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Extreme Manned Helicopters: A Review[1]

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Introduction

Reports of anomalous aerial phenomena continue to be made in America and many other parts of the world. One of the explanations advanced to identify them is a helicopter of some kind. This paper was prepared to help field investigators compare what was seen with what is currently known about selected helicopter performance characteristics. The emphasis here is upon extreme speed, size, and noise level.

Definitions:

Absolute Ceiling: *The highest altitude at which level flight can be attained.*

Combat Ceiling : *The highest altitude at which a 500 foot per minute (fpm) rate of climb can be attained.*

Compound Helicopter - *A helicopter with an auxiliary propulsion system which provides thrust in excess of that which the rotor(s) alone could produce, thereby permitting increased forward speeds; wings may or may not be provided to reduce the lift required from the rotor system.*

FAI - Fédération Aéronautique Internationale, *"FAI - The World Air Sports Federation"*

1. This review was prepared by Richard Eaton at the request of NARCAP's Chief Scientist. Eaton is a highly experienced pilot with over 6,000 flight hours and has flown a variety of fixed and rotary wing airplanes including ten different helicopter models. References are cited in brackets. (Ed.)

FL - An airplane's flight level (FL) refers to a specific barometric pressure surrounding the airplane and expressed as a nominal altitude in hundreds of feet. The pressure is computed assuming an international standard sea-level pressure of 1013.25 hPa (29.92 inHg), and therefore is not necessarily the same as the aircraft's true altitude either above mean sea level or above ground level. Thus a FL of 320 for example is approximately equivalent to an altitude of 32,000 feet.

HIGE - Hover Ceiling - In Ground Effect

HOGE - Hover Ceiling - Out Of Ground Effect

Pure Helicopter - A type of rotorcraft in which lift and thrust are supplied by driven rotors only.

Service Ceiling - The highest altitude an aircraft can still achieve a 100 fpm rat of climb

UAV - Unmanned Aerial Vehicle

1.) **Fastest Pure Helicopter @ Sea Level: Westland Lynx (UK)** [1]

Operational since 1978, the Westland Lynx was designed as a multi-purpose helicopter. The world speed record for a pure helicopter was set on 11 August 1986 when a Westland Lynx 800 *G-LYNX* piloted by John Egginton sustained, 249.1 mph (400.87 kph). The Westland Lynx's service ceiling is 10,597 ft, (3,230m).

Westland Lynx

2.) **Fastest Compound Helicopter @ Sea Level: Sikorsky X2 (USA)** [2]

This research helicopter was piloted by Kevin Bredenbeck on 15 September 2010 to a sustained speed of 299 mph (481 kph), earning the Sikorsky X2 the *unofficial* title of world's fastest compound helicopter. Unfortunately, no other specifications have been released by Sikorsky. (Picture below)

Sikorsky X2

3.) **Fastest Helicopter at Flight Level (FL) 300: Aerospatiale SA 315B Lama (France)** [3]

Aerospatiale SA 315B Lama

Operational since 1971, the Aerospatiale SA 315B is the only helicopter on record to reach FL300 and this was specifically for the purpose of making an altitude record attempt. On 21 June 1972, Jean Boulet of France piloted an Aerospatiale Lama to an absolute altitude record of 40,814 ft (12,442m). At that extreme altitude the engine flamed out and the helicopter had to be (safely) landed via another record breaker — the longest-ever autorotation in history. The helicopter had been stripped of all unnecessary equipment prior to the flight to minimize its weight and the pilot was breathing supplemental oxygen. The standard production SA 315B has a service ceiling of 17,715 ft (5,400m).

4.) a. **World's Largest Helicopter: Mil Design Bureau Mi-26 (Russia)** [4]

Operational since 1977, this gargantuan helicopter carries a crew of five – 2 pilots, 1 navigator, 1 flight engineer, and 1 flight technician. It has the internal capacity to accommodate 90 troops *or* 60 stretchers or 44,090 lb (20,000 kg) of cargo. Its length is 131 ft 3¾ in (40.025 m) (rotors turning) and has a rotor diameter of 105 ft 0 in (32.00 m). It's height is 26 ft 8¾ (8.145m) and has a disc area of 804.25 m^2 (8,656.8 ft^2). It's empty weight is 62,170 lb (28,200 kg). It has a service ceiling of 15,100 ft. (4,600m).

Mi-26

4.) b. **Largest Helicopter (U.S.A.): Boeing 234LR (CH-47F)** [4]

Operational since 1962, the CH-47 has been on the scene a long time.

Boeing CH-47F

The Boeing CH-47 carries a crew of three (pilot, copilot, flight engineer) and has an internal capacity of from 33 to 55 troops *or* 24 litters and 3 attendants *or* 28,000 lb (12,700 kg) cargo. Its length is 98 ft 10 in (30.1m). Each rotor diameter is 60 ft 0 in (18.3m). The CH-47's overall height is 18 ft 11 in (5.7m) with a disk area of 5,600 ft^2 (2,800 ft^2 per rotor disc) (260 m^2). Empty weight**:** 23,400 lb (10,185 kg), loaded weight is 26,680 lb (12,100 kg) Max. Takeoff Weight**:** 50,000 lb (22,680 kg) . The CH-47F has a service ceiling of 18,500 ft, (5,640m).

