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Production Div. Wright Fd

HEADQUARTERS
TWENTY THIRD FIGHTER GROUP
Office of the Commanding Officer

A.P.O. 627
New York, N.Y.
6 February 1943.

SUBJECT: General Technical Data and Flight Characteristics of the Japanese Zero Fighter Airplane.

TO: Commanding General, China Air Task Force.

1. Subject airplane is a type Zero Mark I, Carrier Fighter, Japanese No. P 5016. All tests were conducted by the undersigned, and such conclusions and remarks contained herein regarding performance as do not involve mathematical rates or measures are the opinion of this officer.

2. All tests were carried out at Kunming, China, and comparative performance with P-40K and P-43A1 aircraft was tabulated. Inasmuch as the elevation of the Kunming airdrome is above 5000 feet, the minimum altitude at which performance tests were run was 10000 feet.

3. Inasmuch as subject airplane is being flown to India this date, and numerous photographs have already been forwarded, technical data given is brief and of a general nature. Proper facilities do not exist at this station for complete disassembly and inspection of parts, or for testing of materials. No dimensions are given as these are already known and have been published by the Air Forces Intelligence Service.

4. GENERAL TECHNICAL DATA

a. The Japanese Navy Zero airplane is a low wing, single radial engine, single seat, all metal, flush riveted monoplane of very light construction. The fuselage is of semi-mono-coque design. The thickness of wing and fuselage skin covering is .02", and is unstressed. The landing gear is fully retractable. The weight of the airplane, fully serviced, with belly tank installed, is approximately 5600 pounds.

b. Engine: The engine is a 14 cylinder, twin row radial of almost identical design to our own Pratt & Whitney R-1535 series, and is tightly cowled. Accessories and accessory drive are similar to our own engine, the chief differences being in the oil cooler design and the float type carburetor. This engine, contrary to opinion and data expressed elsewhere, will not develop 900 H.P. nor is its altitude performance superior to our own standard fighter craft engines of single stage, single speed, mechanically driven blowers. This engine at full throttle and full r.p.m. with the aid of 160 indicated mph of ram,

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will hold zero boost only to 16000 feet indicated. Our own P-40K Allison V-1710-73 will, at 3000 rpm, hold zero boost, with benefit of 230 indicated m.p.h. of ram, to 22000 feet indicated. However, it is believed that the propeller on this particular Zero airplane is not set to permit maximum allowable r.p.m. (maximum obtainable r.p.m. was 2075).

c. Fuel System: The fuel system consists of two wing tanks of 55 gallons capacity each, one fuselage tank mounted ahead of the instrument panel of 37 gallons capacity, and one non-streamlined detachable belly tank of 88 gallons capacity (total fuel capacity 235 U.S. gallons). All tanks are non-bullet proof. A motor driven fuel pump of similar design to our own furnishes fuel to the carburetor at a pressure of .35 Kg/cm^2. This is believed to be normal pressure; the pressure increases markedly with positive acceleration forces on the airplane. A wobble pump of similar design to our own supplements the motor driven pump. Two fuel cocks control the selection of tanks (the forward cock is shown in the lower left hand corner of attached cockpit picture, just aft of the two fuel gages). One cock controls selection between the belly and fuselage tanks; its third position is "off". The other cock controls selection between the two wing tanks; its four positions are: "left wing, right wing, both and off". The systems controlled by the two cocks are in parallel, but should not be used simultaneously as fuel will drain from the higher fuselage tank to the lower wing tanks when the two systems are inter-connected. Thus, if such draining fills the wing tanks, the action will continue with fuel running thru the wing tank overflows until the fuselage tank is completely drained. 91 octane fuel was used in the conduct of all tests, and at full throttle at 10000 feet no detonation was experienced. This indicates that timing was probably slow, inasmuch as engine is reportedly designed to operate on 100 octane fuel; normal performance probably was still further reduced thereby.

d. Landing Gear: The landing gear is retractable and of the conventional full cantilever, laterally braced type. The gear retracts inboard and forms a flush, integral surface with the fuselage. The landing gear lock is of a mechanical finger and recession. The finger, however, abuts against the recession at approximately a 20° angle off of a dead center position. The plate containing the lock recession is an integral part of the strut itself, hence the locking device bears a 20 degree component of the entire lateral forces on the gear, reduced by the ratio of lever arms about the main hinge point of the strut. The main wheels are small and there is little clearance between wheels and wheel cowling. The struts are of conventional, telescoping oleo type. The gear is hydraulically actuated. The tail wheel is four inches in diameter and mounts a hard rubber tire. It is fully retractable normally, but on this plane has been slightly damaged so that it does not fully retract. A landing hook, raised and lowered by a lever on the right side of the cockpit, is mounted just ahead of the tail wheel.

e. Propeller: The propeller is a three aluminum blade, hydraulically operated, constant speed type.

f. Engine Accessories:

(1) Boost control. An automatic boost control is provided. A selector lever is provided in order that this control may be thrown in or out of operation as desired. Details of construction and operation of the boost control are unknown.

