AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

			Reference:	**CA18/2/3/8471**	
Aircraft Registration	**ZS-RNB**	**Date of Accident**	7 April 2008	**Time of Accident**	0915Z
Type of Aircraft	Robinson R22 Beta II		**Type of Operation**	Demonstration	
Pilot-in-command Licence Type	Commercial	**Age**	32	**Licence Valid**	Yes
Pilot-in-command Flying Experience	Total Flying Hours	766.7		Hours on Type	244.2
Last point of departure	Grand Central Aerodrome (FAGC)				
Next point of intended landing	Grand Central Aerodrome (FAGC)				

Location of the accident site with reference to easily defined geographical points (GPS readings if possible)
Grand Central helicopter general flying area (GPS co-ordinates: S 26°01.037' E 028°05.851'), elevation 4 625 ft above mean sea level (AMSL)

Meteorological Information	Surface wind 320° at 5 kts, temperature 22℃, clouds scattered at 4 000 ft				
Number of people on board	1 + 1	**No. of people injured**	1 + 1	**No. of people killed**	0

Synopsis

The flight instructor and a passenger (potential student) had just concluded a demonstration flight in the general flying area (GFA) south of FAGC.

The helicopter climbed to 350 ft above ground Level (AGL) when the instructor elected to demonstrate an autorotation to his passenger. The instructor initiated his autorotation demonstration at 350 ft, flying in a northerly direction with the wind coming from the east. Four to five seconds following the initiation of the autorotation, the main rotor revolutions per minute (RPM) warning sounded and he made an attempt to open the throttle whilst lowering the collective pitch control, to no avail. The helicopter landed hard on the skids. The aircraft was substantially damaged, including failure of the left skid and the tail boom severing.

Both the pilot and passenger were injured in the incident.

The pilot had noted shortly after initiating the manoeuvre that his main rotor RPM had decayed to about 88%, which was substantially lower than the norm following entry into autorotative flight. Even though he had immediately unloaded the rotor disc by lowering the collective pitch lever and rolling on the throttle as advised in the pilot's operating handbook, he was unable to recover from the low RPM condition. This may have been due to a lack of altitude and the helicopter being in a blade stall state as a result of the low RPM and the fairly high descent rate. He managed to maintain level flight whilst descending and as the ground approached, he attempted to cushion the impact by pulling maximum collective pitch. However, this had no effect on the rotor system as the rotor system had already stalled. A hard landing followed at a substantial rate of descent, which was evident from the deformation of the skid gear and the subsequent impact sequence and damage to the helicopter.

Probable Cause

Hard landing following a fairly high descent rate as result of a low rotor RPM/blade stall.

IARC Date		Release Date	

AIRCRAFT ACCIDENT REPORT

Name of Owner/Operator	: Hover Dynamics
Manufacturer	: Robinson Helicopter Company
Model	: R22 Beta II
Nationality	: South African
Registration Marks	: ZS-RNB
Place	: Grand Central helicopter general flying area
Date	: 7 April 2008
Time	: 0915Z

All times given in this report are co-ordinated universal time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus two hours.

Purpose of the Investigation:

*In terms of Regulation 12.03.1 of the Civil Aviation Regulations (1997), this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and **not to establish legal liability**.*

Disclaimer:

This report is produce without prejudice to the rights of the CAA, which are reserved.

1. FACTUAL INFORMATION

1.1 History of Flight:

1.1.1 A flight instructor, accompanied by a passenger (a potential student pilot) was engaged in a demonstration flight in the Grand Central helicopter general flying area located to the south of Allendale Road in Midrand when the accident occurred. The purpose of the flight was to demonstrate the skills and techniques required to fly a helicopter as well as the capabilities of a helicopter.

1.1.2 According to the flight instructor, they were flying at low level and had initiated their climb to return to Grand Central (FAGC). The pilot then decided to demonstrate to his passenger an engine failure recovery, should the engine fail at that specific moment. According to the pilot they were at a height of approximately 350 ft above ground level (AGL), flying in a north-easterly direction with the wind from the east, when he entered into autorotational flight. He knew from previous climb engine failure practice that it takes about 4 – 5 seconds for the rotor revolutions per minute (RPM) to recover.

