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~~RESTRICTED~~ 8th Part of Report No. A.& A.E.E./783.

15 SEP 1942

AEROPLANE AND ARMAMENT EXPERIMENTAL ESTABLISHMENT.

BOSCOMBE DOWN.

Kittyhawk IAL229
(Allison V 1710 F3R)

~~Combat heating tests~~

Progress of issue of report.

Report No.		Title
8th Part of A.&	A.E.E./783	AK.572 - Rate of climb and P.E. measurements
9th	do	AL.229 - Fuel consumption trials and range flight with a long range jettisonable ventral tank fitted
10th	do	AL.229 - Performance tests with an external fuel tank fitted
11th	do	AL.229 - Take-off and landing trials with and without overload fuel tanks
12th	do	AK.572 - Engine cooling trials & AL.229

Summary.

The heating supplied to the guns of Kittyhawk AL 229 was below the minimum requirements and only provided a temperature rise of 16° C. when tested in the condition as received. This temperature rise was considerably increased by two small modifications that were made to isolate the air in the gun bay from the rest of the wing.

The first modification consisted of cardboard and fabric blanking pieces on the blast tubes where they pass through the front spar web, and this increased the temperature rise by 10° C.; the second modification sealed the 3 inch holes in the front ends of the gun compartments where the gun barrels passed through, and this again increased the temperature rise.

It is recommended that, pending the development of an improved heating system (which should incorporate the second modification above) by the parent firm, all squadrons operating Kittyhawk aeroplanes in temperatures less than -26°C. should fit blanking pieces round the blast tubes where they pass through the front spar web.

The tests were made between 22nd June and 11th July, 1942.

1. Introduction.

Tests were required to determine the extent of the heating applied to the guns of the Kittyhawk aeroplane.

2. Condition of aeroplane relevant to tests made.

This production type Kittyhawk aeroplane was fitted with six .50" Browning guns in gun bays in the wings just outboard of the wells for the main-wheels, and these were heated by hot air from behind the main coolant radiator.

3. Description of the system.

Air was collected from behind the coolant radiator by two oval ducts approximately 2 inches by 3 inches which opened to the air stream at an angle of 45 degrees. The air was then led along inside the leading edges of the wings by 2½ inch diameter lagged flexible ducts; on the starboard side, the duct passed immediately behind the opening in the wing root for the cold air supply to the cockpit and was exposed to the air stream. The flexible ducts passed through the front spar into the wells for the retraction of the main wheels, where they were shielded from the external air by canvas which covers the whole well.

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From the wheel wells each duct passed through a metal bulkhead into the gun bay where a metal junction branched into three 1½ inch diameter ducts, a metal conduit carrying the air to the inboard gun and a flexible pipe to each of the centre and outboard guns. The exits of the ducts for the inboard guns were just ahead of the gun casing, while those for the centre and outer guns ended halfway along the gun casing. In all cases the ducts directed the air backwards along the inboard sides of the guns.

The gun bays and ammunition boxes were entirely unlagged but, with the exception of the forward end of the gun bays, were well sealed from the rest of the wing. Each gun barrel passes through three 3 inch holes, one in the front end of the compartment and one in each of the two front spar webs; in addition, there were two 1-inch holes in the inboard bulkhead of each gun bay and these opened into the wheel well inside the canvas cover. Ball and socket joints were fitted to the blast tubes where they projected through the leading edge, but these were a very poor fit and did not prevent the external air from entering the wings; on this aeroplane the starboard installation was slightly superior to the port in this respect. The ejection chutes were open and were not fitted with deflector plates but they fitted close up to the gun casing.

4. Position of test instruments.

Eight Cambridge thermometric elements were used; one element was fitted in the breech block of each gun, and one was strapped to the underside of the rear portion of each outer gun and was insulated from the gun casing by a strip of rubber. These two thermometers, referred to as "plate" type in the results, were fitted to give a comparison between the temperature of the air in the bay and that of the gun breech.