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(2) Mixture control. Two mixture control devices are provided. One is automatic for all normal operation. The other is a manually operated control for leaning the idling mixture - this is operated whenever the engine tends to load up during prolonged periods of idling.

(3) Carburetor. The carburetor is a double barrelled, float type. No idle cut-off device is incorporated.

(4) Oil Cooler. The oil cooler is mounted below the engine and is fed thru a duct in the ring cowling, with a butterfly valve shutter mounted in its throat. The cooler consists of a coil of copper tubing.

(5) Other engine accessories are very similar to our own conventional designs.

g. Hydraulic System: The hydraulic system operates the landing gear and flaps. It is very similar to that of our own P-43 aircraft, and its normal operating pressure is about 750 pounds per square inch. The motor driven hydraulic pump is not disengageable and supplies continuous pressure to the system. A hand operated pump is provided similar to our own two stroke, piston-type pumps. The wheel system and flap system are in parallel and common selector levers are provided for both systems exactly as in the P-43. In this particular airplane the motor driven pump rotor has been removed for safety (the hose connections of the hydraulic system are slightly deteriorated) and all operations are accomplished with the hand pump.

h. Controls: All air control surfaces, linkages, and operating devices are conventional. Ailerons and elevators are of very small area and the tail must be held down at all warm up speeds in excess of 1500 r.p.m. Stabilizer skin protrudes as a flap to make a flush joint with rudder and elevator surfaces. Tab control is provided for elevator control surfaces only. The stick is conventional and contains no actuating levers or buttons. Gun trigger and selector levers are mounted on the throttle control. The rudder is controlled by a solid bar instead of individual pedals. Brakes are convewntional hydraulic and are toe operated. All engine, propeller, and accessory controls are conventional and conventionally located.

i. Armor: This airplane contains no armor, bullet proof glass, bullet proof fuel tanks, or any other kind of protection.

j. Armament: The armament consists of two manually charged 30 caliber, synchromized machine guns firing thru the propeller above the propeller axis, and two twenty mm. cannon, one mounted in each wing just outboard of the propeller arc. Rates of fire are unknown. The wing guns are charged by compressed air from a cylinder reservóir. Ammunition and magazines for the guns have been forwarded under separate cover to the Commanding General, 10th U.S. Air Force. Details of gun operation and ammunition are unknown.

k. Radio: No radio equipment was obtained with this airplane.

l. Oxygen Equipment: Oxygen equipment has been forwarded under separate cover. The undersigned did not see this equipment.

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M. Instruments and Cockpit Controls: The following instruments and cockpit controls are indicated in the accompanying cockpit photograph.

(1) Artificial horizon - similar to our own.

(2) Bank and turn - similar to our own.

(3) Air speed indicator - one of our own was installed in this plane.

(4) Rate of climb indicator - similar to our own. Graduated in hundreds of meters per second.

(5) Oil and fuel pressure gages - Graduated in Kg/cm^2.

(6) Tachometer - Graduated in hundreds of r.p.m.

(7) Altimeter - Graduated in hundreds of meters.

(8) Cylinder head temperature - One of our own is installed in this plane.

(9) Oil temperature gage - Graduated in degrees centigrade.

(10) Manifold pressure gage - graduated in centimeters of mercury above and below standard atmospheric (standard atmospheric pressure is designated as zero boost on the gage).

(11) Inclinometer - Mercury column indicates climbing or diving altitude of airplane in degrees. Normal altitude of zero degrees is assumed by airplane at about 190 m.p.h. indicated in level flight at 4000 meters altitude.

(12) Fuel gages - These gages are of the liquidometer type and must be energized by pulling out the small button adjacent to gage and releasing. After energizing, the gages read accurately in level flight for about 15 seconds. The gages are graduated in liters.

(13) Compass - Conventional floating card type with adjustable, course-setting, planar compass rose mounted around periphery of compass bowl. Correction card is mounted underneath.

(14) Oil cooler flap control.

(15) Cowl flap control.

(16) Engine primer.

(17) Ignition switch.

(18) Booster coil control button.

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(19) Propeller contol lever (full rear position gives high r.p.m.).

(20) Mixture control - Use of this control is not fully understood, as in the rear position of this lever, mixture control is automatic. Movement of the lever to any forward position at any altitude causes no perceptible change in engine operation.

