SECRET
DETAIL No.: 119/A/30.

RAAF HEADQUARTERS
DIRECTORATE OF TECHNICAL SERVICES
SPECIAL DUTIES AND PERFORMANCE FLIGHT

REPORT
ON
BRIEF FLIGHT TRIALS OF JAPANESE
FIGHTER TYPE O
MK.II
S.S.F. HAP.

DATE OF ISSUE: 16th October, 1943.
### AERONAUTICAL SYMBOLS

#### 1. FUNDAMENTAL AND DERIVED UNITS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Metric</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unit</td>
<td>Abbreviation</td>
</tr>
<tr>
<td>Length</td>
<td>l</td>
<td>meter</td>
</tr>
<tr>
<td>Time</td>
<td>s</td>
<td>second</td>
</tr>
<tr>
<td>Force</td>
<td>N</td>
<td>newton</td>
</tr>
<tr>
<td>Power</td>
<td>W</td>
<td>watt</td>
</tr>
<tr>
<td>Speed</td>
<td>m/s</td>
<td>meter per second</td>
</tr>
</tbody>
</table>

### 2. GENERAL SYMBOLS

- $W$: Weight = $mg$
- $g$: Standard acceleration of gravity $9.80665 \text{ m/s}^2$
- $m$: Mass = $\frac{W}{g}$
- $I$: Moment of inertia $= mk^2$. (Indicate axis of radius of gyration $k$ by proper subscript.)
- $\mu$: Coefficient of viscosity
- $\nu$: Kinematic viscosity
- $\rho$: Density (mass per unit volume)
- $\rho$: Specific weight of "standard" air, 1.2255 kg/m$^3$

### 3. AERODYNAMIC SYMBOLS

- $S$: Area
- $S_w$: Area of Wing
- $C$: Chord
- $A$: Aspect ratio, $b^2/S$
- $V$: True air speed
- $q$: Dynamic pressure, $\frac{1}{2}pV^2$
- $L$: Lift, absolute coefficient $C_L = \frac{L}{qS}$
- $D$: Drag, absolute coefficient $C_D = \frac{D}{qS}$
- $D_p$: Profile drag, absolute coefficient $C_{D_p} = \frac{D_p}{qS}$
- $D_i$: Induced drag, absolute coefficient $C_{D_i} = \frac{D_i}{qS}$
- $D_p$: Parasite drag, absolute coefficient $C_{D_p} = \frac{D_p}{qS}$
- $C$: Cross-wind force, absolute coefficient $C = \frac{C}{qS}$

- $\alpha$: Angle of attack
- $\beta$: Angle of downwash
- $\alpha_0$: Angle of attack, infinite aspect ratio
- $\alpha_1$: Angle of attack, induced
- $\alpha_2$: Angle of attack, absolute (measured from zero-lift position)
- $\gamma$: Flight-path angle

Standard density of dry air, 0.12497 kg-m$^-3$, 15°C and 760 mm; or 0.002378 lb-ft$^-3$, sec$^-1$

Specific weight of "standard" air, 1.2255 kg/m$^3$; 0.07651 lb/cu ft

Where $l$ is a length dimension (e.g., for an aerofoil of 1 chord, 100 mph, standard pressure at the corresponding Reynolds number 935,400; for 1 m $^3$/100 nps, the corresponding Reynolds number is 6,865,000).
INTRODUCTION

The Hap is a single seater low wing all metal monoplane fighter which was captured at Buna airfield in repairable condition. The aircraft was subsequently reconstructed and put into flying condition, by Air Technical Intelligence Unit of Allied Air Forces at Eagle Farm (see Ref. 1).

The engine which is a twin row 14 cylinder air cooled radial, was repaired in U.S. Air Corps Civilian Contract shops in Melbourne and dynamometer tested by C.S.I.R. (See Ref. 2).

This aircraft is a development of the Japanese single seater Navy fighter type C Mk.I S.S.F. "Zeke" from which it mainly differs in the following respects:

AIRFRAME: The folding wing tips have been removed and replaced by short fairings, making the wing plan form square tipped and reducing the span from 39' - 4" to 36' - 4"; the ailerons have also been shortened. The firewall has been moved back 8 inches, the engine cowling lengthened and its shape improved. The position of the air intake has been changed and it is now situated in the top cowling.

