CIVIL AERONAUTICS AUTHORITY

Technical Development Report No 10

STUDY OF SAFETY OF AIRCRAFT HAVING SINGLE DUAL-GEARED POWER PLANT

By K S CULLOM

Power Plant Section

Formerly Report No 12, Safety and Planning Division, Bureau of Air Commerce, Department of Commerce, Reprinted by the Civil Aeronautics Authority

APRIL 1938

UNITED STATES GOVERNMENT PRINTING OFFICE

WASHINGTON 1940

CONTENTS

275046°— 40

Study of Safety of Aircraft Having Single Dual-Geared Power Plant

SUMMARY

A study was made of the probable relative safety of commercial aircraft using a dual-geared power plant, as compared with aircraft using the conventional twin engine power plant arrangement A "dual-geared power plant" as the term is employed in this report, consists of two engines bolted together and driving a single propeller by means of suitable gearing

This study was based on an analysis of power plant failures and resulting accidents on twin engine aircraft operating on scheduled airways during the past three years

The analysis indicated a probable decrease in the total number of accidents by substitution of the dual-geared power plant for the twin engine power plant

It is concluded that airplanes with dual-geared power plants will be as safe and possibly safer than airplanes with twin engine power plants

It is recommended that the use of dual-geared power plants be approved for certification for air line operation now requiring twin engines

INTRODUCTION

A "dual-geared power plant" as the term is employed in this report, consists of two engines bolted together and driving a single propeller by means of suitable gearing Clutches incorporating a free wheeling arrangement are used

The purpose of this study is to determine the relative safety of aircraft using a single dual-geared power plant, as compared with the conventional twin engine arrangement, and to make recommendations with regard to approval or disapproval of such aircraft for twin engine air line operation

METHOD OF ANALYSIS

The statistical data on which this report is based covers reduction gear and controllable pitch propeller failures and accidents due to the failure of one engine, on twin engine aircraft operating on scheduled airways for the period 1935–1937, inclusive It was believed that data beyond 3 years would not be representative of modern equipment and practice

As there is no service experience data available on dual-geared power plants, the relative reliability of some parts is unknown, (particularly reduction gears and clutches) In this study it has been assumed that the engines, reduction gear and propeller of a dual-geared power plant would be equal in reliability to those in use on current twin engine aircraft As the number of propellers is reduced to one half by the use of the dual-geared power plant it was assumed that the total number of propeller failures would also be reduced to one half

It was assumed that in the case of propeller failures which permitted continuation of the flight with dual propellers, the use of one propeller would have occasioned a precautionary landing In the case of all other propeller failures and all reduction gear failures it was assumed a forced landing would have been necessary with a single propeller It was also assumed that one half of all forced landings due to propeller or gear reduction failure would result in accidents

It was assumed that all accidents with dual power plants attributable to loss of maneuverability with failure of one engine would have been avoided with the dual-geared power plant in which no change in maneuverability would be expected with loss of one engine In those

cases where there was reasonable doubt as to whether or not loss of maneuverability was the cause of the accident it was assumed 50 percent were so caused

The use of a constant speed propeller with the dual-geared power plant was assumed

DATA

All pertinent information on all power plant failures reported to the Bureau from 1935 to 1937, inclusive, the results of which might have been changed by the use of a dual-geared power plant, is included in the accompanying data

A summary of this data by years is shown in Table III and a complete summary in Table IV

RESULTS

Table V shows the results of each power plant failure considered together with the results which would have occurred if a dual-geared power plant had been used based on the method of analysis adopted

It will be noted that the ten actual accidents which resulted from the occurrences studied would have been reduced to six accidents under the assumed conditions with a dual-geared power plant

DISCUSSION

It is believed that the assumption that 50 percent of all forced landings would result in accidents may possibly be unfair to the dual-geared power plant as in some propeller failure cases in which forced landings were assumed continued flight might have been possible

The analysis of take-off accidents due to engine failure is believed to be conservative as in only three cases, 13, 16, and 17 (Table II), were accidents assumed to be entirely eliminated and the evidence in these three cases seems quite convincing

A factor which could not be considered in view of the absence of confirming data and which would favor the dual-geared power plant is the probability of lower single engine flying speed with such a plant Such a decrease might be expected due to the elimination of control surface drag occasioned by offset thrust when operating on one engine of a conventional dual-engine plane

The assumption that power plant failures will not be increased by the use of dual-geared power plants is believed to be warranted It must be granted that some forms of single engine failure would cause failure of the other engine in a dual-geared power plant but not in a twin-engine power plant This is believed offset, however, by the fact that some forms of single engine failure would cause a forced landing with a twin-engine power plant due to rotation of the damaged engine by the propeller and would not cause a forced landing with a dual-geared power plant due to the free-wheeling clutch

CONCLUSIONS

It is concluded that an airplane having a dual-geared power plant will be as safe as an airplane with conventional dual-engine power plants and may possibly be safer

RECOMMENDATIONS

1 It is recommended that aircraft equipped with a dual-geared power plant which complies with the requirements of CAR 13, 14 and 04 6 be considered eligible for certification as twin-engine aircraft for air-line operation

2 It is further recommended that special attention be paid to reliability of the propeller, reduction gear, and engine mounting, as all three are performing double duty

TABLE I—Reduction Gear and Propeller Failures

Case No	Nature of failure	Result	Year
	REDUCTION GEAR FAILURES		
1	Stationary gear	Failure was detected before take-off	1937
	C P PROPELLER FAILURES		
2	Crack at tip	Continued flight to scheduled stop	1935
3	1½" tip lost	Continued flight to scheduled stop	1936
		Failure not detected until inspection	
4	3" tip lost	Safe precautionary landing	1937
5	4' tip lost	do	1935
6	4½" tip lost	do	1936
7	do	do	1936
		(Continued flight 10 miles)	
8	12" tip lost	Forced landing Plane badly damaged	1937
9	14" tip lost	Forced landing Engine lost in flight Plane severely damaged	1935