5. **World's Smallest Helicopter : Gen H-4 (Japan)** [5]

Gen H-4

Crew: One
Empty weight: 70 kg (154 lb)
Gross weight: 220 kg (485 lb) **Fuel capacity:** 19 litres (4.2 imp gal; 5.0 US gal)
Powerplant: 4 × Gen 125-F two cylinder, air-cooled, two stroke engines, 7.5 kW (10 ea.)
Main rotor diameter: × 4 m (13 ft 1 in)
Maximum speed: 200 km/h (124 mph; 108 kn)
Cruising speed: 100 km/h (62 mph; 54 kn)
Rate of climb: 4 m/s (790 ft/min)
Service Ceiling: Unknown

6.) **World's Quietest Helicopter:** **MD 520N "NOTAR" (U.S.A.)**

MD 520N "NOTAR"

Operational since 1991, the MD 520N features the NOTAR (**No** **Ta**il **R**otor) anti-torque system, with benefits including increased safety, far lower noise levels and performance and controllability enhancements. Instead of an anti-torque tail rotor, a fan exhaust is directed out slots in the tail boom, using the Coanda Effect for yaw control. Propulsion is provided by one Rolls Royce 250-C20R+ gas turbine power plant and its service ceiling is 14,175 ft, (4,320m). This helicopter tends to be much quieter than similar size helicopters due to several factors.

First, the MD 520N has five lightly loaded main rotor blades. This results in a smaller blade vortex interaction (BVI). Simply stated, the "blade vortex interaction" is the interaction between the way rotor blade's vortices are shed and the way they interact with the other rotor blades. BVI is also known as "Blade Slap" and accounts for the "pop pop pop" sound the rotor system makes when in flight. Blade slap is most noticeable when the helicopter is making a high speed shallow decent. BVI can be affected by the way the helicopter is flown and by the shape of the blade tips themselves. Thickness of the blade is a great factor in blade noise.

Second, a major source of noise that comes from a conventional helicopter (one with a single main rotor and a single tail rotor) comes from the tail rotor itself. Like the main rotor, the tail rotor blades also produce blade vortex interactions. In the tail rotor the noise is of a higher frequency due to the fact that the tail rotor rotates at a higher velocity than the main rotor. Another model, the MD Explorer has eliminated the tail rotor altogether by controlling the torque effect of the main rotor by exhausting air from a fan located aft on the main transmission out through the tail boom and through controllable slots at the end of the tail boom. See following press release from MD Helicopters:

"ANAHEIM, Calif., Feb. 2, 1997 -- Recent Federal Aviation Administration (FAA) noise certification tests have reaffirmed that McDonnell Douglas helicopters equipped with the NOTAR® system are the quietest helicopters in their classes.
The single-turbine MD 520N, with an effective perceived noise level (EPNdB) of 80.2 in level flight, remains the quietest helicopter in the world, followed by the twin-turbine MD Explorer (83.1). The new 6,250-pound, FAA Category A MD Explorer is awaiting further validation of FAA test results that are expected to qualify it as the quietest helicopter flying.

For single-turbine helicopters, the MD 600N, which carries seven passengers plus the pilot, has an Appendix J SEL of 79.0 dBA, followed by the AS350 (estimated at 84.2), and the B407 (85.1). MD 600N test results indicated that competitive helicopters are up to 53 percent louder.

Preliminary test results from recently completed Appendix H tests show that the new FAA Category A MD Explorer will have an EPNdB of 81.2 in level flight, lower than the current MD Explorer (83.1), the AS 355N (86.2), the A109 K2 (89.1), the BK 117 C1 (89.7), the B230 (90.5) and the BO 105 CBS-5 (90.9). Results indicate that the five competitive twin-turbine helicopters, which weigh between 5,600 and 8,400 pounds, are 40 to 90 percent louder than the Category A MD Explorer."

It is also important to note that the US military does, in fact, operate a fleet of super quiet "Special Operations" helicopters, such as were used in the recent Bin Laden raid in Pakistan. Designed to leave a minimal noise "footprint," these helicopters have been fitted with various noise suppressing systems, including special main and tail rotor blades which reduce the noise signature of the helicopter to a minimum. Due to the secretive nature of their mission requirements little information has been released to the public about these special operations helicopters.

7.) **Manned Quadrotors**

No manned quadcopters have been built yet, but the concept is currently under study. A photo of an unmanned quadcopter is shown here called the Aeryon Scout. It is designed in Canada.