1.1.3 He recalls counting the seconds as he turned into wind. At about 4 – 5 seconds into the manoeuvre, the low rotor RPM audio warning sounded and the low rotor RPM amber warning light illuminated on the instrument panel. At a glance at the RPM gauge, the pilot recalled seeing the main rotor RPM needle at about 88%, which was unexpectedly low. He then opened the throttle and attempted to maintain forward speed to initiate a recovery. He does not recall any response from the engine. Prior to ground impact, he raised the collective pitch lever fully and attempted to straighten the helicopter with right yaw pedal as they were to make ground contact with about 30° right drift. They impacted the ground with the left skid first, followed by the right skid approximately 1 m further on. The left skid gear then collapsed and the helicopter cartwheeled, coming to rest on its right-hand side.

1.1.4 The accident occurred in daylight conditions at a geographical position determined as S 26° 01.037' E 028° 05.851', at an elevation of 4 625 ft above mean sea level (AMSL).

1.1.5 Both occupants sustained cuts and bruises during the impact sequence. The pilot was taken to hospital were he received stitches to a cut on his forehead.

1.2 Injuries to Persons:

Injuries	Pilot	Crew	Pass.	Other
Fatal	-	-	-	-
Serious	-	-	-	-
Minor	1	-	1	-
None	-	-	-	-

1.3 Damage to Aircraft:

1.3.1 The helicopter sustained substantial damage to the tail boom, main rotor blades, tail rotor, windshield and skid gear.

Figure 1: The main wreckage with the tail boom severed.

1.4 Other Damage:

1.4.1 There was no other damage caused.

1.5 Personnel Information:

1.5.1 Pilot-in-command:

Nationality	South African	Gender	Male	Age	32
Licence No.	*****************	Licence Type	Commercial		
Licence valid	Yes	Type Endorsed	Yes		
Ratings	Instructor; Night				
Medical Expiry Date	30 July 2008				
Restrictions	None				
Previous Accidents	None				

Flying Experience:

Total Hours	766.7
Total Past 90 Days	150.1
Total on Type Past 90 Days	20.9
Total on Type	244.2

1.6 Aircraft Information:

1.6.1 Airframe:

Type	Robinson R22 Beta II	
Serial Number	3252	
Manufacturer	Robinson Helicopter Company	
Year of Manufacture	2001	
Aircraft Certification Status	Type Certified (FAR 27 and FAR 21)	
Total Airframe Hours (At Time of Accident)	3 562.3	
Last MPI (Hours & Date)	3 500.0	23 February 2008
Hours Since Last MPI	62.3	
C of A (Issue Date)	7 September 2007	
C of A (Currency Fee Expiry Date)	6 September 2008	
C of R (Issue Date) (Present owner)	29 October 2001	
Operating Categories	Standard	

Engine:

Type	Lycoming O-360-J2A
Serial Number	L-37578-36 A
Hours Since New	3 301.0
Hours Since Overhaul	564.0

1.6.2 A weight and balance calculation (see next page) was conducted during an interview with the pilot at the aviation training organisation (ATO). The calculation indicated that the helicopter was being operated within the prescribed limits as stipulated in the POH, Section 2, Limitations, Pages 2 – 5.

R22 Weight and Balance

Aircraft	ZS-RNB	**Date**	07/04/2008
Pilot			
Weight	**Loaded**		1301.69
	Empty		1212.59
Endurance	**No Reserve**		1 Hr 39 Min
	30 Mins Reserve		1 Hr 8 Min

	Longitudinal			Lateral	
Item	Weight	Arm	Moment	Arm	Moment
Aircraft	859.85	104.4	89768.34		
Pilot and Baggage	171.96	79	13584.75	10.7	1839.96
Passenger and Baggage	180.78	79	14281.40	-9.3	-1681.23
Empty Weight	1212.59	97.0	117634.48	0.1	158.73
Main Fuel	57.60	108.6	6255.36	-11	-633.60
Auxillary Fuel	31.50	103.8	3269.70	11.2	352.80
Total Take off Weight	1301.69	97.7	127159.54	0.0	36.66

