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Interim Report on V-g Records on Helicopters

By

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Summary.—*V-g* records have been obtained during the past year on *Hoverfly* I helicopters. Some data have also been obtained on a *Hoverfly* II and a Sikorsky S.51. The *V-g* records on these aircraft were obtained mainly during test flying, which included blind flying and some general flying.

It was not possible to separate the flight accelerations from the landing accelerations, but these were small except in the case of engine-off landings which were the subject of separate tests.

1. *Introduction.*—In order to provide information which could be used in formulating helicopter strength requirements, it was required to fit *V-g* recorders to helicopters at the Airborne Forces Experimental Establishment. *V-g* records for test flying and some general flying have been obtained over a period of about twelve months.

2. *Description of Aircraft.*—*V-g* recorders have been fitted to *Hoverfly* I and II, and Sikorsky S.51 helicopters.

The *Hoverfly* I[1] is a two-seater helicopter with pilot and passenger seated side by side in the nose of the aircraft. It has a three-bladed main rotor of 38 ft dia. and an 8 ft dia. tail rotor for torque compensation. A Super Scarab R-550-3 air-cooled engine of 180 h.p. is fitted. The maximum all-up weight is 2750 lb.

The *Hoverfly* II[2] is similar to the *Hoverfly* I, but is cleaner aerodynamically. The main rotor and tail rotor are 38 ft and 8 ft dia. respectively. The Franklin 0-405-9 air-cooled engine gives 235 h.p. The maximum all-up weight is 2800 lb.

The Sikorsky S.51[3] is a four-seater helicopter with a 48 ft dia. three-bladed main rotor and an $8\frac{1}{2}$ ft dia. tail rotor for torque compensation. It is powered by a Pratt and Whitney Wasp Junior R-985-B4 air-cooled engine of 450 h.p. The maximum all-up weight is 4985 lb.

3. *V-g Recorders.*—The *V-g* recorder[4] is an instrument which records and correlates the accelerations and indicated air speed of the aircraft in flight. The recorder should be mounted as near as practicable to the centre of gravity of the aircraft. Fig. 1 shows the position chosen for the *Hoverfly* I.

The *V-g* recorder used for the tests on the *Hoverfly* I had an air speed range of 20 to 160 knots. This speed range was greater than desirable and a new instrument with a speed range of 0 to 125 m.p.h. was obtained.

* A.F.E.E. Report Rota 5, received 4th May, 1949.

For the *Hoverfly* II, a similar instrument with a speed range of 0 to 150 m.p.h. was obtained.

In the case of the S.51 performance tests, the speed range of one of the early instruments was reduced to 0 to 110 m.p.h. After the first two slides however the instrument became unserviceable and an unmodified recorder was used for further tests.

The acceleration range in all cases was $-2g$ to $+4g$, and the datum line with the aircraft at rest was $+1g$.

4. *Records Obtained.*—4.1. *General.*—*V-g* recorder slides were usually left in the instrument for a period of about five hours flying and the resulting diagram gave the peak accelerations and velocities during that time. The records from several slides were superimposed to obtain each envelope of accelerations and velocities shown in Fig. 2. Except in the case of climb and phugoid tests on the S.51, the operating altitude did not exceed 2000 ft.

4.2. *Hoverfly* I.—*Hoverfly* I helicopters made test flights which included blind flying and contact night flying. Some general passenger flights were also done. Fig. 2a shows the accelerations obtained during forty-six flying hours.

Fig. 2b shows the *V-g* envelope for twenty-one hours flying and includes the accelerations produced by simulated engine failure at 500 to 600 ft. In these tests the landing loads were much greater than normal and may have occurred at speeds up to 40 knots. At speeds greater than 40 knots the aircraft was airborne and the recorded accelerations are not complicated by the inclusion of landing accelerations.

4.3. *Hoverfly* II.—Fig. 2c shows the accelerations and velocities which occurred during air testing. The total number of flying hours was two.

