AVIA 18/775

R.T.P. FILE COPY

25 MAY 1944

2nd Part of Report No. A.& A.E.E./766
Production Aircraft Test Report No.63.

AIRCRAFT AND ARMAMENT EXPERIMENTAL ESTABLISHMENT
BOSCOMBE DOWN

UNCLASSIFIED

RESTRICTED

STOCK 10
DATE 15/12/52
REDUCE TO 12
AUTHORISED
DATE 16.12.52

Lancaster I LL.905
(4 Merlin 24)

Performance and handling trials
of a production aircraft.

A.& A.E.E. ref: 3708/1/Eng.
M.A.P. ref:- DTD.Admin.Instr.No.10.
Date of tests:- 8th April and 14th May 1944.

Progress of issue of report

Report No.	Title
47th Part of A.& A.E.E./766	ME.563 - Performance and handling trials of a production aircraft.
48th -do-	JB.127 - Flame damping trials with ducted multi-ejector exhausts.
49th - do-	JB.127 - Oil cooling and radiator suitability tests.
50th -do-	JB.127 - Climb and level speed performance.
51st -do-	ME.698 - Performance and handling trials of a production aircraft.

1. Introduction.

Brief performance and handling trials were required on this aircraft to establish any material changes in performance or handling characteristics that might occur in the production of the type.

LL.905 was the 2nd Lancaster I from the Armstrong Whitworth plant at Coventry to undergo these A.& A.E.E. trials.

The aircraft was tested by an A.& A.E.E. pilot and technical observer with the co-operation of the RAF Station at Binbrook.

2. Condition of aircraft.

2.1. External features. This aircraft was a standard production Lancaster as described in the 22nd Part of Report No. 766,b except for the three following details:

(a) Merlin 24 engines fitted.
(b) Paddle blade propellers, type A5/148
(c) The static vent used for the pilot's instruments was in the original position i.e. it was not modified according to R.A.E. Technical Note Instr. No.726, except for the flight on 14th May in which repeat stalling tests only were made.

The pressure side of the pilot's A.S.I. was connected to a W.B.E. Mk.VIII head below the nose.

The general external finish of the aircraft was normal for the type.

A list of the airframe modifications incorporated is given in the Appendix.

2.2. Propeller details. The following data was supplied by the A.I.D:-

Propeller type: Hydromatic Type A5/148 23 Ex - 493.
Serial Nos: NK.69177 NK.51974 NK.69590 NK.69604

2.3. Loading. The tests were made at a take-off weight of 65,000 lb. with the C.G. 60 ins. aft of the datum point undercarriage down. This loading was calculated from the A.I.D.'s computed tare loading (See Appendix).

/Handling

www.aircraftperformance.org

Courtesy of Neil Stirling

Handling tests were made at the following loadings:-

Tests	Wt. lb.	C.G.position ins aft of datum	Flaps and u/c
General handling	65000-60500	61.0-55.9	Up and down
Stalls	61500	58.4/56.5	Up/Down
Dive	61500	61.0	Up
2 & 3 engine handling	61000	57.5	Up
Approach and landing	60500	55.9	Down

These loadings were obtained by consumption of fuel and/or movement of crew.

The design limits of the C.G. range are from 43.5" to 60.6" aft of the datum point, undercarriage down.

2.4. Engine limitations and numbers. The following limitations were applicable to the Merlin 24 at the time of test:-

	RPM	Boost lb/sq.in.
Take-off	3000	+18
Max. for climb	2850	+ 9
Max. for cruising	2650	+ 7
Max. for emergency (1 engine cut)	2850	+ 9

The following numbers for the engines were obtained from the engine logs:

151149	151779	89371	151541
440033	440348	336185	440229

3. Scope of tests.

3.1. Performance. The performance on climb was measured using maximum cruising power in M.S. gear up to 11500 ft., changing to maximum climbing power in F.S. gear thereafter.

The supercharger gear was changed at a height which permitted measurement of the full throttle rates of climb in M.S. gear and no other significance should be attached to the height chosen.