ENGINE: The engine has been developed from the Nakajima model 12 used in the Zeke. The model 21 on Hap has a two speed blower, a re-designed reduction gear and a down draft carburettor. The cylinder cooling has been much improved, which permits the engine to operate on leaner full throttle mixtures compared with the earlier type engine and the power output has thus been considerably increased. (See Ref. 2).

Hap was received at Special Duties and Performance Flight on 9/9/43 having been allotted by A.T.I.U. for brief flight trials. Combat and initial flight trials had been carried out at Eagle Farm but the weight, C.G. position and position error were unknown and the instruments were not calibrated. Automatic photo-observers were fitted for the purpose of recording performance figures and rates of roll. It is, however, emphasised that the time available for the tests was entirely inadequate for the work to be done thoroughly, and it was only due to good luck and generally satisfactory weather conditions, that the short programme originally scheduled was completed. For work of this nature, a period of two months is an absolute minimum as breakdowns and unserviceability require longer to repair than with standard equipment.

In testing rates of roll, information on control and wing stiffness would have been of great interest but it was not possible in the time available to fit the necessary equipment required for this work.

Proper engine cooling tests would also have been of much interest as the cooling of this engine is remarkably good.

24/9/43.

The aircraft returned to Eagle Farm on
1. **GENERAL DETAILS** (See Ref. 3)

1.1 **The aircraft**

- **Manufacturer:** Mitsubishi
- **Name:** Type O Mk.II S.S.F. "Hap" (Carrier borne fighter)
- **Type:** Low wing all metal cantilever monoplane.
- **Overall dimensions:**
  - Length: 29' - 9"
  - Span: 36' - 4"
  - Height: 9' - 2"
- **Construction:** All metal semi-mono-coque with fabric covered control surfaces.
  Throughout the structure, extraordinary emphasis has been laid on lightness.
- **Undercarriage and Tail Support:**
- **Armament:**
  - 2 x 20 mm. cannon in wings
  - 2 x 77 mm. machine-guns in upper cowling.

1.2 **Aerodynamic Data**

- **Wings:**
  - **Gross Area (S):** 232.4 sq.ft.
  - **Span (2a):** 36.4 ft.
  - **Mean Chord:** 6.4 ft.
  - **Aspect ratio:** 5.7
  - **Diagonal on 30% chord line (measured on lower surface):** 6.50°
  - **Taper Ratio:** .44
  - **Wing Loading:** 24.3 lb./sq.ft.

- **Chords:**
  - **Root:** 9.4 ft.
  - **Tip:** 4.128 ft.

- **Section:**
  - **Root:** NACA 2315
  - **Tip:** NACA 3309

- **Flaps:**
  - **Type:** Split
  - **Area:** 16.44 sq.ft.
  - **Flap span/23:** .29
  - **Flap chord/wing chord (mean):** .230

- **Longitudinal Control:**
  - **Tail surface area (S):** 81.63 sq.ft.
  - **Elevator area/Sl:** .21
  - **Tail volume co-efficient:** .522
  - **Type of balance - Aerodynamic:**
  - **Percentage balance:** 11.35
  - **Trim tab area:** 1.19 sq.ft.
Directional Control:
- Pin & Rudder Area (S") 15.6 sq.ft.
- Rudder Area/S" .49 sq.ft.
- Pin & Rudder Volume .074
- Co-efficient Aerodynamic
- Type of balance 9.64
- Percentage balance .065 sq.ft.
- Trim tab area

Lateral Control:
- Type of ailerons Fise
- Aileron area 20.2 sq.ft.
- Aileron area/S .087
- Aileron Span/wing span .526
- Type of balance Aerodynamic

1.3 Engine Details

Manufacturer: Nakajima
Name: Sakae Model 21
Type: 14 cylinder two row air-cooled radial

Bore: 5.12 inches (130 mm.)
Stroke: 5.9 inches (150 mm.)

Displacement: 1700 cu.in.