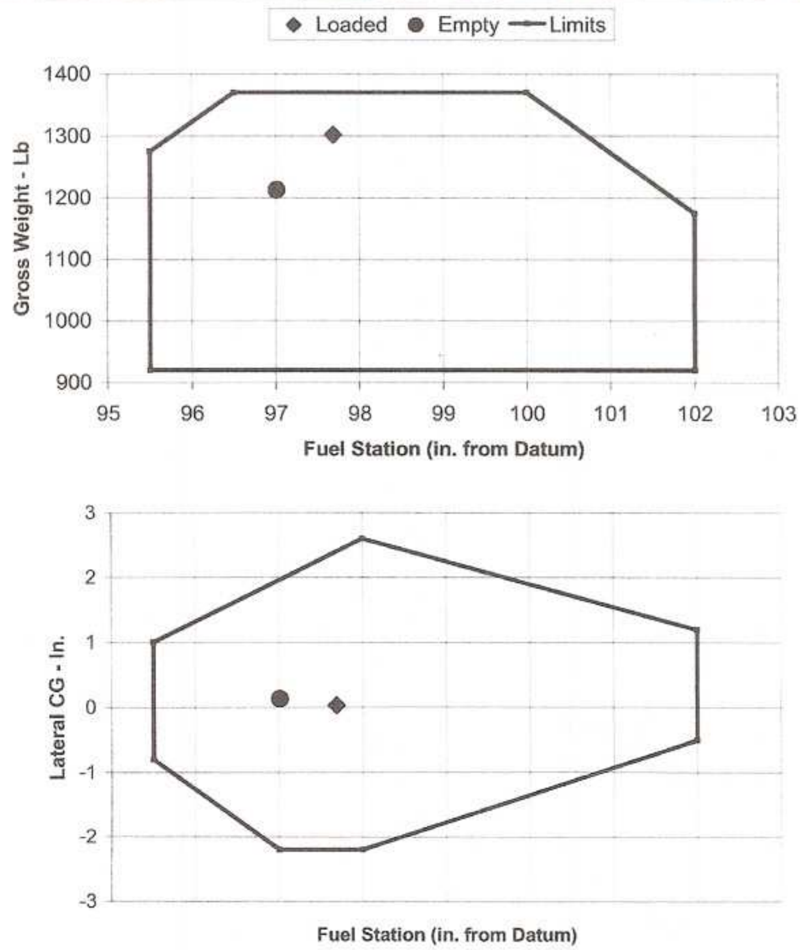


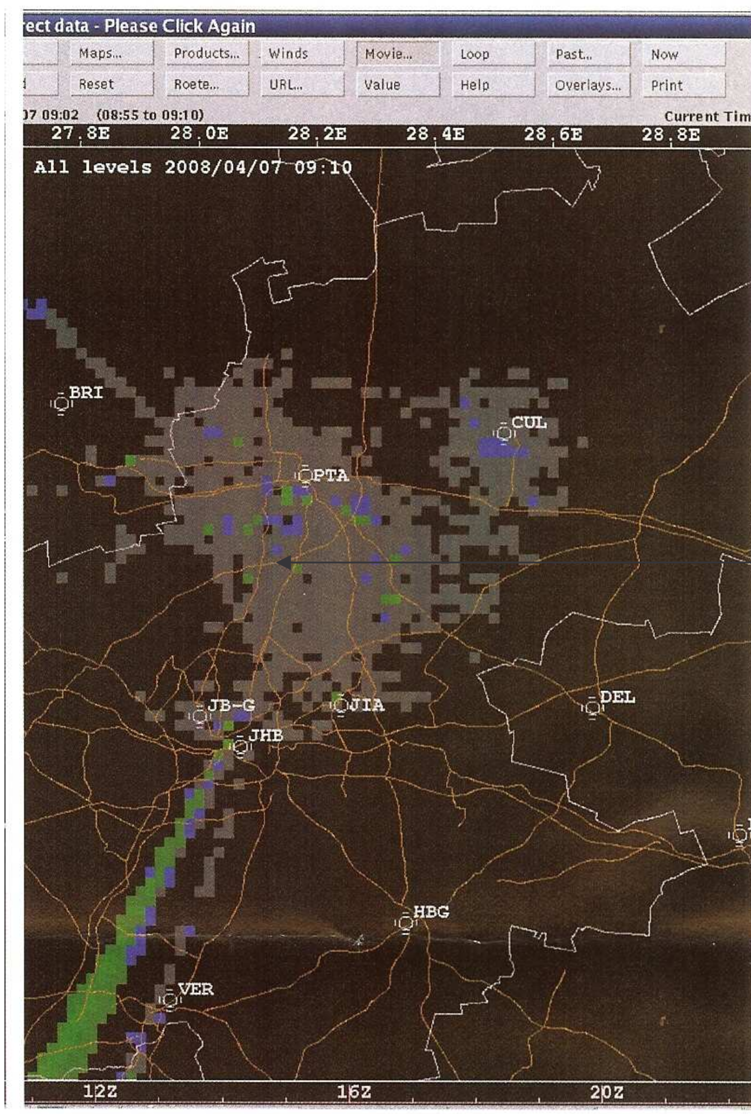
Figure 2: Weight and balance calculation for the flight in question

