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MEMORANDUM REPORT ON
Arado 234, AAF No. T2-1010

Date 10 October 1946

SUBJECT: Pilot's Observations on the German Arado 234

OFFICE TSFPE Contract or Order No.

SERIAL No. TSFTE-2028 Expenditure Order No.

A. Purpose

The purpose of this report is to forward pilot's comments on the handling characteristics of the German Arado 234.

B. Factual Data

1. Introduction

a. The German Arado 234 is a single place, all metal, high wing, reconnaissance and light bomber airplane. It is powered by two underslung Jumo 004-B1 turbo jet units rated at approximately 1980 lbs. thrust at 8700 rpm. The wing span is 47 feet 4 1/2 inches, the length of the fuselage is 41 feet 7 1/2 inches; the height measured from the top of the vertical stabilizer to the ground is 13 feet 8 1/2 inches.

b. The tricycle landing gear is completely enclosed in the fuselage when in the retracted position. There are two main fuel tanks in the Arado 234, both of which are located in the fuselage (total capacity 536 gallons fuel).

c. Ten hours flight time was obtained on the airplane by Major R. J. Cardenas, Captain J. M. Little, Lt. C. J. Clemence, Jr., and Lt. Colonel F. J. Ascani, Bomber Operations Section, Flight Test Division, to determine its handling characteristics. All flights, except for three maximum speed points, were conducted at a recommended reduced power setting of approximately 8000 rpm as compared with the rated rpm of 8700 to conserve the life of the engines.

2. Weight and CG Location

All flights were made at a take-off gross weight of 17,429 lbs. and a CG location of 20.7% M.A.C.

3. Flight Characteristics

a. Cockpit Layout

The cockpit of the Arado 234 is designed to accommodate one man although it could easily be arranged to carry two. Access to the cockpit is satisfactory, and entry is facilitated by sufficient recessed steps covered

by spring loaded doors and hand-holds in the left side of the fuselage. The cockpit opening on the top of the fuselage is large enough for entry with winter flying clothing and parachute. The layout is simple and provides ample side and head space for the average pilot. The pilot sits in the nose of the fuselage in a slightly reclined position with his feet relatively high. The pilot's seat can be adjusted in only two positions and this must be accomplished on the ground. Similarly, the rudder pedals are ground adjustable only. The control column is equipped with a quick release lever which enables the pilot to throw the column forward prior to bailing out through the escape panel located immediately above the pilot's head. All controls are located on two panels or shelves at elbow height on either side of the pilot. The left shelf contains the engine controls, landing gear and flap controls, rudder and elevator trimming devices, and position indicator lights. The right shelf contains Reidel starter controls, fuel gages, tail pipe and fire warning temperature gages, fuel pressures and radio controls. Suspended immediately in front of the pilot and slightly below eye level are the flight instrument, tachometers, and oil pressure gages. The main electrical panel with all circuit breakers is located behind the pilot's right shoulder.

b. Taxiing and Ground Handling

It is strongly recommended that in order to avoid possible accidents while taxiing, the airplane be towed for all ground operations other than actual take-off and landing. Due to the extremely narrow landing gear and very poor brakes, directional control on the ground is hazardous. Turning can be accomplished to a small extent by differential use of the engines. There appears to be no tendency for the jet units to overheat during ground operation.

c. Take-off and Initial Climb

The take-off run without Jato units is relatively long using 8500 rpm. The average distance for seven take-offs was estimated at 4500 to 5500 feet; the recommended airspeed, wheels off, is 200 to 210 KM/HR (125 to 130 mph). Directional control is easily maintained by using differential power and rudder which becomes effective early in the take-off run. Because the pilot sits so far in front of the main gear, when the nose wheel is raised the pilot feels that he is airborne. This is not the case, for the airplane will roll 200 to 300 feet on the main gear before becoming airborne. As the landing gear is raised a slight yawing occurs because neither the gear nor the doors move in unison, however, this situation is easily controlled. When the flaps are retracted at approximately 250 KM/HR (155 mph) a slight sink, which can be controlled is noticed, but not much altitude is lost and the airspeed builds up rapidly. For minimum trim change it is recommended that the elevator trim be set at approximately one and one half graduations ahead of the "start" position. The initial rate of climb is adequate with good control throughout and torque is non-existent.

d. Climbs

The airplane has an excellent rate of climb for 8000 and 8200 engine rpm. Average data obtained by stabilizing the airspeed and reading the rate of climb indicator is as follows: (Approximately 8000 ft. altitude). These results must be considered as being approximations only since the

necessary test equipment for obtaining accurate data was not installed.