Supercharger: Single stage, two speed: Low: 6.397 High: 8.425

Carburettor: Down draft type with manually operated mixture control

Air screw reduction ratio: 0.585 : 1 (17.1 : 10)

Power Ratings: B.H.P. R.F.M. A.M.P. Super Altitude
Military Rating 960 2600 40 in. Low 0
(5 mins) 1020 40 in. Low 6400
885 40 in. Low 15300

Maximum Continuous (Rated) Power
905 2400 36 in. Low 0
800 40 in. Low 7000
High 15200

Fuel Used: 92 Octane
Starting Gear: Hand inertia type

Fuel Tanks:
- One fuselage tank 16.5 gals.
- Two wing tanks 47.5 gals ea.

One additional jettiscable tank of 75 gallons capacity can be carried under the fuselage, attached to the centre wing section.

The tanks are not self-sealing.
1.4 Airscrew Details.

Type: Metal, 3 bladed constant speed type with counterweights.

Rotation: Clockwise from pilot's seat

Diameter: 10' - 0"

Pitch Range: 20°

Blade Sections: Modified Clark Y over greater part of blade, low drag sections at tips.

1.5 Aircraft Weights.

The all up weight of the aircraft during the tests was 5650 lb. This is the maximum weight of the aircraft, with full fixed tanks, but without the droppable belly tank. Full equipment was carried, the ammunition being substituted by the correct amount of lead weight in the magazines. The radio equipment was not original, but the difference in weight is not appreciable. The automatic observer which weighs 18 lb. was carried in excess of the normal equipment.

The centre of gravity location for the above condition was 26.8" behind the leading edge of the wing at the root, the auto-observer causing the C.G. to be 0.5" to the rear of the normal all up weight position.

2. PERFORMANCE

The test results have been reduced to standard atmospheric conditions by the methods of Ref.5. Only level speed and climb performances were tested and it is to be noted that the engine had not been overhauled since its initial start up. It did, however, run quite well during the trials.

Take off, fuel consumption and cooling tests could not be carried out in the available time.

The Position Error was determined by the aneroid method. A check by an alternative method especially in the low speed range, is desirable, but was not carried out in the limited time available as the level speed and climb corrections were not affected.

2.1 Level Speed

The results are shown in Table I and Fig.3. Although repeat tests could not be carried out, the results obtained show good agreement when used for calculating "extra t" induced". Drag at 100 ft./sec., a value of 56 lbs. being obtained.

2.2 Climb

Results are given in Table II and Fig.4. Above 32,000 ft. the rate of climb at 2400 r.p.m. fell off noticeably and was improved by increasing the engine revolutions to 2800 r.p.m., corresponding to the military power rating. Climbs above 10,000 ft. are complicated by the mixture control being hand operated, and considerable scatter of results has occurred. In the circumstances
2.2 Climb (Contd)

Individual climbs may show considerable variation of results and pilots technique becomes very important, particularly with such a sensitive mixture adjustment.

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**TABLE I**

**LEVEL SPEED PERFORMANCE**

**COWL GILLS CLOSED**

**WEIGHT 5,650 LBS.**

<table>
<thead>
<tr>
<th>Standard Height(ft)</th>
<th>MILITARY POWER - 2600 RPM</th>
<th>RATED POWER - 2400 RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Manifold Blower</td>
<td>T.A.S.</td>
</tr>
<tr>
<td></td>
<td>In. Hg.</td>
<td>M.P.H.</td>
</tr>
<tr>
<td>0</td>
<td>40</td>
<td>Low</td>
</tr>
<tr>
<td>1000</td>
<td>40</td>
<td>Low</td>
</tr>
<tr>
<td>2000</td>
<td>40</td>
<td>Low</td>
</tr>
<tr>
<td>3000</td>
<td>40</td>
<td>Low</td>
</tr>
<tr>
<td>5000</td>
<td>40</td>
<td>Low</td>
</tr>
<tr>
<td>7500</td>
<td>40</td>
<td>Low</td>
</tr>
<tr>
<td>8600</td>
<td>40</td>
<td>Low</td>
</tr>
<tr>
<td>9800</td>
<td>40</td>
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</tr>
<tr>
<td>10000</td>
<td>38h</td>
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<tr>
<td>12500</td>
<td>36h</td>
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<td>12500</td>
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<td>16600</td>
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<tr>
<td>16800</td>
<td>38h</td>
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<td>17500</td>
<td>35</td>
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<tr>
<td>20000</td>
<td>28h</td>
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<tr>
<td>25000</td>
<td>23</td>
<td>High</td>
</tr>
<tr>
<td>30000</td>
<td>17</td>
<td>High</td>
</tr>
</tbody>
</table>