5. Scope of tests.

The aeroplane was climbed to the altitudes stated and was then flown level at these altitudes until the temperatures had stabilized for 10 - 12 mins; the temperatures were noted at every 5,000 ft. on the climb and at every 3 mins. during level flight.

Test No.1. was made with the aeroplane in the condition as received.

For Test No.2. temporary cardboard and fabric blanking pieces were placed round the gun barrels where they pass through the front spar, thus to some extent isolating the gun bays from the leading edge compartment and excluding the cold air which entered the wing through the ball and socket joints in the leading edge.

For Test No.3., the blanking pieces were removed and the holes round the gun barrels in the front end of the gun bay were stuffed with rag as a temporary method of isolating the gun bay from the rest of the wing.

6. Results. The temperature rises over the outside air temperature are shown graphically in Figures 1,2, and 3. The actual stabilized temperatures and the temperatures corrected in accordance with A.D.M. 498 are given below, together with the other relevant data.

	Test No.1.22.6.42.		Test No.2.29.6.42.		Test No.3.11.7.42.	
Height	26,000 ft.		27,500 ft.		27,500 ft.	
A.S.I.	148 m.p.h.		125 m.p.h.		126 m.p.h.	
Boost	18½" Hg.		21" Hg.		21" Hg.	
R.P.M.	2,300		2,300		2,300	
Rad. Temp.	109°C.		108°C.		96-97	
Rad. Shutter	Neutral		Neutral		Neutral	
Air Temp.	- 32½°C.		- 34°C.		- 39½°C.	
	Actual °C.	Corrd to ADM.498	Actual °C.	Corrd to ADM 498	Actual °C.	Corrd to ADM 498
Port Plate	- 6	- 22	- 2	-17½	- 25	- 37
Port Outer	-16	- 33½	- 5	-21½	- 11	- 23½
Port Centre	- 8	- 24	- 3	-19	- 11	- 23½
Port Inner	-15½	- 33	- 8	-25	- 3	- 14½
Stbd.Inner	- 6	- 22	- 3	-19	- 6	- 17½
Stbd.Centre	- 9	- 25½	- 6	-22½	- 9	- 21
St bd.Outer	-13	- 30	- 6	-22½	- 11	- 24½
Stbd.Plate	- 5	- 21	-11	-28½	- 20	- 33½

←Breech→

7. Discussion of results.

A. The plate type thermometers provide an indication of the temperature of the air surrounding the guns but, due to the eddies in the air flow, they do not give the true gun temperatures. The breech thermometers, however, which are fitted in the breech blocks of the guns, give an accurate reading of the temperatures at the critical points in the guns. The temperatures quoted below, therefore, are confined to the readings of the breech thermometers.

In the condition as received, the heating supplied to the guns was very much below the minimum requirements of A.D.M. 498 - i.e. a minimum temperature of - 10°C for .50" Browning guns. The modification made for test No.2. increased the minimum temperature rise from 16½° to 26°, although the tests were made 1,500 ft. higher. In test No.3. the radiator temperature was 10° lower than for the previous tests and it is considered that this drop in temperature would cause a drop in gun temperature of 2° - 5°; as it was, however, the minimum temperature rise was 28½° while the maximum rise had increased from 26½° in test 1, and 31° in test 2, to 36½° in test 3.

8. Conclusions.

The heating supplied to the six .50 inch guns of the Kittyhawk aeroplane was well below the minimum requirements of A.D.M. 498. Two simple modifications tested did provide a slight improvement, but this was not sufficient to comply with acceptance requirements.

9. Recommendations.

9.1. It is therefore recommended that the parent firm should undertake the development of a system to give at least 45° temperature rise in the breeches of the guns. Pending the development of a new system, it is suggested that some form of seal should be incorporated where the gun barrels pass through the forward end of the gun bay, to isolate the air in the bay from the rest of the wing, as this will raise the gun temperatures 10°- 20°C.

9.2. For those aeroplanes already in service, it is recommended that some form of seal should be fitted round the blast tubes where they pass through the front spar web immediately inside the leading edge, and it is within the capabilities of operational squadrons to fit this modification.