1.7 Meteorological Information:

1.7.1 Weather information obtained from the South African Weather Services (SAWS) indicated the most likely weather conditions at the place of the accident to be as follows:

Wind direction	320°	Wind speed	5 kts	Visibility	+10 km
Temperature	22℃	Cloud cover	Scattered	Cloud base	4 000 ft
Dew point	6℃				

1.7.2 A radar image (Figure 3 below) for 0910Z on 7 April 2008 shows the development of isolated thundershowers to the south of the Midrand area.



Accident site

Figure 3: Radar image for Gauteng area on 7 April 2008 at 0910Z

1.7.3 The Investigating team arrived on scene approximately 30 minutes after the accident occurred. The wind at the time was observed to be from the west (270°M) at between 5 – 10 kts.

1.7.4 The weather information below was obtained from the pilot's questionnaire:

Wind direction	North	Wind speed	5 kts	Visibility	Clear
Temperature	20°C	Cloud cover	None	Cloud base	None
Dew point	Unknown				

1.7.5 Density Altitude:

Pressure Altitude	4 650 ft
Temperature	22°C
Density Altitude	**6 500 ft**

Reference: Pilot's Operating Handbook, Robinson R22, Section 5, Pages 5 – 3.

1.8 Aids to Navigation:

1.8.1 No difficulties with the navigational aids were known or reported.

1.8.2 The helicopter was fitted with a magnetic compass and a transponder.

1.9 Communications:

1.9.1 The pilot broadcasted his intentions on the VHF frequency 125.8 MHz as he was flying outside of controlled airspace below the the western sector of the terminal control area (TMA).

1.10 Aerodrome Information:

1.10.1 The accident occurred in the FAGC helicopter general flying area located to the south of Allendale Road, Midrand at S 26° 01.037' E 028° 05.851', at an elevation of 4 625 ft above mean sea level (AMSL).

1.11 Flight Recorders:

1.11.1 The aircraft was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR). Nor were it required by regulation to be fitted this type of helicopter.

1.12 Wreckage and Impact Information:

1.12.1The helicopter impacted the ground with the left skid first, in an upright position and on a heading of 050°M. The right skid impacted approximately 1 m further on, which as a result of the substantial rate of descend, failed on impact. This caused the helicopter to nose over and cartwheel, during which the main rotor blades severed the tail boom. The main wreckage came to rest on its right-hand side approximately 15 m from the first point of impact. Pieces from the severed tail boom and tail rotor assembly were found approximately 15 m further down the wreckage trail.

Figure 4: The wreckage trail and main wreckage.

1.13 Medical and Pathological Information:

1.13.1 The pilot was in possession of a valid aviation medical certificate without any restrictions endorsed on it.

1.14 Fire:

1.14.1 There was no evidence of a pre- or post-impact fire.

1.15 Survival Aspects:

1.15.1 The accident was considered to have been survivable as the damage sustained by the cockpit/cabin area was limited to both windshields. Both occupants sustained only minor cuts and bruises during the impact sequence and were properly restrained by making use of the aircraft equipped safety harness.

1.16 Tests and Research:

1.16.1 None considered necessary.

1.17 Organisational and Management Information:

1.17.1 This was a demonstration flight that was conducted under the auspices of an aviation training organisation (ATO).

1.17.2 The ATO that was responsible for the demonstration flight was in possession of a valid CAA ATO Approval Certificate, no. CAA/0110, which was issued on 28 August 2007 with an expiry date of 30 June 2008.