The radiator flaps were open throughout the climb.

A climbing speed of 160 mph ASI was used up to 16,000 ft. decreasing 2 mph/1000 ft. thereafter. These speeds were used on previous climbs on other Lancaster I and III aircraft in this series of production tests.

The level speed performance was measured at maximum cruising conditions (2650 rpm +7 lb/sq.in. boost) with the radiator flaps closed between 6,000 ft. and 21,000 ft. at height intervals of 2,000 ft.

3.2. Handling. General handling tests, including stalls, dive and two and three engine flight, were made under the loading conditions quoted in para. 2.3.

4. Results of tests.

4.1. Performance. The performance results have been corrected to standard ICAN atmospheric conditions and the level speeds to approx. 95% of the take-off weight i.e. 62,000 lb., by methods given in Report No. A.& A.E.E./Res/170, with a supercharger constant of C = .002.

The position error correction for the port static vent has been taken from the 14th Part of Report No. A.& A.E.E./766,b on Lancaster III ED.565 which had a similar installation in regard to the vent position and to the local fuselage form.

/The

www.aircraftperformance.org

The full results of the climb and cruising speed performance are given in Tables I and II and Figs. 1 and 2. A summary of the results is given below:-

Climb

Rate of climb in M.S. gear) 2650 rpm +7 lb/sq.in.boost)	(590 ft/min. at 3,000 ft. (500 ft/min. at 9,500 ft. F.T. height.
Rate of climb in F.S. gear) 2850 rpm +9 lb/sq.in. boost)	(500 ft/min. at 11,500 ft. and up to (16000 ft. F.T. height.
Estimated service ceiling	22000 ft.
Time to 20,000 ft. (engine conditions changed at 11,500 ft.)	41.6 mins.

Cruising speeds at F.T. heights.	M.S. gear	F.S. gear
True air speed at max. cruising power 2650 rpm +7 lb/sq.in.boost.	251 mph @ 10,000 ft.	257 mph @ 16,000 ft.

Cruising ceiling. It is estimated that the speed/height curve enters the cruising threshold (based on an E.A.S. of 155 mph) at 22,000 ft; this height is therefore the cruising ceiling.

For definitions of cruising ceiling and threshold see Report No. A&EE/Res/180.

4.2. Handling. Comparison of the handling characteristics of this aircraft has been made with respect to other Lancaster I and III aircraft tested by the A.& A.E.E. pilot. The aircraft was found to be normal for the type as regards general handling control and stability characteristics, for all loading conditions tested.

Some notes on specific tests made during the course of the flight are given below:-

4.21. Control characteristics and stability. The general control characteristics and stability were assessed over the speed range of the aircraft.

The aileron control was assessed by making reversed aileron turns approximating to Rate 2 up to 20,500 ft. No deterioration of control was noticeable either with height or during the progress of the trials.

There was adequate trimmer range for all conditions of flight on four engines.

4.22. Stalling characteristics. (Wt.61,500 lb. C.G. 58.4" aft, flaps and undercarriage up and 56.5" flaps and undercarriage down). The aircraft was trimmed in a straight glide at 11,000 ft. with the engines throttled right back as follows:-

	Flaps and u/c up	Flaps and u/c down
Trimmed speed	145 mph ASI	130 mph ASI
Elevator trimmer setting	9 divs. tail heavy	2 divs. nose heavy

It was not possible to completely stall the aircraft with flaps and undercarriage up, the minimum speed reached being 130 mph. The stall was reached with the flaps and undercarriage down but the stalling speed was difficult to assess owing to vibration on the airspeed indicator. The impression obtained was that the stalling speed was 115 mph ASI.

Analysis subsequently showed that both these speeds were abnormally high and a further flight was therefore made to check these values under the same loading conditions on 14.5.44.

On this occasion however the static vent to the A.S.I. had been moved to the position given in R.A.E. Tech. Note 726 and was therefore as in the tests on Lancaster III JB.565, described in the 22nd Part of Report No. A.& A.E.E./766,b.

