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30th Part of Report No. AAE/861/1



MINISTRY OF SUPPLY

AEROPLANE AND ARMAMENT EXPERIMENTAL ESTABLISHMENT

BOSCOMBE DOWN

CANBERRA B. MK.2 WD 959
(2 X AVON 1)

FURTHER ASSESSMENT OF TWO-POSITION AIR BRAKES
DESCENDS FROM HIGH ALTITUDE

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AUTH *E.F. Poles 10501*
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DATE MAY 12 1954

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31. DEC. 1953

AEROPLANE AND ARMAMENT EXPERIMENTAL ESTABLISHMENT
BOSCOMBE DOWNCanberra B. Mk. 2 WD 959
(2 x Avon 1)Further assessment of two-position air brakes;
descents from high altitudeA. & A.E.E. Ref: 5704,e/5/H.J.K.
M. O. S. Ref: 7/Acft/2711/11/R.D.L.2(b)/J.N.R.
Date of test : 3rd November, 1953Progress of issue of Report

Report No.	Title
25th Part of AAEE/861/1	WD 945 - Pressure cabin trials.
26th - do -	WD 959 - Assessment of two-position air brakes.
27th - do -	WD 954 - Measurement of static thrust and other engine parameters on two Avon Mk.1 turbo-jet engines under various climatic conditions.
28th - do -	WJ 565 - Acceptance trials of bombs, aircraft, T.1. 1,000 lb. (HS/HA) - Carriage and release.
29th - do -	WD 958 - Night photographic trials of F.24 camera and 4.5 inch photoflash.

Summary

Tests were made on a Canberra B. Mk.2 to determine the optimum conditions for the most rapid emergency descent to 40,000 feet from a cruising height of 48,000 feet. Calculations were also made to find the optimum conditions for the quickest descent from high to low altitude.

When wing-tip tanks are not carried, both the descent from 48,000 feet to 40,000 feet and the descent from high to low altitude can be made more quickly with the air brakes at the mid-position than with the brakes fully out, owing to the higher Mach numbers that can be used in the former configuration.

When tip tanks are carried, the over-riding limitation of 0.8 I.M.N. makes the descent times with the two air brake extensions approximately equal.

Although all the tests made show little foreseeable benefit from the use of the extra air brake extension, nevertheless we confirm the original decision that the extra extension be retained as a reserve against future developments in operational techniques. Pilots' Notes should then recommend the use of the mid-position of the air brakes for descent, particularly for the emergency high altitude descent.

This Report is issued with the authority of


Air Commodore,
Commanding A. & A.E.E.

/Introduction....

1. Introduction

Flight trials with the 'two-position' air brakes on Canberra B. Mk.2 WD 959 were interrupted by the damage sustained during a landing with the nose-wheel retracted. The results obtained up to that time were given in the 26th part of this Report, but it was considered desirable that, at the first convenient opportunity, the assessment should be extended by the measurement of the rates of descent from 48,000 feet to 40,000 feet, that is, the conditions for an emergency descent. These further measurements have now been made and the results are given herein.

2. Description of aircraft relevant to tests

The aircraft was as described in the 26th part of the Report. The loading at take-off was 33,000 lb., with the C.G. 27.3 inches aft of datum (0.249 S.M.C.), undercarriage down. The weight of the aircraft during the measured descents was between 30,000 and 27,000 lb..

3. Scope of tests

In each test, the aircraft was first flown level at approximately 0.78 I.M.N. (indicated Mach number) at 48,000 feet, with undercarriage and flaps up and air brakes in. On receiving a signal from the observer, the pilot rapidly throttled the engines to the required extent (either to fully idling or to 6,500 r.p.m.), opened the air brakes to the mid or fully open position, and put the aircraft into a sustained dive to 40,000 feet at a constant indicated Mach number. The conditions at which dives were made were:-

- (a) air brakes mid-position, engines fully throttled, 0.785 I.M.N.,
- (b) " " " " " " " " , 0.825 I.M.N.,
- (c) " " " " " " " " , 0.845 I.M.N.,
- (d) " " fully out, " " " " , 0.785 I.M.N.,
- (e) " " " " " " " " , engines operating at 6,500 r.p.m., 0.785 I.M.N..

The final configuration represented the possible operational situation where the pilot is unwilling, even in an emergency, to descend to altitudes where he is more vulnerable to enemy attack. In these circumstances, he cannot throttle his engine below 6,500 r.p.m. unless he intends to descend to 28,000 feet, since at higher altitudes there is a risk of engine fire when the throttles are re-opened.

The time histories of the descents from the initial signal until a height of 40,000 feet was reached were determined by visual observations of a stop watch and the navigator's altimeter. There was no automatic observer.