(21) Throttle lever with gun selector and actuating controls mounted thereon - Wing or synchronized guns may be separately fired, or all may be fired simultaneously.

(22) Idling mixture control - This lever is spring loaded with normal position to the rear. Pushing the lever forward leans the idling mixture and prevents fouling of the engine during engine warm up. Apparantly there is no thermostatically controlled by-pass around the oil cooler, for it requires about five minutes for the oil to warm up sufficiently for take off (at an air temperature of 50° F).

(23) Fuel wobble pump lever.

(24) Selector button for engaging automatic boost control.

n. Miscellaneous:

(1) Primer - An engine primer supplies fuel to three cylinders for starting.

(2) Magneto - Ignition is furnished by a magneto very similar to our own. A magneto booster coil, actuated by a button just above the ignition switch, is used for starting.

(3) Cowl Flaps - Cowl flaps similar in construction and purpose to our own radial engine cowl flaps are operated by a hand crank on the forward right hand side of the cockpit.

(4) Belly Tanks - The belly tank is of excellent construction and is secured to the fuselage beneath the airplane with one connection. It is released by a handle on the left side of the cockpit.

(5) Foot Guards - A foot guard is provided on each rudder pedal (see cockpit picture) - thus if the pilot loses the use of one leg he can still actuate the rudder.

(6) Canopy - The canopy is of the standard sliding type with stud and slot type lock. Various slots along the canopy track afford different positions of opening for the canopy. There is no emergency release.

5. The materials used in the Zero airplane are of excellent quality. Generally, the workmanship of both airplane and power plant is rather mediocre. The most notable feature of the construction of this airplane is its utter lack of sectionalization. Any damage inflicted necessitates a major depot overhaul for repair.

6. **PERFORMANCE:**

a. High speed tests were as follows:

ALTITUDE	10000'	15000'	20000'	25000'
INDICATED SPEED	238 m.p.h.	219 m.p.h.	190 m.p.h.	171 m.p.h.
TRUE AIR SPEED	286 m.p.h.	289 m.p.h.	270 m.p.h.	265 m.p.h.
R.P.M.	2050	2050	2050	2950
MANIFOLD PRESSURE	+12 cm. Hg.	+2cm. H.g.	-8 cm. Hg.	-13 cm. Hg.
CYLINDER HEAD TEMP.	225° C.	228° C.	226° C.	225° C.
OIL TEMPERATURE	55° C.	55° C.	55° C.	55° C.
OIL PRESSURE	5 Kg./cm.^{2}	5 Kg./cm^2	5 Kg./cm^2	4.8 Kg./cm^2
FUEL PRESSURE	0.42 Kg./cm^2	0.4 Kg./cm^2	0.4 Kg./cm^2	0.38 Kg./cm^2

Notes: 1. All of above performances were run at full throttle and maximum r.p.m. propeller setting.

2. It is believed that oil temperature gage was inaccurate.

3. True air speed was computed by estimating temperature at the various altitudes. A free air temperature gage was not available.

b. Maximum climb tests were as follows:

ALTITUDE	10000-15000	15000-20000	20000-25000
AVERAGE INDICATED AIR SPEED	130	125	118
AVERAGE RATE OF CLIMB	2690 Ft./S	2410 Ft./S	1785 Ft./S

c. Estmated normal cruising at 12000 feet indicated is 1700 r.p.m. and -7 cm. Hg. boost. The power output under these conditions is unknown; the indicated air speed was 197 mph, or a true air speed of approximately 245 mph. Fuel consumption under these conditions was 37 gallons per hour. Fuel consumption at other power output conditions was not tested due to limited time and a very limited supply of fuel.

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d. Airplane stalls as follows:

	FLAPS UP	**FLAPS DOWN**
POWER ON	62	53
POWER OFF	70	59

Ceiling tests were not conducted on account of lack of proper oxygen equipment.

7. RELATIVE PERFORMANCE WITH P-40K AND P-43 A-1 AIRCRAFT:

a. Climb - The Zero airplane maintains a higher rate of climb than the P-40K-1 at all altitudes in excess of 10000 feet. However, it is believed that below 5000 feet, the P-40K-1 would climb faster. The P-43 A-1 will maintain a higher rate of climb than the Zero at any altitude above 12,500 feet. In climb tests with this airplane, the P-43 was operated at 2500 r.p.m. and 42" Hg., and with this output did not achieve the advantage in climb until 12,500 feet was reached. However, with maximum allowable output of the P-43 engine (2700 r.p.m. and 48.5 in. Hg.) it is believed this airplane would outclimb the Zero at any altitude. The P-43 was not operated at maximum engine performance on account of the extreme importance of conservation of equipment in this theatre.

b. High speed and acceleration - Both the P-40K-1 and the P-43A-1 are considerably faster than the Zero at any altitude. Accelaration tests were run at 13000 feet indicated with the following results:

(1) P-40K-1 vs Zero. Airplanes were flown side by side at 200 m.p.h. indicated. On signal, both engines were given full throttle and full r.p.m. For seven seconds the two planes accelarated equally, at which time the P-40 began to pull away very rapidly. Twelve seconds after acceleration signal was given, the differential speed was estimated as ten m.p.h.