TABLE II—Landing and Take-Off Accidents

[Due to failure of one engine]

Case No	Description of accident	Result	Year
	LANDING ACCIDENTS		
10	Because of failure of right engine pilot returned to regular airport with full passenger load Visibility was poor and pilot had been notified by radio that another plane was flying in and out of clouds near airport When near edge of field it was noticed landing gear had not low ered Pilot continued flight and turned to right to come in again for a landing, but lost alt tude Could not nose down to gain speed because of obstacles so made an emergency landing on a lot adjacent to field, with landing gear partly down Landed in a nearly normal position, but wiped off landing gear and ground looped to right	No one injured Plane badly damaged	1935
11	This accident occurred during routine test flight of a replacement right engine Pilot circled field and came in to land with right engine apparently dead and believing he would over shoot opened the throttles either to circle the airport and attempt another landing or to attempt an emergency landing elsewhere At this time it was definitely observed right en gine was not functioning The pilot gained or maintained enough altitude to clear the hangar ahead of him However in attempting to maintain this altitude with the left engine only, the airplane was flown in a semistalled attitude and slowly gave way to the right due to all the available power being on the left side After fly ng approximately 3 000 feet beyond the hangar line in this manner the airplane was allowed to stall further with the result that it fell to the ground in the beginning of a right spin	Fatal accident Plane crashed and destroyed by fire 6 persons killed	1936
	TAKE-OFF ACCIDENTS		
12	About 10 feet from the ground right engine slowed up momentarily Pilot gunned left engine which caused right wing to strike the ground Landing gear gave way and plane ground looped to rest	No persons injured Plane badly damaged	1935
13	Left engine revved down when just off ground with 80 mile air speed and landing gear up Plane was fully loaded Left wing dropped and right engine was throttled to set plane down but pilot couldn t get landing gear down in time Left gear collapsed, and plane ground looped to rest	No persons injured Plane badly damaged	1935
14	Right engine revved down on take-off Pilot closed throttle. Landing gear was retracted and could not be lowered in time Right landing gear gave way, and plane ground looped to right	No persons injured Plane badly damaged	1935
15	Right engine cut out at 30' altitude Right wing dropped and plane suddenly swerved to right Pilot was unable to hold the ship on a straight course and maintain flying speed Right wing and tail wheel struck fence and small trees causing ship to nose down and strike the ground on right wing	No persons injured Plane badly damaged	1936
16	Left engine died down on take-off, swerving plane to left and resulting in a severe ground loop	No persons injured Plane badly damaged	1936
17	When 20 feet off ground, left engine suddenly revved down, and plane swerved to left and started to settle Then right engine started to lose revs Plane hit airport fence and swung around 180°, landing against trees (Carburetor icing responsible)	No persons seriously injured Plane washed out	1935

TABLE III —Break-Down of Data by Years

[Twin-engine aircraft on scheduled airways 1935-37 inclusive]

	Reduction gear failures				C P propeller failures				Take-off accidents (1 engine cut out)				Landing accidents (1 engine cut out)				Grand total
	1935	1936	1937	Total	1935	1936	1937	Total	1935	1936	1937	Total	1935	1936	1937	Total	
Number of failures	0	0	1[1]	1	3	3	2	8									
Number of precautionary landings				0	1	2	1	4									
Number of forced landings				0	1	0	1	2									
Number of accidents (total)				0	1	0	1	2	4	2	0	6	1	1	0	2	10
Number of accidents causing serious personal injury				0				0				0	0	1	0	1	1
Number of fatal accidents				0				0				0	0	1	0	1	1
Number of aircraft badly damaged				0	1	0	1	2	4	2	0	6	1	1	0	2	10
Number of aircraft washed out				0				0	1		0	1	0	1	0	1	2

[1] Failure occurred on ground before take-off

TABLE IV —Summary of Power Plant Failures and Resulting Accidents to Twin Engine Aircraft on Scheduled Airways

[1935–37 inclusive]

	Reduction gear failures	C P prop failures	1 Engine cut out		Total
			Take-off	Landing	
Number of failures	(1)	8			
Number of precautionary landings		4			
Number of forced landings		2			
Number of accidents (total)		2	6	2	10
Number of accidents causing serious personal injury		0	0	1	1
Number of fatal accidents		0	0	1	1
Number of aircraft badly damaged		2	6	2	10
Number of aircraft washed out		0	1	1	2

[1] Failure occurred on the ground before take-off

TABLE V —Results

Case No	Type of failure	ACTUAL RESULT Twin engine: Continued flight	Precautionary landing	Forced landing	Accident	ASSUMED RESULT Dual geared: Continued flight	Precautionary landing	Forced landing	Accident
1	Red gear		1[1]					1	½
2	Propeller	1					½		
3	do	1					½		
4	do		1					½	½
5	do		1					½	½
6	do		1					½	½
7	do		1					½	½
8	do			1	1			½	½
9	do			1	1			½	½
10	Engine landing		1		1		1		1
11	Engine landing		1		1		1		½
12	Engine take off			1	1			1	
13	Engine take off			1	1			1	½
14	do			1	1			1	½
15	do			1	1			1	
16	do			1	1			1	
17	do			1	1			1	1
TOTAL		2	6	8	10	0	3	10	6

[1] Assumed precautionary landing