* Full throttle heights in Low Blower

/ Full throttle heights in High Blower
<table>
<thead>
<tr>
<th>Standard Height (ft.)</th>
<th>Time from Start (min)</th>
<th>Rate of Climb (ft/min)</th>
<th>Rate of TAS (MPH)</th>
<th>Military Power - 2600 RPM</th>
<th>Rated Power - 2400 RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>3410</td>
<td>146</td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td>1000</td>
<td>.29</td>
<td>3410</td>
<td>148</td>
<td>40</td>
<td>.36</td>
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<tr>
<td>2000</td>
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<td>3410</td>
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<td>6100</td>
<td>1.79</td>
<td>3410</td>
<td>160</td>
<td>40</td>
<td></td>
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<tr>
<td>7500</td>
<td>2.20</td>
<td>3220</td>
<td>164</td>
<td>38</td>
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<td>2785</td>
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<td>12500</td>
<td>3.95</td>
<td>2775</td>
<td>177</td>
<td>40</td>
<td>4.64</td>
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<tr>
<td>15000</td>
<td>4.85</td>
<td>2775</td>
<td>184</td>
<td>40</td>
<td>5.71</td>
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<tr>
<td>15500</td>
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<td></td>
<td></td>
<td></td>
<td>5.93</td>
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<tr>
<td>15700</td>
<td>5.10</td>
<td>2775</td>
<td>185</td>
<td>40</td>
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<tr>
<td>17500</td>
<td>5.78</td>
<td>2520</td>
<td>185</td>
<td>37</td>
<td>6.83</td>
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<td>20000</td>
<td>6.84</td>
<td>2175</td>
<td>186</td>
<td>33</td>
<td>8.11</td>
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<tr>
<td>25000</td>
<td>9.60</td>
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<td>188</td>
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<td>11.53</td>
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<tr>
<td>30000</td>
<td>14.15</td>
<td>790</td>
<td>191</td>
<td>21½</td>
<td>17.53</td>
</tr>
<tr>
<td>32000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21.60</td>
</tr>
<tr>
<td>35000</td>
<td>29.30</td>
<td>100</td>
<td>194</td>
<td>17</td>
<td></td>
</tr>
</tbody>
</table>

* Full throttle heights Low Blower
ø Full throttle heights High Blower

**NOTE:** The full throttle height on military power, low blower is lower than found by Dynamometer (Ref. 2). Due to the effect of ram, it should actually have been at a higher altitude, but it has not been possible to ascertain the reason for this discrepancy, which in any case is not appreciable.
Fig 1: Har Pitot Head Details

Date: 13-10-43

Note: need projects from leading edge of port manoeuvre 28

Dimensions:
- Total length: 120 inches
- Diameter: 8 inches
- Half diameter: 4 inches
- Radius: 2 inches
3. HANDLING TRIALS:

3.1 General:

(a) Starting Up:

The engine is started by means of a hand inertia system which operates quite efficiently. The airman engages the starter by cranking and the booster coil is switched on by the pilot. There is a priming pump in the cockpit but all the priming in flight was carried out by using the accelerator pump attached to the hand throttle.

(b) Stopping Engine:

If stopped immediately after landing the engine was found to oil up. The procedure was therefore adopted of running up to 2000 r.p.m., testing switches, and putting the airscrew into full coarse prior to stopping. The plugs were kept clean in this way and the engine remained serviceable for the remainder of the flying done during the tests, as well as the flight back to Brisbane.

(c) Engine Operation in Flight:

The original boost gauge was fitted in the cockpit and was used throughout the tests. It is calibrated in cm. of mercury above or below standard atmospheric pressure, its range being from -45 cm. to plus 25 cm.