With flaps and undercarriage up, the minimum speed reached with the control column fully back and 12 divisions of tail heavy trim was 115 mph ASI, but the aircraft had not stalled.

With flaps and undercarriage down, the aircraft was stalled with 2 divisions of tail heavy trim at 96 mph ASI.

4.23. Dive. (Wt.61,500 lb. C.G. 61" aft, flaps and undercarriage up.) The aircraft was trimmed for maximum cruising level flight at 8,500 ft. and dived to 5,000 ft. with the throttles approximately one-third open.

/The

www.aircraftperformance.org

The maximum speed obtained was 360 mph ASI, which is the maximum permissible speed.

The following trimmer positions were noted on entering the dive:-

Elevator	Aileron	Rudder
1½ divs. nose heavy	neutral	neutral

The elevator trim was moved back to one division tail heavy to steady the dive but no trim was necessary for recovery.

4.24. Two and three engine handling. (Wt. 61,000 lb. C.G. 57.5" aft, flaps and undercarriage up). The aircraft was trimmed for maximum climbing flight at 5300 ft. at best climbing speed.

At the above conditions the port outer engine was throttled right back with the propeller windmilling, the working engines remaining at 2850 rpm +9 lb/sq.in. boost. The resultant change in directional trim could temporarily be held on the rudder pedals until rudder trim (5 divisions) was applied.

The propeller of the port outer engine was then feathered and the port inner engine throttled right back with the propeller windmilling at 1800 rpm. The working engines were running at 2850 rpm +9½ lb/sq.in. boost and full starboard rudder trim (12 divisions) applied. At the above conditions with the wings held level, the aircraft could be flown without turning at 210 mph ASI, with zero foot load. At 190 mph ASI the foot load was moderate and could have been held for long periods. At 155 mph ASI maximum rudder movement had been applied.

4.25. Approach and landing. (Wt. 60,500 lb. C.G. 55.9" aft, with flaps and undercarriage down). A glide approach was made with the engines throttled back to 140 mph ASI and the response to control movements assessed during the glide. All controls were normal.

5. Conclusions.

The performance and handling characteristics of Lancaster I LL.905 may be regarded as normal for the type.

Circulation list

C.R.D.
D.T.D.
D.D.T.D.
D.O.R.
D.D.R.D.A.
D.D.R.D.T.
A.D.R.D.T.1.
A.C.A.S.(T.R.)
D.R.A.E. 5 copies
DD/AP7
R.D.T.3.
D.E.D.
D.D.(1)R.D.E.
A.D.R.D.E.1.
A.D.R.D.E.2.
A.D.R.D.E.4.
A.D.R.D.L.2. 2 copies 1 for action
A.D.D.A.N.A.
Overseer Armstrong Whitworth
Inspector " "
A.F.E.E.
T.F.2.
Chief Overseer
C.I. Accidents.
R.D.T.(Accidents)
O.C.Handling Sqdn. Hullavington
R.T.P.(TIB) 6 copies +1
R.T.P.2(a) 35 copies
R.T.O. A.V.Roe 3 copies
R.T.O. Rolls-Royce, Derby. 4 copies
R.T.O. " " Hucknall. 2 copies

Chief Technical Officer.

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

WWIIaircraftperformance.org

TABLE I

Performance on climb using max. cruising power in M.S. gear changing to max. climbing power in F.S. gear.
Take-off weight:- 65,000 lb.
Radiator flaps open.

Standard height ft	Time Mins	Rate of climb ft/min.	ASI mph	Mean Boost lb/sq.in.	Mean RPM	S/C gear
4000	6.6	580	160	7.0	2650	MS
6000	10.0	550		↓	↓	↓
9500 *	16.6	500		↓	↓	↓
11500 ø	21.2	370		5.5	↓	↓
14000	26.3	500		9.0	2650	FS
16000 *	30.2	↓	↓	↓	↓	↓
20000	41.6	230	152	5.6	↓	↓
21000	46.6	170	150	4.8	↓	↓

* Full throttle heights.
ø S/C gear and engine conditions changed.
Estimated service ceiling 22,000 ft.