4.4. S.51.—The envelopes in Figs. 2d and 2e include level speeds, partial climbs, full climbs and general flying in calm and bumpy weather. The total flying hours for 2d and 2e were eleven and twelve respectively.

Fig. 2f shows the *V-g* envelope for handling and stability trials over a period of ten flying hours.

5. *Discussion.*—In obtaining *V-g* records on these helicopters it was not possible to separate the flight accelerations from the landing accelerations. In normal flights however the accelerations produced at touch down were small and well within the envelope. On the other hand the landing bumps in the simulated engine failure tests were, in some cases, as heavy as the pilot thought the aircraft structure could reasonably be expected to withstand.

The envelopes of *V-g* records in Fig. 2 show that the flight accelerations at speeds above 40 knots varied from $2g$ to $0g$, *i.e.*, $\pm 1g$ from the datum. At speeds below 40 knots the peak accelerations shown in Figs. 2c and 2f are thought to have occurred in flight as no heavy landings appear to have been made; the range of acceleration is $-1g$ to $+2g$ from datum. Larger accelerations up to $+2{\cdot}5g$ were obtained in the engine-off landing tests.

6. *Conclusions.*—Above 40 knots the greatest range of flight accelerations recorded was $\pm 1g$ from datum. At low speeds the maximum range of flight accelerations was $-1g$ to $+2g$.

In the engine-off landing tests the maximum acceleration range was $-1g$ to $+2{\cdot}5g$.

7. *Further Developments.*—*V-g* records will continue to be taken on helicopters whenever possible. It is hoped that suitable instruments will become available for separating landing loads from flight loads.

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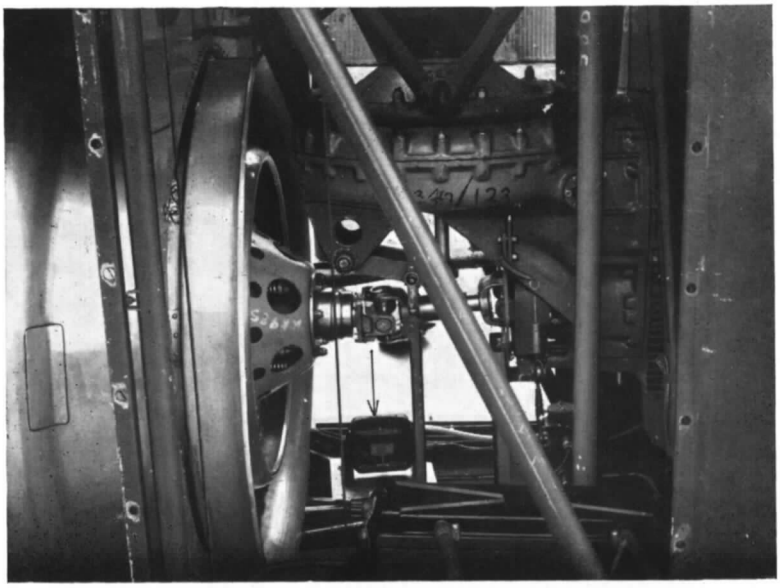
2	H. A. Mather	Performance of *Hoverfly* II. Part I. Determination of Weight and C.G. Limits. A.F.E.E. Report No. Rota 2. August, 1947.
3	J. S. Glass and H. A. Mather ..	Sikorsky S.51 VW 209. Performance and Handling Tests. A.F.E.E. Report No. Rota 3. A.R.C. 11,238. December, 1947. (Unpublished.)
4	—	Routine Measurement of Flight Acceleration. Instrumentation Instruction Leaflet No. I. T.2031. July, 1946.

Position of recorder shown by arrow.



Close-up view from opposite side of helicopter.

FIG. 1. Position of *V-g* recorder on *Hoverfly* I.