The following ratings were observed:

<table>
<thead>
<tr>
<th>Boost</th>
<th>Engine Revs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Military rating (5 min.)</td>
<td>25 cm. 2500 39.8&quot;</td>
</tr>
<tr>
<td></td>
<td>15 cm. 2400 35.8&quot;</td>
</tr>
</tbody>
</table>

At full throttle position only plus 15 cm. of boost are available, boost control being automatic. If a control on the dash board is pulled out, a maximum of plus 25 cm. may be obtained. This is not a complete over-ride, as the boost is still automatically controlled and is limited under any condition of flight (including take-off), to plus 25 cm.

The two speed blower control is situated at the bottom of the throttle quadrant. To engage high blower the engine speed is reduced to 1500 r.p.m. and the lever smartly moved from the rear to the forward position on the quadrant.

The r.p.m. control is by means of a constant speed airscrew governor system, screwing being carried out by one unwanted. Although the engine operated at 2500 r.p.m. on the governor setting, the engine overspeeds up to 3000 r.p.m. in dives over 300 m.p.h., which indicates that the pitch range of the airscrew is insufficient.

The mixture control is by hand, one control being attached to the throttle quadrant and the other above and forward of it. Both these controls are situated...
on the port side of the cockpit. An exhaust gas temperature gauge is fitted, the temperature giving an indication of the mixture strength. At high powers the engine appeared to run best at about 670 deg. C. exhaust temperature. Up to 10,000 ft. the mixture control is not sensitive. As altitude increases the mixture has to be leaned first by means of the control in the throttle quadrant. At 25,000 ft. this lever is at the end of its movement, and so, above this altitude, the other control is used. The mixture control then becomes very sensitive, small alterations to the control making large alterations to the mixture strength, the resultant exhaust temperatures varying from under 500 deg. C. to 700 deg. C.

The engine becomes very rough when too rich above 25,000 ft. and if the control is moved a fraction too far towards the lean position it will cut, the total range of movement being of the order of 1/4" along the quadrant. If the mixture is set correctly at 30,000 ft. the engine is liable to cut if dived down to 28,000 ft. unless the mixture control is richened up.

The cowl gills and oil cooler shutter are mechanically operated with controls and indicators as shown in the cockpit views.

(d) The Operation of the Hydraulic System:

The flap and undercarriage are operated by the hydraulic system. Pressure is normally maintained by an engine driven pump. The landing gear and flap selector lever have three positions - up, neutral and down - the pressure being by-passed in each case in the neutral position.

To operate the flaps, however, the landing gear lever must be in either the up or down position. When not using the hydraulic system, it is important to return both levers to the neutral position to avoid overheating of the hydraulic fluid, which takes place very quickly.

All the controls are well within the reach of the pilot, and are shown in the photograph of the starboard side of the cockpit.

The undercarriage retracting cylinders are so small that the retraction is slow, it being facilitated by skidding the aircraft. The emergency hydraulic hand pump is situated on the starboard side of the cockpit floor, its handle being stowed on the starboard side of the instrument panel. In the event of its being inoperative the wheels may be released from the up position by pulling two cables located on the cockpit floor. It is most probable that the wheels could then be shaken down by skidding the aircraft.

The indicators for the wheel position consist of green, red and amber lights - these being one each for the main wheels and tail wheel, as well as mechanical indicators protruding from the upper surface of the mainplane for the landing wheels. The green light indicates that the respective wheels are locked down, while the red shows that they are locked up. The amber comes on when the wheels are neither up nor down.

There is a horn but this only serves to warn the pilot that he has not returned the landing gear selector lever to the neutral after retraction. The flap position is determined from a mechanical indicator on the starboard side of the cockpit.
Cockpit Lay-out:

Entry to the cockpit is from the port side of the fuselage.

The cockpit lay-out is quite satisfactory as regards ease of access and does not call for any undue reaching or bending. The rudder control with pedals fully extended is, however, too short even for a short Allied pilot. The seat is satisfactory and may be adjusted by a lever on the starboard side.

The canopy is easy to operate and can be locked in full open, closed, and several intermediate positions. It cannot be jettisoned.

The visibility is good with the canopy open and shut, both on the ground and in the air, and is not obstructed by cowling if opened.

Photographs of the cockpit are given in Figures 5, 6 and 7, and a key to the instruments is attached.