4. Results of tests

When the engine was throttled and the air brakes extended, the aircraft apparently climbed about 200 to 300 feet within the first few seconds. Although the pilot rapidly applied down elevator to enter the dive, applying negative acceleration sufficient to lift the pilot and observer from the seats for several seconds, nevertheless the first 1,000 feet reduction in height occupied between 10 and 25 seconds, which was approximately a quarter of the total time taken to reduce height to 40,000 feet.

With the air brakes at the mid-position, there was slight aileron snatching in the descent at 0.825 I.M.N. and violent aileron snatching, involving heavy aileron spectacle forces, at 0.845 I.M.N.. At 0.785 I.M.N., with the air brakes either at the mid-position or fully out, there was no aileron snatching.

The ambient air temperatures during the trials were obtained from independent meteorological observations as -57°C at 48,000 feet and $-50\frac{1}{2}^{\circ}\text{C}$ at 40,000 feet (the I.C.A.N. standard temperature is $-56\frac{1}{2}^{\circ}\text{C}$ at both altitudes).

/Time.....

Time histories of the descents are given in figure 1. These show that, under air temperature conditions very close to the I.C.A.N. standard value and at aircraft weights near 30,000 lb., the following times were taken to descend to 40,000 feet:-

Air brake position	I.M.N.	Engine settings	Time (seconds) for descent
Mid	0.825 and 0.845	Idling	45
"	0.785	"	105
Full	"	"	80
"	"	6,500 r.p.m.	100

Brief calculations (based on English Electric Company's flight test report AF/4, part 3) show that changes in aircraft weight, even up to 40,000 lb., did not noticeably change these times for descent. The effects of air temperature difference from standard were also negligible.

5. Discussion of results

5.1. The increase in the rate of descent resulting from either increasing air speed at the mid air brake extension or extending the air brakes fully instead of to the mid-position at a given airspeed were in good agreement with the values predictable from the 26th part of this Report (figure 3 and section 4.2) and the English Electric Company's flight test report number AF/4, part 3 (figure 6).

The most important result was that extra extension of the air brakes at 0.785 I.M.N. gave a markedly lower increase in rate of descent than could be obtained by increasing airspeed to values at which Mach number drag rise effects were making serious contributions.

5.2. The determination of the technique to be recommended for the most rapid descent to 40,000 feet in an emergency must depend upon the Mach number limitations imposed and the extent to which the pilots respect them under the emergency conditions.

Considering the aircraft not fitted with wing-tip tanks, no Mach number limit is directly imposed in Pilots' Notes but there is a recommendation that speed should not be increased beyond 0.83 I.M.N.. The mid-position of the air brakes could be used at this speed, with a much more rapid descent than was possible with the air brakes fully out, when a limit of 0.79 I.M.N. was imposed. It may well be that, in an emergency, the pilot would be tempted to put the air brakes fully out and deliberately exceed 0.79 I.M.N., despite the considerable, even dangerous, buffet induced. From the evidence obtained, however, it seems likely that a speed of about 0.82 I.M.N. with the air brakes fully out would be required to give a descent as rapid as at 0.83 I.M.N. with the air brakes at the mid-position. It seems desirable that pilots be informed, through Pilots' Notes, that the most rapid descent from extreme altitude to 40,000 feet can be achieved with the air brakes at the mid-position, using 0.83 I.M.N..

When the aircraft is fitted with tip-tanks, a limit of 0.80 I.M.N. is imposed. From figure 1, it can be inferred that the time to descend at 0.80 I.M.N. with the air brakes at the mid-position would be little different from that at 0.79 I.M.N. with the air brakes fully out*. Therefore it can be recommended that, in this configuration also, the mid-position of the air brakes should be used, since the gain from using full opening is likely to be small.

/5.3.....

* Slightly shorter times than those given in the figure are to be expected because of the higher drag with tip-tanks fitted.

5.3. The J.A.C. Air Brake Working Party recommended that it should be possible to reduce altitude from 48,000 to 40,000 feet within 60 seconds. This requirement was met at 0.825 and 0.845 I.M.N. with the air brakes at the mid-position, but not at any other of the conditions tested. As stated in section 4, this will apply over a large weight range.

5.4. An assessment of the air brakes in terms of time to descend from high to low altitude could not be given at the time the 26th part of this Report was written. With the additional information now obtained it is shown by calculation that the mid-position of the air brakes gives a somewhat more rapid descent than that given by the full extension. At all heights down to 25,000 feet, the mid-position shows a definite advantage through the use of higher Mach numbers. From 25,000 feet to 13,000 feet, the over-riding air-frame limitations of 0.79 I.M.N. (down to 15,000 feet) and 0.75 I.M.N. (down to 13,000 feet) give a moderate advantage to the full position. At lower altitudes again, the higher speeds permitted with the mid-position offset any benefits from the extra brake extension.

