federal Aviation Administration.

International Civil Aviation Organisation (2021). *Document 9261: Heliport manual*. International Civil Aviation Organisation.

Jordan, S. C., Johnson T., Sterling M., and Baker, C. J. (2008) Evaluating and Modelling the Response of an Individual to a Sudden Change in Wind Speed, *Building and environment, Vol. 43*.

Transportation Research Board (2013). *Apron Planning and Design Guidebook.* Washington, DC: The National Academies Press. Retrieved from https://nap.nationalacademies.org/read/22460/chapter/4

Resources

Helicopter Downdraft Dangers - YouTube

Submissions

Under section 26 of the *Transport Safety Investigation Act 2003*, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. That section allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the following directly involved parties:

- Civil Aviation Safety Authority
- United Kingdom Civil Aviation Authority
- Transport Canada
- Federal Aviation Administration

Submissions were received from:

- Civil Aviation Safety Authority
- United Kingdom Civil Aviation Authority
- Transport Canada

The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.

Appendix 1: Conversion tables

Table 1: Knots to kilometres per hour conversion table

kt	km/h
1	1.852
10	18.5
20	37.0
30	55.6
40	74.1
50	92.6

Table 2: Kilometres per hour to knots conversion table

km/h	kt
1.852	1
20	10.8
40	21.6
60	32.4
80	43.2
100	54.0

Appendix 2: Occurrence data

Reference No.	Investigation No.	Date/time	Location/state	Phase of flight	Injury level	Aircraft model	Summary
OA2018-00396		8/01/2018 13:00	near Alfred Hospital (HLS), Vic.	Approach	Minor	AW139	During final approach, a pedestrian was subjected to rotor wash resulting in minor injuries.
OA2018-05243		27/07/2018 11:00	Bathurst Hospital (HLS), NSW	Approach	Minor	AW139[10]	A pedestrian reported being subjected to rotor wash resulting in minor injuries.
OA2018-05244		27/07/2018 20:00	Warren Health Centre (HLS), NSW	Approach	Nil	AW139	During approach, rotor wash from the hovering aircraft resulted in minor damage to structures on the ground.
OA2019-00659		24/01/2019 12:00	near Latrobe Regional Hospital (HLS), Vic.	Approach	Nil	AW139	Rotor wash from the helicopter disturbed a loose object and damaged a vehicle.
OA2020-06455		27/12/2020 13:00	Alfred Hospital (HLS), Vic.	Landing	Serious	AW139	During landing, the helicopter's rotor downwash affected a pedestrian on the street adjacent to the landing area resulting in serious injury.
OA2021-05170	AB-2021-028	28/10/2021 7:50	Alfred Hospital (HLS), Vic.	Landing	Serious	AW139	During landing, the helicopter's rotor downwash affected a pedestrian on the street adjacent to the landing area resulting in serious injury.
OA2022-02001		24/05/2022 8:52	Royal Prince Alfred Hospital (HLS), NSW	Landing	Nil	AW139	During approach to a raised helicopter landing site, downwash caused debris located adjacent to the landing area to become dislodged and fall to the ground below.
OA2022-02750		13/07/2022 17:08	Innisfail Hospital (HLS), Qld	Take-off	Serious	AW139	During take-off, the helicopter's rotor downwash affected a pedestrian on the pathway adjacent to the landing area resulting in serious injury.
OA2022-04733		25/12/2022 15:00	Mareeba Hospital (HLS), Qld	Take-off	Minor	AW139	During take-off, the helicopter's rotor downwash affected a pedestrian on the pathway next to the landing area resulting in minor injury.

[10] Operator confirmed AW139 helicopter involved but was unable to confirm the registration of the aircraft.

Appendix 3: Area of consideration

Adapted from the guidance in AC 139.R-01. All images show a 66 m radius circle indicating the area that CASA recommended was kept clear of all loose objects and non-essential people.

Source: Google Earth annotated by the ATSB

Australian Transport Safety Bureau

About the ATSB

The ATSB is an independent Commonwealth Government statutory agency. It is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers.

The ATSB's purpose is to improve the safety of, and public confidence in, aviation, rail and marine transport through:

- independent investigation of transport accidents and other safety occurrences
- safety data recording, analysis and research
- fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia, as well as participating in overseas investigations involving Australian-registered aircraft and ships. It prioritises investigations that have the potential to deliver the greatest public benefit through improvements to transport safety.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, international agreements.

Purpose of safety investigations

The objective of a safety investigation is to enhance transport safety. This is done through:

- identifying safety issues and facilitating safety action to address those issues
- providing information about occurrences and their associated safety factors to facilitate learning within the transport industry.

It is not a function of the ATSB to apportion blame or provide a means for determining liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner. The ATSB does not investigate for the purpose of taking administrative, regulatory or criminal action.