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KITTYHAWK. A L229

GUN HEATING TESTS. Nº 1.

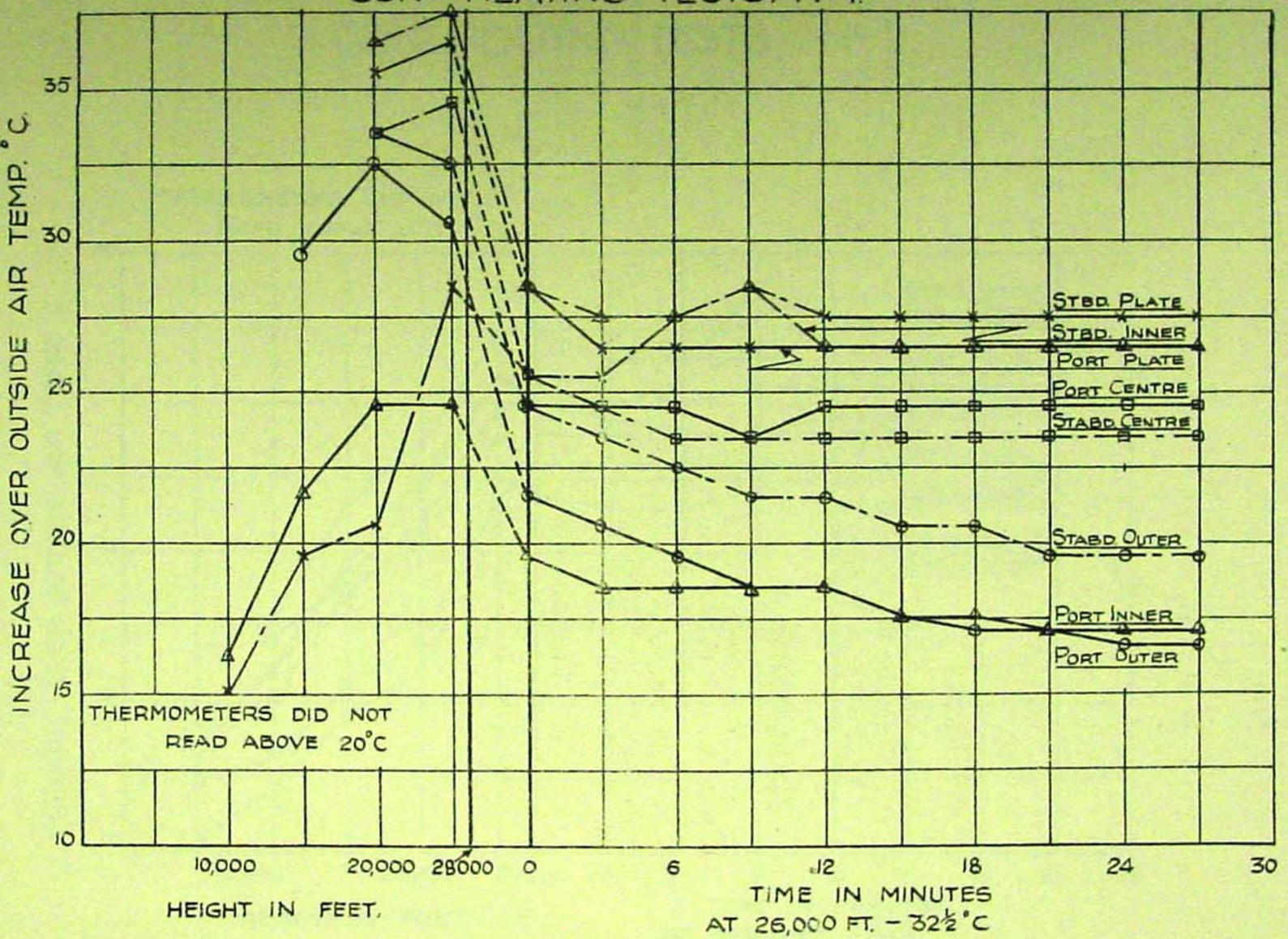

FIG. 1

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KITTYHAWK. AL229

GUN HEATING TESTS Nº 2.

