ACCIDENT

Aircraft Type and Registration:	UAS Schiebel Camcopter S-100 (unregistered)	
No & Type of Engines:	1 Austro Engine Wankel R-1	
Year of Manufacture:	2008 (Serial no: 232)	
Date & Time (UTC):	18 October 2016 at 0926 hrs	
Location:	Ship stationed off the coast of Benbecula, Outer Hebrides	
Type of Flight:	Aerial Work	
Persons on Board:	Crew - N/A	Passengers - N/A
Injuries:	Crew - N/A	Passengers - N/A
Nature of Damage:	Destroyed on impact with, and immersion in, water	
Commander's Licence:	N/A	
Commander's Age:	31 years	
Commander's Flying Experience:	999 hours (of which 999 were on type) Last 90 days - 8 hours Last 28 days - 6 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot, and manufacturer's investigation report	

Synopsis

As the unmanned aircraft (UA) lifted off from the ship's helideck it immediately pitched up and transited rearwards with insufficient height to clear the 19-cm high gunwale about 2 m behind it. The impact damaged the UA tail structure, leading to a failure of the tail rotor transmission and resulting in the UA spiralling into the sea alongside the ship.

Following an investigation by the manufacturer software changes have been made to reduce operator workload during the takeoff.

History of the flight

The flight was part of a trial to demonstrate the transfer of command and control from a land-based control station to one located on the ship *SD Northern River*. The ship-based pilot control operator, positioned on the ship's deck adjacent to the helipad, took control of the UAS and was flying a series of planned deck landings and takeoffs. These were uneventful until the third takeoff when, as the UAS became airborne, it immediately pitched up and transited rearwards with insufficient height to clear the 19-cm high gunwale about 2 m behind it. The wind was 310° at 13 kt.

The impact damaged the UA tail structure which subsequently led to a failure of the tail rotor transmission, resulting in the UA spiralling into the sea alongside the ship where it sank to the seabed. The water depth was approximately 30 m.

The UAS was recovered 48 hours later and sent to the manufacturer, where the on-board data logger was downloaded and the recorded data analysed.

UAS information

General

The Schiebel CAMCOPTER S-100 (Figure 1) is a vertical takeoff and landing (VTOL) UAS that can operate at day and night with a data-link range of 200 km. It can navigate automatically via pre-programmed GPS waypoints or can be operated with a control unit carried by the pilot control operator. Its maximum airspeed is 130 kt; a loiter speed of 55 kt provides a maximum endurance of more than 6 hours with a 35 kg payload (extendable to over 10 hours with optional external AVGAS fuel tanks fitted). The maximum wind speed for takeoff and landing is 25 kt. It is 3.11 m long, 1.12 m high and has a main rotor diameter of 3.4 m. The empty mass is 110 kg and the maximum takeoff mass is 200 kg. Payload capacity is 50 kg.

Figure 1
Schiebel CAMCOPTER S-100

Operator control of the UA

The UA control unit carried by the operator includes a joystick for cyclic control with a force sensitive thumb rocker sensor located on the top for climb-rate inputs (Figure 2). It includes a display of input commands.

The control system also includes a selectable trim mode that enables the operator to enter a trim setting for the UA. However, the trim does not take effect until the UA is airborne and certain climb performance and control conditions are met.

Figure 2

Operator joystick showing climb-rate thumb rocker control

Shipboard take-off procedures

For shipboard operations, the manufacturer specifies that a climb-rate input of at least 55% (of the maximum) is required for takeoff. This is emphasised during pilot operator training.

Manufacturer's investigation findings

An investigation was carried out by the manufacturer which, in summary, determined that for all three takeoffs, the operator's climb-rate inputs were below the 55% minimum required for shipboard operations. For the accident flight this started at 37%, reducing to 7% over 1.3 seconds; however, this was in addition to a rear cyclic command not present on the first two takeoffs until the UA was higher off the helideck. As the UA moved backwards without climbing, the operator selected 100% climb rate but continued to command more rear cyclic, increasing rearward acceleration. The investigation also noted that the ship's upward heave at the time also contributed to the UA's failure to climb away from the ship.

The logged data also suggested that the conditions for the trim commands to become active would have been met about 2.2 seconds after takeoff (about 0.1 seconds before the collision).

Safety action

The manufacturer has implemented a software change to reduce operator workload during takeoff. If the UA is on the ground and the trim mode has been selected:

- Operator thumb rocker climb-rate inputs between -50% and +50% produce an automatic climb rate command of +50% until the trim becomes active, and
- All cyclic joystick inputs are ignored until the trim becomes active.