IAS		Rate of Climb	
Km/Hr	MPH	Meters Sec.	Ft./Min.
300	185	9	1775
350	217	11	2170
400	248	8	1575
450	279	7	1380

e. Handling and Control at Various Speeds.

The controls in the Arado 234 are very effective throughout the entire speed range. Forces are light to moderate and control feel is good. At lower speeds approximately 300 Km/Hr the aileron forces increase, but not excessively. Rate of response to the controls is rapid and smooth at all speeds.

f. Trim and Stability.

Longitudinal trim of the aircraft is obtained in flight by changing the angle of incidence of the horizontal stabilizer, rather than by the conventional method with tabs. Lateral trim is obtained by pre-setting the mass balance geared tabs on the ailerons, which can be adjusted on the ground only. Directional trim is obtained through a conventional rudder trim tab. After pre-setting, aileron trim was not required in flight. The elevator trim is accomplished through a lever arm acting on a ratchet principle similar to an automobile jack. The direction of the movement is controlled by a knob on the end of the lever arm which must be turned through 180° in order to change the direction of trim. No difficulty was encountered operating this mechanism, but it is inconvenient, especially during take-offs. Throughout all maneuvers performed, sufficient trim was available to trim the airplane for "hands off" flight. Stability characteristics on the whole were satisfactory. At a trim speed of approximately 350 mph IAS and the flight center of gravity, the aircraft's dynamic and static longitudinal stability were satisfactory both stick fixed and stick free. For directional control, oscillations induced by sharp rudder deflections were quickly damped and the airplane was considered stable about the vertical axis.

Aileron deflections in the stick fixed condition produced a rudder "snaking" tendency; this condition was much more severe in the stick free condition and the oscillations did not completely dampen out. Rudder "snaking" occurs after abrupt uncoordinated maneuvers and is not especially serious since it can be stopped by coordination of controls.

When the Arado 234 is banked to the left in a stick fixed condition with rudder neutral the left wing goes down slightly and remains there with no tendency to return. In a stick free condition, the wing appears

to continue to drop slowly, accompanied by a tendency for "dutch roll" which appeared to dampen out slowly. This would indicate the airplane is spirally unstable.

One objectionable condition was the "galloping" of the airplane at high speeds. This was caused by the hydraulically operated "bullets" in the turbo jets for which no over-ride switch was installed in this airplane.

At slow speeds, no rudder or elevator reversals were experienced, and the stick forces did not lighten as the controls were moved to the extreme position.

g. Stalls and Stall Warning

There is ample stall warning evidenced by a buffeting appearing approximately 10-12 KM/HR (6-8 mph) above the stall and increasing up to the stall. If the mirror port holes (to view the turbo jet units) are left open the noise level increases and the increased airflow can be felt in the cockpit. Average stalling speeds are as follows:

Stall	Power On	Power Off
Wheels and Flaps Up	203 KM/HR 126 mph	206 KM/HR 128 mph
Wheels Down & Flaps Up	194 KM/HR 120 mph	200 KM/HR 124 mph
Wheels Down & Flaps Down	190 KM/HR 118 mph	195 KM/HR 121 mph
Wheels Down & Flaps Full Down	180 KM/HR 112 mph	185 KM/HR 115 mph
Single Engine - Clean	209 KM/HR 130 mph	- - - - - - - - -

Power on stalls were entered with an average power setting of 8000 rpm; power off stalls with the units idling at 5500 rpm. At the stall the airplane showed no tendency to roll, and the break was sharp and clean. The recovery is easily accomplished, but the amount of altitude to regain airspeed is considered greater than that required for conventional aircraft.

h. Maneuverability and Aerobatics

The Arado 234 is exceptionally maneuverable for a bomber. Rate of roll is high and the radius of turn is restricted due to structural load limitations; however, maximum forces tested were approximately 3 g's. No aerobatics were performed.

i. Control on Reduced Number of Engines

With one unit idling at 5500 rpm, the other unit at 8000 rpm, at approximately 300 KM/HR, level flight rudder trim is sufficient to maintain direction and keep the wings level. No aileron trim is required. Maneuverability is good and the rudder forces required for control are not excessive.

j. Changes in Trim When Operating Landing Gear and Flaps.