TABLE II

Level speed performance at max. cruising power
Corrected to 62,000 lb.
Radiator flaps closed.

Standard Height ft	TAS mph	ASI mph	Corrections mph		Mean boost lb/sq.in.	Mean RPM	S/C gear
			P.E.	C.E.			
6000	243	230	-7.3	-0.6	7.0	2650	MS
10000 *	251	224	-7.1	-1.1	7.0	↓	↓
14000	244	204	-6.5	-1.2	4.1	↓	↓
10000	245	218	-6.9	-1.0	7.0	2650	FS
16000 *	257	208	-6.5	-1.6	7.0	↓	↓
20000	237	180	-6.1	-1.4	4.0	↓	↓
21000	230	172	-6.0	-1.3	3.2	↓	↓

* Full throttle heights
Estimated cruising ceiling, 22,000 ft.

www.ratberformance.org

200 400

APPENDIX

Extracts from inspection, test and modification certificate

Modifications embodied.
397,399,410,415,424,432,435,436,440,446,447,457,459,461,462,463,465,
466,467,468,470,471,473,476,482,483,484,485,489,490,493,494,495,498,
499,500,501,502,504,505,507,510,511,518,519,521,522,523,524,530,531,
532,536,537,538,539,540,541,543,544,550,553,554,555,557,559,562,565,
566,570,574,584,585,586,589,592,598,602,605,606,608,609,610,612,613,
615,616,617,619,622,630,632,640,643,651,660,661,662,corr 1, 664,666,
668,670,672,674,675,676,677,678,680,681,682,684,685,696,698,703,704,
705,707,708,710,713,715,717 pt.1,722,723,724,728,729,731,732,735,737,
739,740,742,744,754,755,756,757,758,773,780,783,789,790,791 795,702 Pt.1
797,801,803,804,806,810,811,814,816,818,819,821 corr 1, 822,824,826,
828,835,836,838,846,848,852,859,860,870,871,872,873,873 corr.1, 881,
882,884,891,893,895,896,900,901,902,905,928,957,958,963,975,985,1009,
1012,1013 Pt.1,1014,1020,1055 Pt.1,1060,1074,1084,1110,876,877,888,
897,913 Pt.1, 1063. 751.

Weight of aircraft = 36500 lb. (computed)

Tare C.G. of aircraft = 45.4 inches aft of datum.

Special Technical Instructions fulfilled:- R.D.A.s 660,707,767,174B,749B,
838B, SM.224. STI/Misc./4. STI/Misc./5. STI/Lanc./3. STI/Lanc./4.

www.aircraftperformance.org

CLIMB PERFORMANCE

FIG. 1

USING MAXIMUM CRUISING POWER IN M.S. GEAR CHANGING TO MAXIMUM CLIMBING POWER IN F.S. GEAR

RADIATOR FLAPS OPEN

WEIGHT - 65,000 LB

52nd PART OF REPORT N° A&AEE/766 | LANCASTER ...LB33 | CURVE N° 6328 | TRACED B.M. | DATE 5.5.44 | CHECKED [signature] | APPROVED [signature] | D/O