1.17.3 The aircraft was maintained by aircraft maintenance organisation (AMO), no. 237, which was in possession of a valid AMO Approval from the CAA at the time. The last maintenance was certified on the aircraft prior to the accident.

1.18 Additional Information:

1.18.1 Rotor Stall

Reference: Wagtendonk, WJ. *Principals of Helicopter Flight*. Page 164.

According to the investigation, the helicopter may have experienced what is known as a rotor stall.

When the helicopter is engaged in a powered descent, it experiences a rate of descent flow in opposition to the induced flow across the disc. Inflow angles are reduced and the blades' angles of attack increase. The root sections of the blades historically have the weakest induced flow.

During a powered descent, the rotor sections may find their angles of attack increased such that they stall. The early rotor stall acts like the early stages of a vortex ring state. Provided the pilot keeps enough power to maintain rotor RPM and provided the aircraft is flown in a manner that avoids the development of vortex ring state, the descent continues normally.

An inexperienced pilot may pull more collective pitch to counteract the rate of descent, not noticing or responding to the lowering of rotor RPM. If the pilot fails to identify and react to the early rotor stall's most prominent symptom, decaying rotor RPM, then trouble is just around the corner. The correct response to a development rotor stall is to increase the throttle to maintain rotor RPM and lower collective simultaneously. Pilots flying helicopters equipped with high-inertia rotors have more time to react than pilots flying low-inertia rotor systems such as the Robinson R22.

The decaying rotor RPM, brought on by the blade roots' stalling, results in less total rotor thrust, which increases the helicopter's rate of descent. This in turn increases the rate of descent flow and decreases the induced flow and inflow angles further. The consequence is that the stalled region at the blade roots spreads out towards the tips. Slower blade rotation means that centrifugal force drops off sharply.

Eventually, a complete rotor stall leads to a loss of directional control, severe blade flapping, possible blade failure from the coning angles, as well as nose-down pitch as the longitudinal stability aligns the fuselage with the rate of descent flow.

1.18.2 Safety notices from the Pilot's Operating Handbook (POH), Section 10, SN-10 deal with fatal accidents caused by low RPM rotor stall:

A primary cause of fatal accidents in light helicopters is failure to maintain rotor RPM. To avoid this, every pilot must have his reflexes conditioned so he will instantly add throttle and lower collective to maintain RPM in any emergency.

The R22 and R44 have demonstrated excellent crashworthiness as long as the pilot flies the aircraft all the way to the ground and executes a flare at the bottom to reduce his airspeed and rate of descent. Even when going down into rough terrain, trees, wires or water, he must force himself to lower the collective to maintain RPM until just before impact. The aircraft may roll over and be severely damaged, but the occupants have an excellent chance of walking away without injury.

Power available from the engine is directly proportional to RPM. If the RPM drops 10%, there is 10% less power. With less power, the helicopter will start to settle, and if the collective is raised to stop it from settling, the RPM will be pulled down even lower, causing the aircraft to settle even faster. If the pilot not only fails to lower the collective, but instead pulls up on the collective to keep the aircraft from going down, the rotor will stall almost immediately. When it stalls, the blades will either 'blow back' and cut off the tail cone or it will just stop flying, allowing the helicopter to fall at an extreme rate. In either case, the resulting crash is likely to be fatal.

No matter what causes the low rotor RPM, the pilot must first roll on throttle and lower the collective simultaneously to recover RPM **before** investigating the problem. This must be a conditioned reflex. In forward flight, applying aft cyclic to bleed off airspeed will also help to recover lost RPM.

1.18.3 A vertical descent or steep approach downwind can result in 'settling with power'. This happens when the rotor is settling in its own downwash and additional power won't stop the descent. Should this occur, reduce collective and lower the nose to increase airspeed. This can be very dangerous near the ground as the recovery results in a substantial loss of altitude.

1.19 Useful or Effective Investigation Techniques

1.19.1 None.

2. ANALYSIS

2.1 According to available evidence, there were no reported defects or malfunctions with the helicopter prior to the commencement of the demonstration flight that could have caused or contributed to the accident.

