ARMY AIR FORCES 9 pages

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AIR MATERIEL COMMAND TSFPE/AM/rah/26275

MEMORANDUM REPORT ON
Frank I, T-2, Serial No. 302

Date 16 July 1946

SUBJECT: Pilot's Comments and Handling Characteristics of Frank I

OFFICE TSFOF Contract or Order No.

SERIAL No. TSFTE-2001 Expenditure Order No.

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Capt USAF

A. PURPOSE

To forward Pilot's Comments on cockpit layout and handling characteristics on the above aircraft.

B. FACTUAL DATA

1. Introduction

The Frank I is a single-place, single-engine, low wing, Japanese Army fighter with hydraulically retracted alighting gear and a glass enclosed sliding greenhouse type canopy. All metal stressed skin construction is used throughout, with the exception of the fabric covered movable control surfaces.

Power is supplied by a Nakajima HA-45 Homare Model 21, twin row, radial, air-cooled, 18 cylinder engine developing 1970 brake horsepower at sea level with 3,000 RPM and 49.6" Hg.

The propeller is a four bladed, constant speed, non-feathering, automatic or manually operated model, similar to the United States Curtiss Electric Type.

A total of 11 1/2 hours was flown on the aircraft by Flight Test pilots, to determine its handling characteristics and to obtain pilot's comments.

The program was hampered by repeated failures of the exhaust stacks due to poor material, welding and method of suspension.

In general the pilots agree that the maneuverability of the Frank I is slightly inferior to that of the Zeke 52, while level flight speeds are much higher with less vibration at comparable velocities. Control forces are lighter than those of most American aircraft even though elevator forces on the Frank I are heavier than those of the Zeke 52.

2. Weight and C. G. Information

Flights were made with a take-off gross weight of 7900 pounds with C. G. position 84.6" aft of reference datum (rear of propeller spinner).

3. Flight Characteristics

a. Cockpit Layout

Entrance to the cockpit is from the left wing root walkway and is facilitated by presence of a retractable step and a push-in type hand hold at the wing trailing edge and a retractable step just below the cockpit opening. The location of the steps is well planned and makes for much easier entry than comparable American types.

The stamped metal pilot's seat is adjustable vertically by means of a handle on its left side. Adjustment in the lower position of its travel is poor due to the failure of the lock pin to engage and occasionally causes annoying shifting of the seat with changes in "G" forces.

Present installation of American shoulder harness is unsatisfactory and affords no protection whatsoever, as no stress member over which to pass the straps has been installed in the event of crash landing. In event of accident involving longitudinal deceleration, sheet metal back of seat would fail allowing pilot's head to strike gunsight or instrument panel.

In general the layout of the cockpit is good, using conventional methods of control installation and operation procedure. Flap and gear controls are on the left cockpit floor. Elevator trim wheel and engine control quadrant are on the left cockpit side. No flight adjustable aileron or rudder trim is installed.

Instrument panel layout is good with logical placement of flight instruments in the upper center position and engine instruments in the lower portion.

The auxiliary electrical panel and ignition boost control containing circuit breakers is in the right forward part of the cockpit below the instrument panel.

Internal and external fuel selector valves, fuel cooler and primer controls are on the right cockpit floor.

Cowl and oil cooler flap controls are on the upper right cockpit side with the radio equipment.

Auxiliary hydraulic pump is on the right rear cockpit side and the mechanical up-lock release is on the left side of the cockpit floor.

The original instruments function well and appear to be reliable with the exceptions listed below:

1. The gyro turn indicator appears to be binding inasmuch as 1/3 needle width right or left is the maximum indication obtainable under any attitude or rate of turn.

2. The caging knob is missing or has been omitted from the artificial horizon making it impossible to cage the instrument for aerobatics or to erect the gyro after it has been upset. After upset, no gyro erection tendency was apparent in five minutes of level flight.

3. The left liquidometer reads consistently lower than the right, even though the fuel tanks theoretically feed evenly.

4. Flight controls consist of a stick and a bar type rudder. Control friction is nominal on the ground with no binding or roughness present; however, interference is present between the automatic mixture control and the stick when attempting to apply full left aileron when the mixture control is set for "normal". The rudder bar is adjustable fore and aft, but still too close to the seat for larger than normal American pilots.

5. Installation of Detrola is unsatisfactory as it blocks view of the Demand Oxygen Panel, is practically impossible to tune and leaves insufficient shoulder and arm room for operation of stick.