Aeryon Scout

8.) **<u>Helicopters That Blur The Line Between Manned and Unmanned.</u>**

Helicopters have been the subject of remotely controlled vehicle technology for nearly a half a century. By the addition of special equipment a “manned” helicopter can be converted to “unmanned” for special types of mission requirements. Two examples come to mind when I think of this. First, the two-place Brantly B-2B (US) has been converted to an unmanned drone helicopter and in its drone configuration has been designated the “**V750 UAV”** (see photo below). This UAV version developed by Qingdao Haili Helicopters Co. Ltd., a joint venture between Brantly International Inc, Qingdao Wenquan International Aviation Investment Co., Ltd, and Qingdao Brantly Investment Consultation Co., Ltd. Its maiden flight was completed in May 7, 2011, and received an order from an unnamed customer:

V750 UAV

Additionally, the **Kaman K-MAX** (Company designation **K-1200**) (see below) is an American helicopter with intermeshing rotors (synchropter) built by Kaman Aircraft. It is optimized for external load operations, and is able to lift a payload of over 6,000 pounds, which is more than the helicopter's empty weight. Normally piloted by a single pilot, a remote controlled UAV version is being developed and in extended practical service in the war in Afganistan.

Kaman K-1200 “K-Max”

Some Concluding Facts about Helicopters

Operationally, helicopters are, in general, "low level utility machines". Their missions usually revolve around performing at lower altitudes, supporting ground based equipment and personnel. From the beginning they've never been intended to be used for high speed, high altitude, long distance operations.

Unlike airplanes which often benefit from the decrease in drag and dynamic pressure found in rarified air, helicopters are their fastest and best performing at low altitudes. Their maximum forward velocity degrades rapidly with altitude due in part to a phenomenon known as "retreating blade stall". A helicopter will rarely be seen flying above 12,000' altitude, although it is possible if the pilot is trying to fly over a cloud deck or higher terrain. When I worked as a helicopter pilot in Papua New Guinea I was called upon at times to make landings on mountain peaks in excess of 12,000' above sea level, but this took careful planning and was a rather rare mission requirement.

Another limiting factor of helicopters flying at higher altitudes is effective loss of tail rotor control. This becomes even more critical while attempting to hover at higher altitudes. Any decrease in air density causes a marked decrease in tail rotor effectiveness. The tail rotor counteracts the torque effect of the main rotor and, in turn, controls the helicopter's yaw axis.

Additionally, there are currently <u>no</u> pressurized helicopters in production. This makes flying helicopters at higher altitudes quite impractical, if not almost impossible. The only helicopters that have made it up into truly rarified air are ones that have been specially outfitted for such record breaking attempts.

It is important to understand that out of all maneuvers a helicopter can accomplish, hovering demands the maximum amount of power a helicopter can produce. For example, a helicopter that has a service ceiling of 16,000 feet may only be able to hover at 9,000 feet maximum. A helicopter that is in forward translational flight will require far less power due to the fact that the rotor blades are more aerodynamically efficient and produce less drag in forward flight than they do in a hover.

Helicopters also have two types of hovering ceilings: In Ground Effect (IGE) and Out Of Ground Effect (OGE). When a helicopter is flying at an altitude that is approximately at or below the same distance above ground level as the helicopter's rotor diameter there is, depending on airfoil and helicopter design, an often noticeable *ground effect*. This is caused primarily by the ground interrupting the rotor tip vortices and downwash behind the rotor. When a helicopter is flown very close to the ground, rotor tip vortices are unable to form effectively due to the obstruction of the ground. The result is lower induced drag, which increases the lift generated by the rotor blades.

A rotary wing generates lift, in part, due to the difference in air pressure gradients between the upper and lower surfaces of the rotor blades. During normal flight, the upper rotor surface experiences reduced static air pressure and the lower surface comparatively higher static air pressure. These air pressure differences also accelerate the mass of air downwards. Flying close to a surface increases air pressure on the lower wing surface, known as the "ram" effect, and thereby improves the aircraft lift-to-drag ratio. As the helicopter gets lower, the ground effect becomes more pronounced. While in the ground effect, the rotor blades will require a lower angle of attack to produce the same amount of lift. If the angle of attack and rotor rpm remain constant, an increase in the lift coefficient will result. Ground effect will also alter thrust versus velocity, in that reducing induced drag will require less power to maintain the same rotor rpm.

Because of the above factors a helicopter will be able to hover IGE, (that is, one and a half times the rotor diameter above ground level) at a much higher altitude than it can hover OGE. For example, a helicopter may be able to hover in ground effect at 10,000 feet altitude mean sea level (msl), but attempts to hover out of ground effect at 10,000feet may be unsuccessful. This is because it takes far more power to hover out of ground effect than in ground effect effect.

It is hoped that the information provided here may aid investigators of unidentified aerial phenomena that might otherwise be misinterpreted as helicopters.

References:

[1] *Federation Aeronautique International (FAI) Absolute Records.*

[2] *Data from* Flug-Revue *NOTE: No other specifications have been released by Sikorsky*.

[3] *Federation Aeronautique International (FAI) Absolute Records.*
[4] Jackson, Paul (2003). *Jane's All The World's Aircraft 2003–2004*. Coulsdon, UK: Jane's Information Group. ISBN 0-7106-2537-5.

[5] Guinness World Records - UK in 2005 and 2008.