(2) P-43 A-1 vs. Zero. The same test was performed as with the P-40K-1, but at an initial speed of 190 m.p.h. indicated. After signal was given, Zero gained about one quarter plane length on the P-43, after which P-43 pulled away, but not as rapidly as the P-40. Again the P-43 was operated at 42 in. Hg. and 2500 r.p.m. - as compared to 3000 r.p.m. and 41 in. Hg. with the P-40.

c. Individual combat - Several dog fights were carried out with both the P-40K-1 and P-43A-1, using various tactics. The Zero is, of course, vastly superior in maneuverability. It was found that the P-40, can, however, effectively fight the Zero without necessarily diving away. This is accomplished by proceeding away from the Zero on initial pass at high speed until approximately one and one half miles away, at which time a maximum turn is begun back into the path of the pursuing Zero. This turn can be completed just in time for the P-40 to pass thru the path of the Zero and barely miss a collision. If the Zero does not dodge from his own attack, the P-40 can fire a very effective head on burst in this manner. Of course, the Zero can take evasive action, but he cannot maneuver into such a position as to get effective fire into the P-40 without also getting return fire.

With the P-43, the same tactics can be used, but head on runs are not advisable with this airplane due to lack of both fire power and protection. It is believed that the best tactics for engaging the Zero in individual combat with the P-43 is to climb away from the Zero and attempt to gain an advantageous position for a diving attack. The P-43 has a slight advantage in rate of climb, as before mentioned, and has a considerably higher best climbing speed.

It is advised never to engage in a turning flight with the Zero with either a P-40 or P-43 type airplane - but the above tactics may be effectively used provided the combat involves only two single airplanes.

8. FLYING CHARACTERISTICS:

a. Maneuverability - The Zero is very maneuverable. It will turn a little shorter than our own P-36A, but is slightly slower than this airplane and has a lower rate of climb. At altitudes below 12000 feet, the P-36A has a much better rate of climb and is almost as maneuverable.

b. Dives - The highest speed attained in diving was 300 m.p.h. indicated. Above 200 m.p.h., the Zero becomes increasingly hard to maneuver, and at 300 m.p.h. requires a great deal of force on the controls for even a gentle turn. At these speeds, the airplane is very stable, and especially so about the longitudinal axis. It has no tendency whatever to roll in a dive, and at 300 m.p.h. it is practically impossible to make it roll. Above 275 mp.h. indicated the P-40 will out maneuver the Zero - thus a Zero airplane pursuing one of our own airplanes in a dive is completely at the mercy of any following P40's or similar pursuit aircraft. This probably explains why they rarely if ever follow our own aircraft in even a shallow dive where they could keep up for a short while.

c. Stalls - The Zero stalls very smoothly, even in tight turns. It has no tendency to whip on stalling, nor does it have any "squashing" tendencies like the P-26. At speeds above about 200 m.p.h. indicated, it is believed impossible to exert enough pressure on the elevators to cause the airplane to stall. This was not actually tried, however, for fear of a structural failure.

d. Landing - The airplane glides at 85 m.p.h with flaps down and lands at about 65. It is very easy to land and has no ground looping tendencies whatever. The tail wheel is non-steer-able and non-lockable.

e. Generally, the Zero is a very simple and easy airplane to operate. It has a high power loading and is consequently easy to get out of "tight spots" of difficult situations. It is structurally very weak, however, and must be handled with respect. It would be very foolish to attempt a forced landing with the Zero in any but very smooth terrain.

9. REMARKS:

a. Visibility is very poor directly ahead and down. Otherwise, visibility is good.

b. Best engine warm-up speed is 900-950 r.p.m.

c. The engine will not run under any conditions of negative acceleration, inverted, or in a steep skid. A Zero is unable to follow any airplane which does a sharp pushover unless it rolls and it cannot roll at high speed.

d. The Zero is manufactured of excellent materials, but it exhibits mediocre workmanship throughout.

10. A more detailed technical report will be submitted on this airplane in the near future.

B. K. HOLLOWAY
Lt. Col., Air Corps
Commanding.

1 Incl:
Cockpit Photograph.