During the trials such instruments as were required for the performance tests were calibrated and fitted by R.A.A.F. The original Japanese instruments are calibrated in the metric system. Elevator trim is the only trim control fitted. A noteworthy feature is also the air inlet for cooling the fuel tanks, operating by means of shutters on the under side of the wing (the tanks are not self-sealing).

Oxygen and wireless equipment fitted were American. The Japanese controls are, however, still fitted.

HAP COCKPIT

Key to Photograph Item Numbers

**Port Side:**

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Air valves for cocking 20 m.m. cannon</td>
</tr>
<tr>
<td>0a</td>
<td>Gun selector switch on throttle</td>
</tr>
<tr>
<td>1</td>
<td>Fire extinguisher control</td>
</tr>
<tr>
<td>2</td>
<td>Elevator trim</td>
</tr>
<tr>
<td>3</td>
<td>Belly tank release</td>
</tr>
<tr>
<td>4</td>
<td>Elevator trim indicator</td>
</tr>
<tr>
<td>5</td>
<td>Throttle control</td>
</tr>
<tr>
<td>6</td>
<td>Mixture control</td>
</tr>
<tr>
<td>7</td>
<td>Pitch control</td>
</tr>
<tr>
<td>8</td>
<td>Blower control</td>
</tr>
<tr>
<td>9</td>
<td>Main switch panel</td>
</tr>
<tr>
<td>9a</td>
<td>Undercarriage warning lights</td>
</tr>
<tr>
<td>10</td>
<td>Cockpit lights</td>
</tr>
<tr>
<td>11</td>
<td>Voltmeter - ammeter</td>
</tr>
<tr>
<td>12</td>
<td>Air temperature gauge</td>
</tr>
<tr>
<td>13</td>
<td>Fuselage fuel gauge</td>
</tr>
<tr>
<td>14</td>
<td>Generator switch</td>
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<tr>
<td>15</td>
<td>Main wing tanks gauge</td>
</tr>
<tr>
<td>16</td>
<td>Wobble pump</td>
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<tr>
<td>17</td>
<td>Fuel tank selector for gauge No. 15</td>
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<tr>
<td>18a</td>
<td>Wing fuel tanks selector</td>
</tr>
<tr>
<td>18b</td>
<td>Fuselage and belly tank selector</td>
</tr>
<tr>
<td>19</td>
<td>Bomb release (used for tail wheel lock during trials)</td>
</tr>
</tbody>
</table>
Starboard Side:

20  Cockpit cool air vent
21  Wireless tuning (American)
22  Cockpit light
23  Japanese wireless control (not operating)
24  Flap indicator
25  Arrestor hook lowering control
26  Arrestor hook indicator
27  D/F loop control
28  Wireless control box (American)
29  Arrestor hook release
30  Pilot seat adjustment
31  Flap control
32  Undercarriage control
33  Emergency hydraulic pump
34  Emergency Undercarriage release
35  Wing tank cooler indicator
36  Wing tank cooler control
37  Cockpit fresh air control
38  Cowl Gill control

Cockpit Front:

40  7.7 Machine Gun
41  7.7 Machine Gun cocking handle
42  Accelerometer (not standard fitting)
43  Ring and bead sight
44  Reflector Sight
45  Rheostat for reflector sight
46  Artificial Horizon
48  Locking Device for Artificial Horizon
47  Turn and Bank indicator
48  Magnetic Compass
49  Rate of Climb Indicator
50  Oil Pressure Gauge
51  Fuel Pressure Gauge
52  Revolution Counter
53  Cylinder temperature Gauge
54  Oil temperature Gauge
55  Boost Gauge
56  Oil Shutter Indicator
57  Oil Shutter Control
58  Booster Coil Switch
59  Oxygen Regulator
60  Control Column
61  Brake Pedal
62  Fore and aft Level
63  Priming Pump
64  Radio Compass Indicator
65  Ignition Switches
66  Altimeter
67  Exhaust temperature gauge
68  Clock
69  Airspeed Indicator
70  Mixture Control and Idle Cut Off
Cad No. 7 Cockpit Front with Instrument Panel.
3 Ground Handling:

Repeated efforts were made in the early stages of flight tests to obtain satisfactory brake operation. All attempts failed, and from the experience gained it is felt that the brakes on this type of aircraft are normally most ineffective. In view of this, ground handling tests were not carried out. Taxying was only done with the aid of ground staff at the tail of the aircraft, as the rudder gives insufficient control for taxiing without brakes.