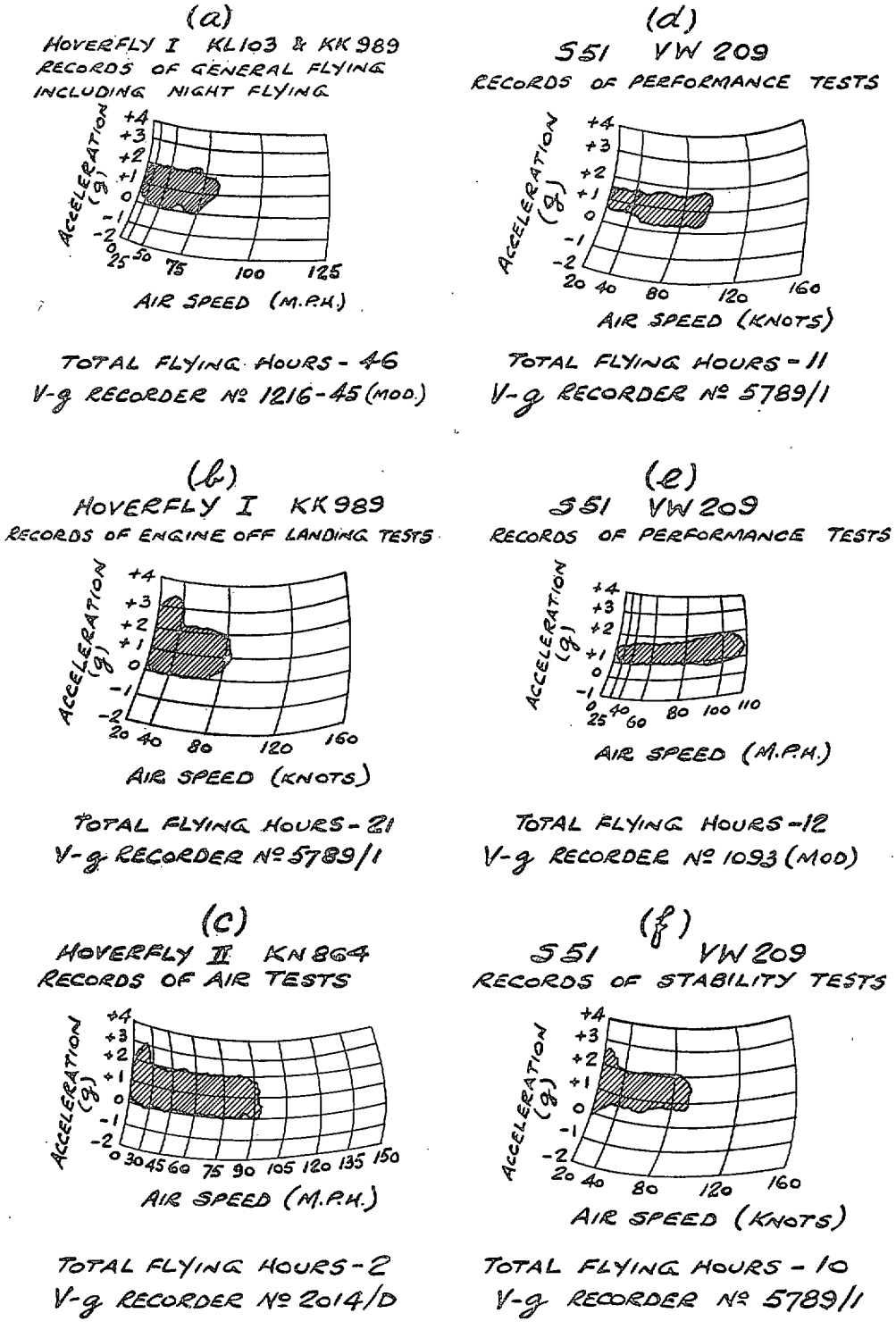


FIG. 2. Envelopes of V-g records on helicopters.

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