HEIGHT - THOUSANDS OF FEET

0 2 4 6 8 10 12 14 16 18 20 22 24

RATE OF CLIMB - FT/MIN

0 200 400 600 800

TIME - MINS

0 10 20 30 40 50

BOOST - LB/SQ.IN

4 5 6 7 8 9

WWW.aircraftperformance.org

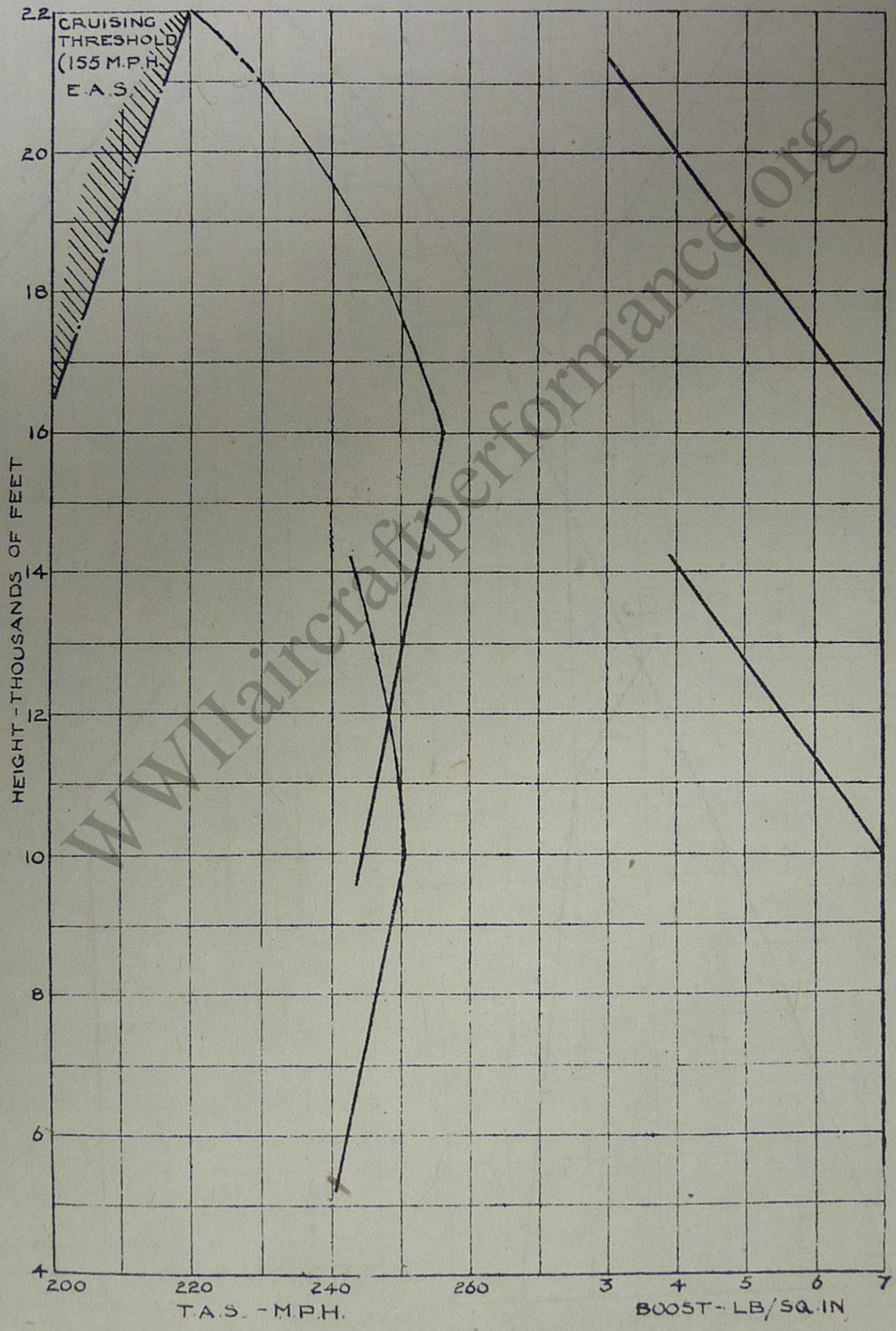
FIG. 2

LEVEL SPEED PERFORMANCE

AT MAXIMUM CRUISING POWER.

2650 R.P.M. RADIATOR FLAPS CLOSED.

CORRECTED TO 62,000 LB.



www.aircraftperformance.org

52nd PART OF REPORT No A & A.E.E./766 | LANCASTER I. LL905 | CURVE No 6329 | TRACED B.M. | DATE 6.5.44 | CHECKED | APPROVED | D/O