Lowering the landing gear produces a slight nose heavy condition, and lowering the flaps increases this condition. These forces are easily trimmed out.

k. Noise and Vibration.

When the port holes containing the rear vision mirrors are open the noise level is relatively high. Noise level is normally very low since the power units are far to the rear of the pilot. Little noticeable vibration was encountered either on the ground or in the air from the turbo jet units or the airframe.

l. Comfort.

In general, the pilot experiences little discomfort with the possible exception that the fixed position of the knees due to inability to adjust the rudder pedals in flight causes cramped knees. Using a seat type parachute there is insufficient head room for a tall pilot. The blast of air caused by the mirror port holes would necessitate the use of heated flying equipment at high altitude.

m. Vision.

Vision is somewhat distorted forward by the curved plexiglass enclosure and is blocked at 2 and 4 o'clock by airframe members. Rear vision is blocked completely and mirrors (which are ground adjusted) must be used to see the wings, turbo jets, or flaps. Overhead vision is good. Vision is satisfactory during climb although slightly restricted downward.

n. Approach and Landing.

Approach characteristics are excellent since the glide angle is relatively flat, vision is good and the controls are very effective. The airplane is difficult to slow down and requires close control of airspeed during approach. No difficulty was experienced in applying power from the idling speed and it is believed no difficulty would be experienced in a "go around". The flare-out is normal with the exception that the nose must be held off the ground before contact of the main gear. Once the main gear touches it becomes almost impossible to keep the nose wheel off the ground. Landing speed was 170 KM/HR or 106 mph IAS in a full stall landing. A landing was made in a 15 mph gusty crosswind and no difficulty was experienced in maintaining complete control in spite of the narrow gear. The landing roll was long due to the poor brakes on this airplane.

4. General Functioning.

a. Power Plant and Associated Equipment.

The Jumo 004-B1 turbo jet units in this airplane functioned

satisfactorily during all the tests. The Reidel starters used were efficient and cool starts were made in all instances. Throughout all flights the tail pipe temperatures were very low averaging about 400°C indicating inaccurate temperature instruments. Although rated rpm is 8700, none of the pilots operated the units above 8500 rpm with the exception of three speed points; these reduced rpm's were used to conserve the units.

b. Hydraulic and Electric Systems.

The landing gear and flaps are hydraulically operated through electric selector switches. Operation was good except on one flight when a ruptured hydraulic line required the utilization of the emergency system. All electrical contacts are of the push button type conveniently located. The 24 volt electrical system functioned satisfactorily throughout the tests.

c. Emergency Systems

A hand operated pump is available for emergency extension of the landing gear and flaps. Once the gear and flaps are extended by this method they cannot be retracted until the lines are bled. This emergency system functioned satisfactorily the only time it was necessary to use it, although it required excessive pressure to operate the hand pump through the final strokes.

. Performance.

The only performance obtained on this airplane consisted of three maximum speed points at 8700 rpm as follows:

Density Altitude	Actual True Airspeed	Still Air Temp.	Arado 234 German Instrument True Airspeed
23,760 feet	474 mph	-27°C	720 KM/HR
15,840 feet	476 mph	-11°C	733 KM/HR
5,800 feet	483 mph	+ 7°C	760 KM/HR

Note: All quantitative performance data listed above are values obtained on the test day. In order to secure the necessary information to correct these results to standard conditions additional instrumentation and flying would be required.

The actual true airspeeds were obtained from the pacer P-80. It should be noted that the static output of the Jumo 004-B is only 1980 lbs. while the 004-D is 2460 lbs.; therefore, it is entirely possible that in normal development the maximum speed of this bomber would be 40 or 50 miles per hour higher than the values listed above, provided Mach number effects do not become critical.

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C. Conclusions

The Arado 234 is a fast, very maneuverable light bomber or reconnaissance airplane with many desirable features. As a light bomber the Arado carries an external load of approximately 3300 lbs. Range for this aircraft may be increased by additional fuel carried directly under the turbo jet units.

D. Recommendations

None.

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