2.2 According to available records, the flight instructor (pilot) was in possession of a valid commercial helicopter pilot licence. He had assessed the wind while flying in the helicopter general flying area, and according to the clues that were available to him, the last recollection he had of the wind was that it would appear to be from a north north-easterly direction. The investigating team arrived at the scene of the accident approximately 30 minutes after it occurred and, at that time, the prevailing wind was assessed to be from the west, with an approaching thunderstorm (cell) to the south of the area. This observation was confirmed by an official weather report from the South African Weather Services, which included a radar image of the area that was taken 5 minutes prior to the occurrence.

2.3 The flight instructor was flying at low level and had started to climb to return to Grand Central Aerodrome. The flight instructor then wanted to demonstrate one last manoeuvre to his passenger, namely 'an engine out recovery from a height of about 350 ft above ground level'. This is a manoeuvre that, if not initiated and flown technically correctly, can be catastrophic as it allows the pilot no room for error and very little time to react and recover. The rate of descent during such a manoeuvre at altitude (density altitude of 6 500 ft) could be in the region of 1 500 to 1 700 ft per minute. At such a rate of descent, the pilot had approximately 13 seconds from the time he entered into the manoeuvre until ground contact.

2.4 The pilot noted shortly after initiating the manoeuvre that his main rotor RPM had decayed to about 88%, which was substantially lower then the norm following entry into autorotative flight. Even though he immediately unloaded the rotor disc by lowering the collective pitch lever and rolling on the throttle as advised by the aircraft manufacturer, he was unable to recover from the low RPM condition. He managed to maintain level flight whilst descending and as the ground approached, he attempted to cushion the impact by pulling maximum collective pitch. However, this had no effect on the rotor system as the rotor system had already stalled. A hard landing followed at a substantial rate of descent, which was evident from the deformation of the skid gear and the subsequent impact sequence and damage to the helicopter.

2.5 The pilot most probably had entered into this specific manoeuvre (300 – 350 ft AGL autorotation) only on a few previous occasions. Although he was familiar with the helicopter and its capabilities, the move required a conditioned/immediate reflex from the pilot in order to ensure the manoeuvre is executed successfully, especially since the helicopter uses a low-inertia rotor system

2.6 It is the opinion of the investigator that the pilot had not assessed that prevailing wind conditions accurately prior to commencing with the autorotation/engine out manoeuvre from a height of approximately 350 ft above the ground. Once entered into the manoeuvre, his rate of descent increased due to a tail wind component prevailing and he was unable to restore rotor RPM timeously. Therefore there was very limited or no inertia in the rotor system to arrest the rate of descent and subsequent landing.

3. CONCLUSION

3.1 Findings

3.1.1 The pilot had a valid commercial helicopter pilot's licence and a valid instructors rating, which was endorsed in his logbook.

3.1.2 The pilot held a valid aviation medical certificate with no restrictions.

3.1.3 The pilot may have started his demonstration at a fairly low altitude.

3.1.4 The pilot followed the requirements of the POH by simultaneously opening the throttle whilst lowering the collective pitch control.

3.1.5 According to available evidence, there were no malfunctions or defects with the helicopter reported prior to or during the flight, which could have contributed to or have caused the accident.

3.1.6 The aviation training organisation (no. CAA/0110) was in possession of a valid CAA Approval Certificate to conduct the demonstration flight in question.

3.1.7 The accident occurred during daylight conditions.

3.1.8 There was an approaching thunderstorm to the south of the helicopter general flying area when the accident occurred.

3.1.9 The prevailing wind during the on-site investigation was from the west and not from the north north-east as assessed by the pilot prior to the execution of the manoeuvre.

3.1.10 Density altitude at the time of the accident was calculated to be at 6 500 ft.

3.2 Probable Cause/s:

3.2.1 A hard landing followed a fairly high descent rate as result of a low rotor RPM/blade stall.

4. SAFETY RECOMMENDATIONS

4.1 It is recommended that the Commissioner during demonstration flights, aviation training organisations should refrain from demonstrating or training auto-rotational type manoeuvres at low altitude (less than 800 ft above ground level). The risk associated with such a manoeuvre is high when not executed accurately, and the result could be catastrophic.

5. APPENDICES

5.1 There are no appendices to this report.

Report reviewed and amended by Advisory Safety Panel: 25 August 2009.

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