There is no tail wheel lock, but one was fitted in view of the unserviceability of the wheel brakes, in order to aid the pilot to keep straight in take off and landing.

The cowl gills are opened for ground running, but may be kept closed under all flying conditions, and in take off.

4 Behaviour During Take-Off:

The take off is carried out without flaps. There is a tendency, during the first three or four seconds, to swing to port against full right rudder if full military power is applied rapidly. This swing is only small, and is not sufficient to swing the aircraft off a normal runway. At lower powers there is ample rudder control. The tail rises early in the run and the aircraft unsticks at 80-85 m.p.h. A.S.I. After raising the undercarriage, which retracts very slowly, the best climbing speed of 140 m.p.h. A.S.I. is quickly obtained and right rudder is required to keep the aircraft properly trimmed, as there is no rudder trim adjustment in the cockpit. For extended climbs at high power this is slightly tiring.

Take-offs and climbs were carried out with cowl gills closed, the cooling of the engine being excellent.

5 Behaviour During Approach and Landing:

The undercarriage is lowered at speeds not exceeding 130 m.p.h. A.S.I. and makes the aircraft slightly nose heavy. This can be trimmed out, but is not necessary as lowering the flaps makes the aircraft tail heavy. These two effects balance each other. The most comfortable approach speed is 95-100 m.p.h. A.S.I., with very little power on.

All landings in this aircraft have been tail up in order to maintain good rudder control after touching down, but three point landings should be quite simple to carry out. After touch-down the aircraft rides hard during the remainder of the landing run.

6 Longitudinal Control:

The elevator control is fairly responsive and light above 95-100 m.p.h. A.S.I. At lower speeds the elevator control becomes less satisfactory and near the stall has little power. As the speed increases the elevators become progressively heavier.
At 200 m.p.h. A.S.I., it is estimated that 75-100 lb. stick force is required to obtain 4G., with a considerable increase in elevator heaviness as the speed approaches 300 m.p.h. A.S.I. Use of the trimming tab is of some assistance, but it is stiff and not particularly convenient to use. Above 16,000 ft. in general, but depending on temperature conditions, the trim became frozen solid and could not be used for manoeuvring.

In cruising flight the aircraft may be trimmed hands off and appears quite stable.

3.7 Directional Control:

The rudder control is ample for all normal flying conditions as already mentioned under take off. On high power slow speed climbs, right rudder pressure is required, there being no rudder trim adjusting device in the cockpit. In dives up to 350 m.p.h. A.S.I. slight left rudder pressure was required, but if flown feet off at this speed only slight skidding resulted.

3.8 Aileron Control:

The aileron control at speeds from the stall to about 140 m.p.h. A.S.I. is light and responsive and good rolls can be executed at 140 m.p.h. At speeds above 140 m.p.h., the ailerons become rapidly heavier until at 300 m.p.h., the stick forces are very great and only very slow rolls can be executed. At high speeds only small stick displacements are possible. There is not much difference in the stick force or rate of roll to the right or left, although rolls to the left at low speeds appear slightly better. There is no aileron trimming mechanism.

A peculiarity was noted on climbs or flying above 27,000 ft. The ailerons started to stiffen up even at slow speeds, and at 35,000 ft. they were virtually frozen solid. On a subsequent climb the controls were, however, kept fairly free up to 33,000 ft. by continually moving the control, but even then the ailerons became quite stiff to operate. The reason for these low temperature effects is not known.