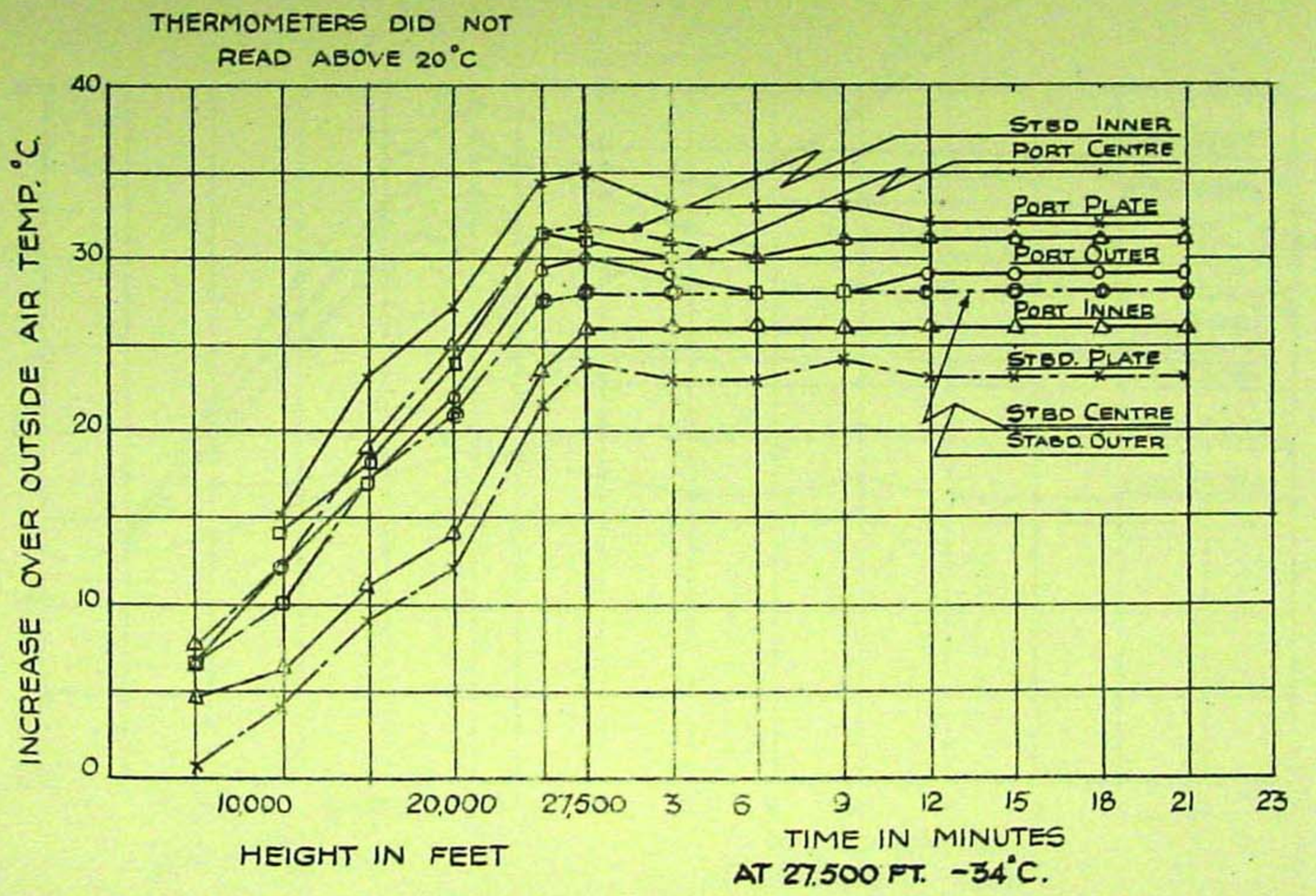

FIG. 2

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KITTYHAWK. A L229

GUN HEATING TESTS Nº. 3.