6. The canopy is barely large enough and has no provisions for jettisoning.

b. <u>Taxiing and Ground Handling</u>

The Frank I handles rather poorly in taxiing due to inadequate brake action and the condition is aggravated by the inferior design of the rudder bar and toe brake assembly. Use of the brakes is mandatory for "s" - ing to obtain forward vision. At the same time use of brakes must be limited as much as possible to prevent overheating and subsequent locking. The tail wheel lock with its slight swivel is a definite aid in cross-wind taxiing.

c. Take-Off and Initial Climb

The take-off characteristics of this aircraft are good, with a comparatively short ground run and negligible torque effect if rated power is applied gradually. If power is blasted on full right rudder and some brake is necessary to counteract the pull to the left. Other than this, directional control is easy to maintain. Three-point take-offs may be safely executed at 95 mph I.A.S. with normal rated power or above. Initial air acceleration is normal with rate of climb becoming very good upon retraction of landing gear. At 150 mph I.A.S. an estimated four seconds is required for gear retraction and causes very little flight longitudinal trim change.

d. Climbs

It is apparent that the rate of climb of the Frank I is very good although no performance climbs were attempted due to flying time restrictions.

e. Handling and Control at Various Speeds

In general the handling and control characteristics of the aircraft are definitely superior to comparable American fighters, especially in the low-speed range; however, rate of roll and radius of turn are slightly inferior to those of the Zeke 52. Control feel is good, rudder and aileron forces are light, well correlated and produce quick positive changes of attitude. Elevator forces, although heavier than those for the rudder and aileron, are not objectionable and progress with "G" forces with no apparent lightening. No flat spots or control reversal tendencies were noticed over an I.A.S. range of from 74 to 350 mph I.A.S. The rudder control is extremely sensitive to 300 mph I.A.S. slightly less sensitive above this speed with little change in directional trim from 150 to 350 mph I.A.S.

f. Trim and Stability

Flight adjustable trim is provided for the elevators only. The trim control works easily but excessive play in the cockpit end of the device makes initial pre-setting of the tab difficult. Very little trim change is necessary throughout the level flight speed range of the aircraft. Only slight longitudinal trim changes occur with operation of the gear and flaps. Aileron and rudder trim appear to be unnecessary after initial rigging adjustments are accomplished. As flown, the Frank I had too much right rudder trim and attendant right wing heaviness which handicapped evaluation of stall and handling characteristics.

From pilot observations alone the stability of the aircraft appears to be very satisfactory. Yaw tests indicate some lateral oscillations, although not of a serious nature.

(Rudder trim would improve Frank as a gun platform).

g. Stalls and Stall Warning

The stalling characteristics of the Frank I are normal and stall warning occurs soon enough to prevent stall if recovery procedure is instituted at the time of the warning.

The following results were obtained from stalls with the configurations as shown:

Power Off - Wheels and flaps up, cowl flaps and canopy closed, 8,000' PA, 2200 RPM throttle closed straight stall.

Stall warning consisting of shudder and elevator buffet occurred at 108 mph I.A.S. - actual stall at 102 mph. Stall is clean and aircraft is stable with negligible tendency to drop off on a wing. Aileron and rudder are effective well below stall speed.

Power Off - Wheels and flaps down, cowl flaps and canopy closed, oil cooler shutters open, 8,500' PA, 2200 RPM, throttle closed, straight stall.

Stall warning, occasionally accompanied by severe canopy buffet, occurs at 92 mph I.A.S. Actual stall at 90 mph I.A.S. Nose drops straight through with no unstable teniencies.

Power On - Wheels and Flaps down, cowl flaps and canopy closed, 8,000' PA, 2200 RPM, 20 MM Hg. Aircraft does not stall in this configuration. Rudder does not stall but becomes inadequate below 81 mph I.A.S. At this speed heading may be maintained by use of full right rudder and right aileron. Aileron becomes inadequate for maintaining altitude below 74 mph I.A.S. Aircraft yaws left and rolls left below 74 mph I.A.S. Control may be regained by increasing airspeed and decreasing power slightly. With M.P. decreased to 20 mm hg the aircraft will stall. The warning occurs at 81 mph and the actual stall accompanied by dropping of the left wing at 79 mph I.A.S.