An automatic photo-observer was fitted which measured degrees of roll and time. Stick movement, stick forces and aileron deflections were not recorded, as there was insufficient time to install the necessary equipment. The rates of roll are presented graphically on Figure No.8.
FIG. No 8

RATES OF ROLL

DATE 16.10.43

D.T.S.
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T.S.7

NOTE:
- H.A.P. Rates of Roll bull diagram below 150 M.P.H. wind with 50 lb. Stick Force
- Tomahawk & Spitfire Rates of Roll for 30 lb. Stick Force or full ailerons

Archives of M. Williams
Control at the Stall:

<table>
<thead>
<tr>
<th>Test No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine</td>
<td>off</td>
<td>off</td>
<td>On 18&quot; Boost, 2200 r.p.m.</td>
</tr>
<tr>
<td>Flaps &amp; U'carriage</td>
<td>up</td>
<td>Down</td>
<td>Down</td>
</tr>
</tbody>
</table>

The aircraft was trimmed to fly "hands off" at 175 m.p.h. A.S.I. and the stick pulled slowly back, keeping the aircraft on an even keel until the stall occurred.

Stall Warning: In all cases buffeting commences 6-10 m.p.h. above stalling speed, and as the speed decreases there is a noticeable falling off of effectiveness of the elevator control.

### Stalling Speed mph. A.S.I.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>83</td>
<td>78</td>
<td>65-70</td>
</tr>
</tbody>
</table>

### Stick Position

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hard back</td>
<td>Hard back</td>
<td>Hard back</td>
</tr>
</tbody>
</table>

### Stick Force lbs.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10-15</td>
<td>10-15</td>
<td>10-15</td>
</tr>
</tbody>
</table>

### Altitude at Stall

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nose slightly above horizon</td>
<td>Nose initially slightly above horizon</td>
<td>Nose slightly higher</td>
</tr>
</tbody>
</table>

### Aileron effectiveness at stall

The ailerons become sloppy at the stall, but remain positive throughout.

### Behaviour at Stall

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>With stick hard back the aircraft remains stalled without any tendency for either nose or wing to drop, airspeed remaining at 83 mph stick hard A.S.I. There is considerable buffetting over the speed alteration.</td>
<td>As in the previous case, there is no tendency to drop a wing, but the nose drops and with the elevator in this condition back the aircraft seesaws</td>
<td>As the stall occurs left wing and nose drop, but there is no tendency for the aircraft to spin or to go on to its back</td>
</tr>
</tbody>
</table>

### Recovery

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Recovery is very easy and is effected with a height loss of not more than 200-ft. by pushing the stick slightly forward.</td>
<td></td>
<td>Recovery is effected easily in less than 600 ft., stick forward.</td>
</tr>
</tbody>
</table>

### Spinning tendency

There is no spinning tendency at any time during the stall.
3.10 Aerobatics:

All aerobatics can be carried out and are quite normal. They can be performed at much lower speeds than on comparable allied aircraft. Upward rolls at 160 m.p.h. A.S.I., loops 200 m.p.h. A.S.I., and rolls off the top at 210 m.p.h. A.S.I.; loops at 200 m.p.h. can be performed quite easily with 26" manifold pressure and 2300 r.p.m. Throughout these comparatively low speed aerobatics the controls are noticeably positive in their effect.

References:

2. C.S.I.R., Division of Aeronautics Report No.3.27
3. R.A.A.F. H.Q., D.T.S., T.S.7 "Examination of Type "0" S.S.P. Mk.II.
4. De Havilland Propeller Division, Report No.21 (Ex.109/15 R)
# APPENDIX

## DRAG ANALYSIS OF 'HAP'

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DRAG DETAILS</th>
<th>DRAG LBS. @ 100ft./Sec.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wing</td>
<td>Profile</td>
<td>21.2</td>
</tr>
<tr>
<td></td>
<td>(L.E. transition)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Surface Roughness</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>Gaps, etc.</td>
<td>.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuselage</td>
<td>Profile</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>(L.E. transition)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Surface Roughness</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Cabin</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Empennage</td>
<td>Profile</td>
<td>5.8</td>
</tr>
<tr>
<td></td>
<td>Control Gaps</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>Interference</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>Pilot, Lights,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Antenna</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>Guns</td>
<td>.2</td>
</tr>
<tr>
<td></td>
<td>Leak Drag</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Plant</td>
<td>Cooling and</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>Leak Drag</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cooler</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total D100 (extra to induced drag at 100 ft. per sec.)</td>
<td>58</td>
<td></td>
</tr>
</tbody>
</table>

Engine assumed to develop 1020 HP at 16,600 ft; measured speed 328 m.p.h., weight 5,550-lb., air-screw efficiency = 83%. (assumed)
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