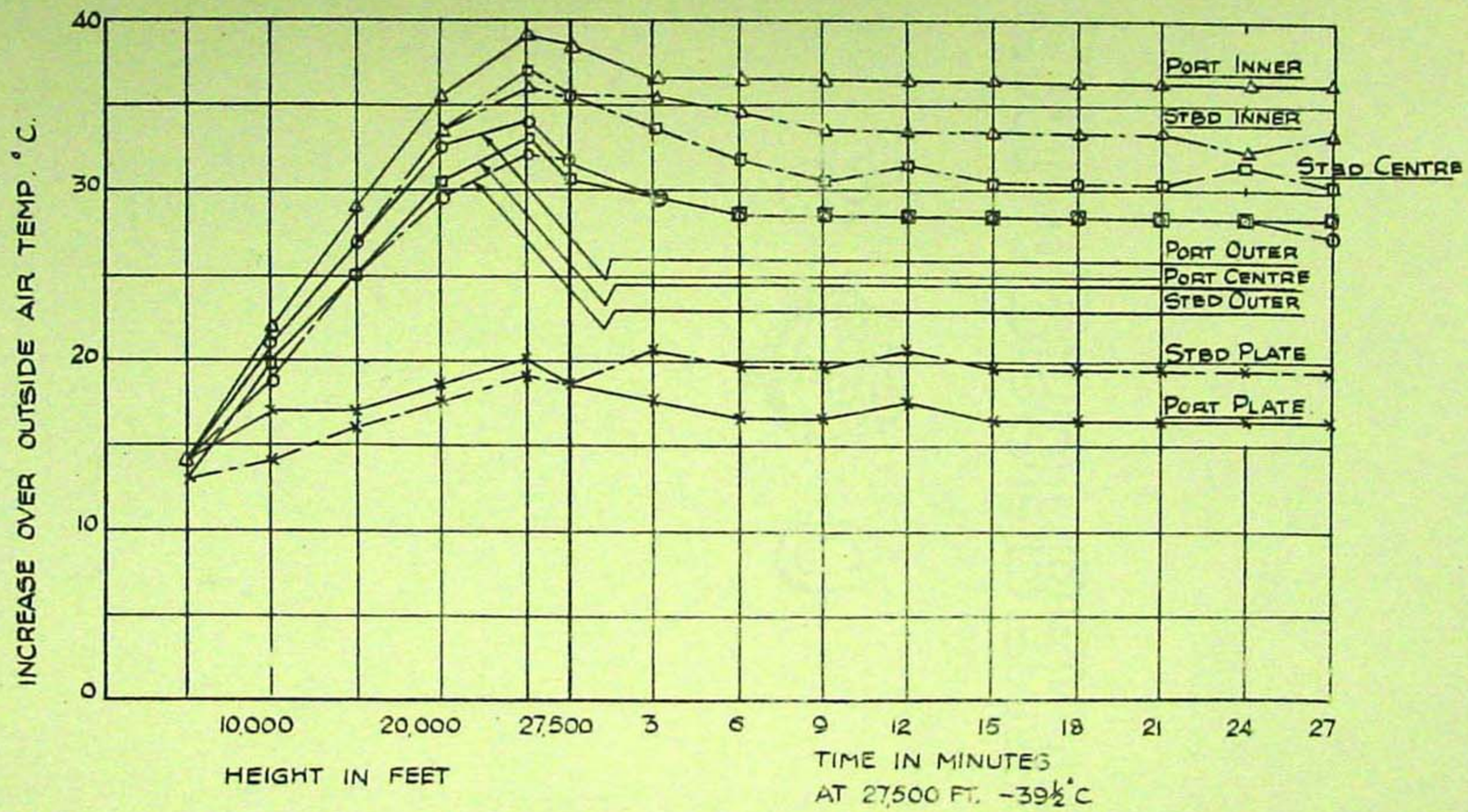

FIG. 3