Turning Stalls - Power on, Wheels and Flaps up, cowl flaps and canopy closed 8,000' PA 2200 RPM 20 mm hg. 60° bank, 3 "G" estimated. Left and right turns, elevator buffet below 160 mph I.A.S. becoming more severe as I.A.S. is decreased. Turn discontinued at 130 mph due to severe elevator buffet and out of trim adjustment of the rudder tab.

h. **Maneuverability and Aerobatics**

The aircraft was found to be quite maneuverable with rate of roll and radius of turn slightly inferior to the Zeke 52. Handling of aircraft in loops and slow rolls is very good although well coordinated maneuvers are difficult due to the lack of flight adjustable rudder and aileron trim.

j. **Changes in Trim when Operating Landing Gear, Flaps, etc.**

Normal changes are apparent, ie, nose down when lowering gear and flaps, nose up when retracting. Right rudder required in power on climb, left rudder in dive. Considerable travel in control position is required for various configurations with little change in control pressure.

k. **Noise and Vibration**

The noise level is normal for propeller driven types with radial engines without exhaust collector rings. The vibration level is definitely lower than that of the Zeke 52 especially at high speed and is nearly comparable to American types. Flight check disclosed high frequency vibration of engine transmitted to aircraft from 2,000 to 3,000 RPM and the level is nearly constant over this range.

l. **Comfort**

The cockpit is comfortable on the ground during warm weather operation only if the canopy is fully open. Cockpit heat level and ventilation volume is good for warm weather operation at low and medium altitudes. Cold weather operation is expected to be very uncomfortable due to the lack of cockpit heat.

The seat is comfortable enough for flights of the duration for which the aircraft was designed. Design of the seat and lack of rudder pedal adjustment would cause discomfort during extended operations.

m. **Vision**

Combat vision is excellent for greenhouse type canopies except, where blocked by the nose forward and the wings and fuselage below. This arrangement necessitates "S" - ing on the ground, gentle turns while climbing and formation flying in a slightly stacked down position with cross coverage for the blind spots below.

n. **Approach and Landing**

The aircraft handles very well on approach and landing. No undesirable air characteristics or ground looping tendencies were disclosed. After extension of the gear below 160 mph and full flaps at 130 mph - the 3 point landing can be satisfactorily executed (with elevator trim tab set for 0# stick force) using 120 mph over the fence and 110 just off the runway, touching down at 92 mph. The ground roll is short and 3 point forward vision is poor.

4. General Functioning

a. Power Plant and Associated Equipment

The operation of the power plant was satisfactory throughout the series of flights. No lack of confidence in the HA-45 Homare engine was expressed by the pilots.

The externally energized inertia starter appears to be of insufficient torque rating to insure consistent starts even in warm weather. Normal procedure in starting was to operate the 110 V Jack and Heintz external energizer at 150 V. which caused severe overheating of field coils.

The operation of the electrically controlled propeller was good. Engine speed was held satisfactorily except in the application of power after a prolonged dive in which case the propeller would overspeed badly unless great care was taken.

All flight and engine controls are smooth in operation with positive response and no binding or roughness throughout the permissable range.

The engine control quadrant friction locks cannot be made to hold the component controls in fixed position. As a result the propeller control tends to vibrate to low RPM, the automatic mixture control to cruising position and the supercharger control to high position.

b. Hydraulic, Pneumatic and Electrical Systems

Some difficulty was experienced with the hydraulically operated landing gear. One occasion the gear retracted only part way and on another the gear retracted but the up locks would not engage. On both occasions an additional cycle of operation appeared to clear up the trouble. The auxiliary hand pump is connected to the reserve portion of the main hydraulic tank and works well. Its capacity is such that approximately 100 strokes of the pump are required to retract or extend the flaps. Auxiliary operation of the landing gear was not checked.

The electrical system functioned well with the exception of one instance of generator failure before take-off.

c. Emergency Systems

No emergency canopy jettisoning or fire fighting apparatus is included in the original installation of the Frank I. In cases of complete hydraulic fluid failure the gear may be unlocked manually and allowed to fall into place aided by yawing of the aircraft until the indicator lights show the down locks have engaged.

5. Performance

None obtained.

C. CONCLUSIONS

It is believed that the Frank I is a fighter aircraft with excellent maneuverability and handling qualities and good rate of climb for its type aircraft. The light power loading and control forces are admirable, although its lack of pilot protection and short range leave much to be desired in the light of present fighter standards.

D. RECOMMENDATIONS

1. No recommendations are submitted on the Frank I.

2. Before the testing of additional Japanese aircraft, the following suggestions are advanced:

a. That shoulder harness which would actually be of value in a crash landing, be installed in contrast to the useless arrangement on Frank I - No. 302.

b. That an effort be made to obtain a more efficient energizer unit, possibly one of higher rating which would directly engage the dog projecting from the propeller spinner.

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