5.5. The advantages and disadvantages of the two-position air brake were discussed at length in the 26th part of this Report. It is not considered that the conclusions then reached are in any way invalidated by the present tests. In particular, the findings of para. 5.2.7. of that part of the Report still stand. It must again be stressed that acceptance of the two-position air brake is conditional upon the fitting of a satisfactory guard to the switch to prevent inadvertent selection of the fully out position.

6. Conclusions

The present series of tests showed that the extra airbrake extension gave no increase in the rate of descent due to over-riding limitations on airspeed. These results confirm the conclusions of the 26th part of the Report that the foreseeable benefits of the extra extension are small.

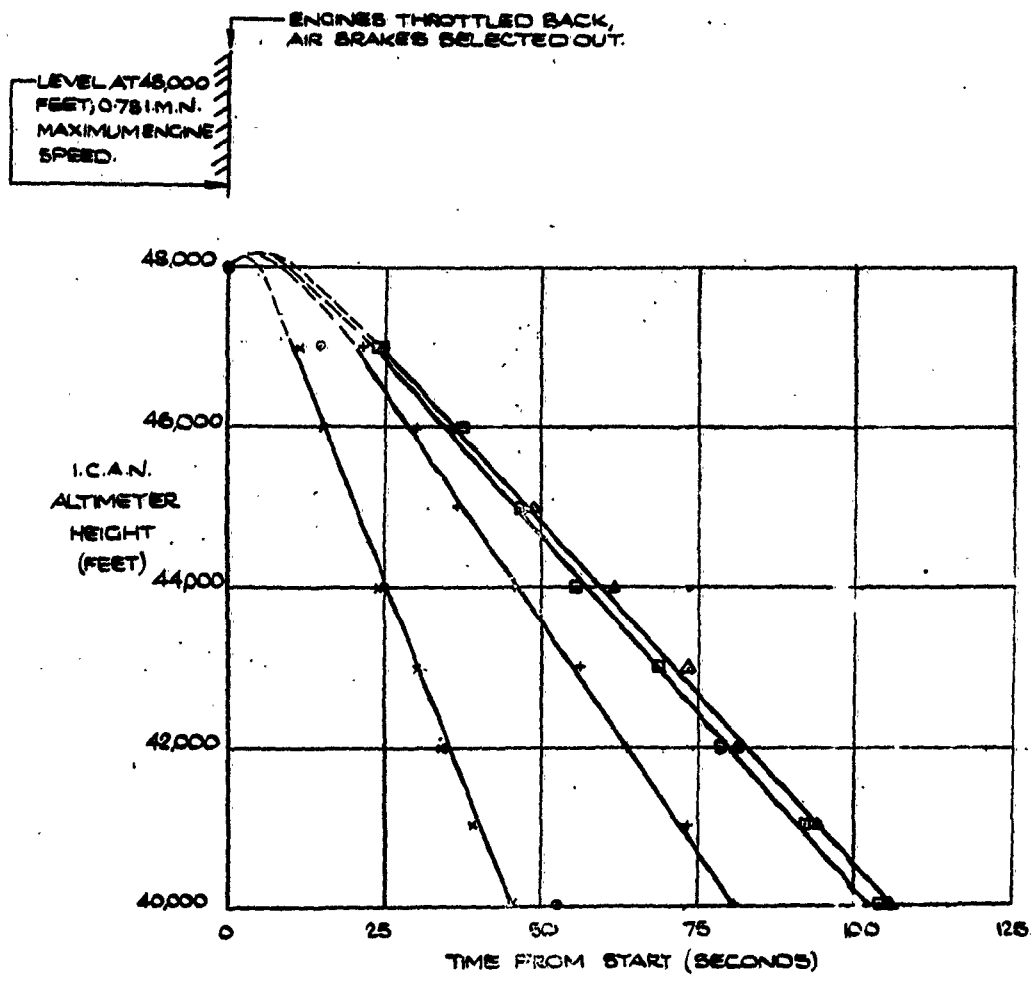
Nevertheless, as stated previously and provided that the operating switch is suitably guarded to prevent mis-use, the extra brake extension can be accepted as a reserve against future developments in operational techniques.

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FIG. 1.

SK. 92A. 5105. 3078 FT. OF. REPORT. N298A. EE. / 861/1. CANBERGAMK. 2. NO 939. TR. SM. CH. ME. H. KEYES. APP. 30-12-56



SYMBOL	I.M.N.	AIR BRAKE POSITION	ENGINE SETTING	AIRCRAFT WEIGHT (LB)
Δ	0.785	MID	IDLING.	28,600
○	0.825	"	"	30,000
x	0.845	"	"	29,350
+	0.785	FULL	"	27,530
◻	0.785	"	6,500 R.P.M.	27,050

DESCENTS FROM HIGH ALTITUDES.



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