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Lockheed Aircraft Corporation

ADVANCED DEVELOPMENT PROJECTS
BURBANK, CALIFORNIA

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TITLE	AIRCRAFT ACCIDENT SUMMARY

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TABLE OF CONTENTS

	<u>Page</u>
SUMMARY	1
ACCIDENT CAUSES	6
UTILIZATION	19
Figure 1	2
U-2 Flight Hours & Major Accidents	
Figure 2	3
U-2 Flight Hours per Major Accident & Major	
Accident Rate per 100,000 Flight Hours	
Figure 3	5
Comparison - Major Accident Rates of Current	
Jet Fighters, B-58 & U-2	
Figure 4	7
U-2 Aircraft Requiring Repair as a Result	
of Accidents	
Figure 5	8
U-2 Major Accidents (destroyed aircraft)	
Figure 6	9
Altitude vs. Major Accident Causes	
Figure 7	11
U-2 Major Accident Distribution by Altitude	
Figure 8	17
Total U-2 Pilot Hours at time of Accident	
Figure 9	18
U-2 Major Accident Distribution by Total U-2	
Flight Hours	

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SUMMARY

Since the first flight of the U-2 on August 1, 1955 until the present month of April 1962 there have been thirty-three accidents with these aircraft. Twenty-five of these are defined as major accidents in accordance with the Flying Safety Air Force Regulation No. 62-14. This report will deal primarily with these major accidents.

The U-2 has an above average utilization rate for single engine jet aircraft and as a result of this, the actual accident rate is not unusual. Figure 1 shows the overall schedule of hours flown from August 1, 1955 through March 31, 1962 and the chronological order of the major accidents. Note also that seven of the twenty-five major accidents listed here have been repaired.

Another form of the data is shown in Figure 2 so that the actual hours flown per major accident can be accounted for. Also, shown here are the major accident rates per 100,000 flight hours as used by the Flight Safety Board at Norton AFB.

Although the U-2 major accident rate is higher than we would like to see it, recognition must be given to the fact that this rate is well within current Air Force experience. A comparison of the

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ALTITUDE (FEET)

		DEFINITE	PROBABLE
	341	Personal Equipment	
	357	Oxygen	
	380		Wet Oxygen
	365		Wet Oxygen
	366		Oxygen
	360		
	376	Autopilot	
	53,000	361	Improper Use Of Flaps
	35,000	346	?
		344	Night Refueling
	24,000	387	Oxygen
			Primary Pressure Reducer Malfunction

Below 1,000 FT

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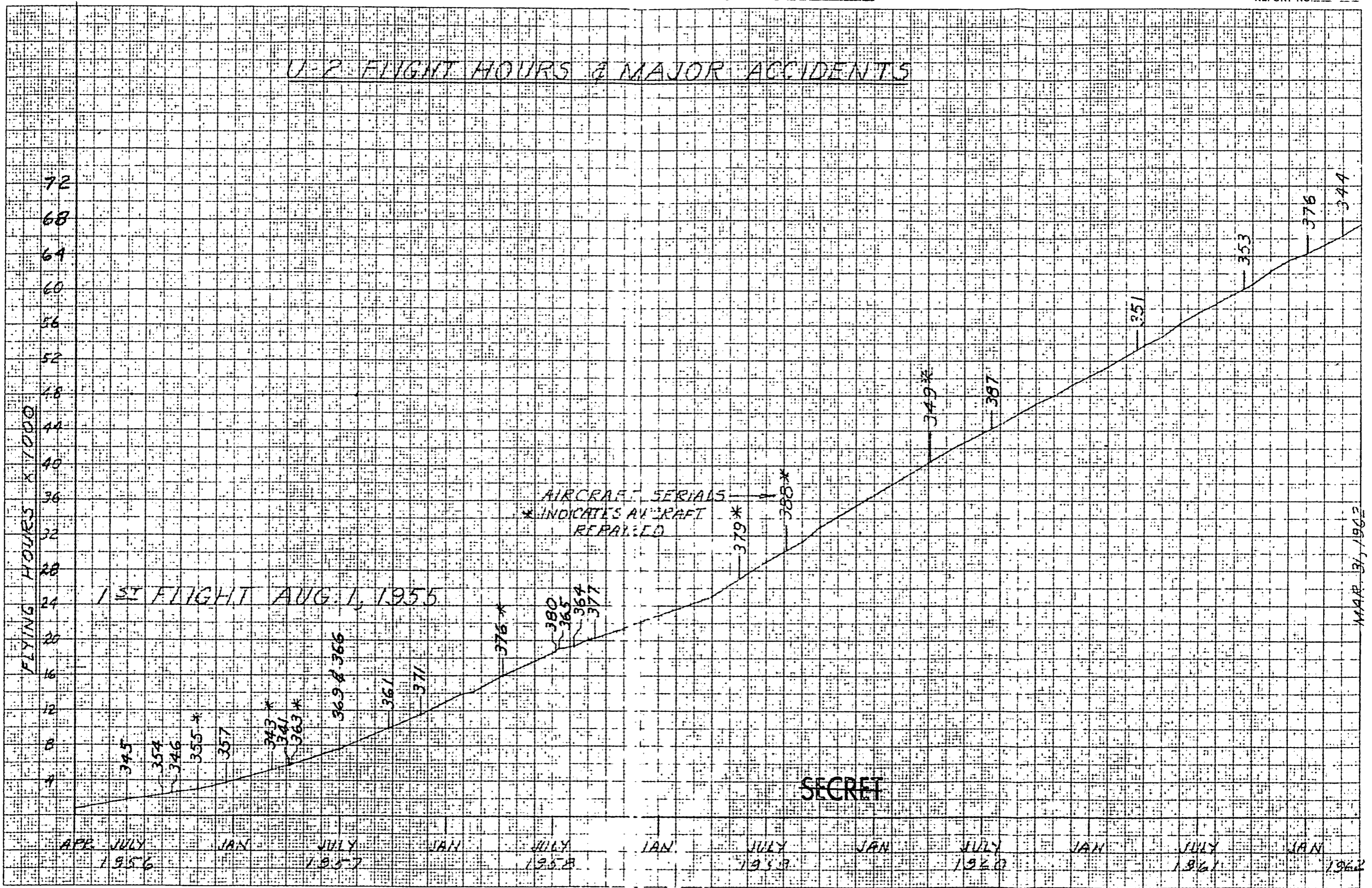
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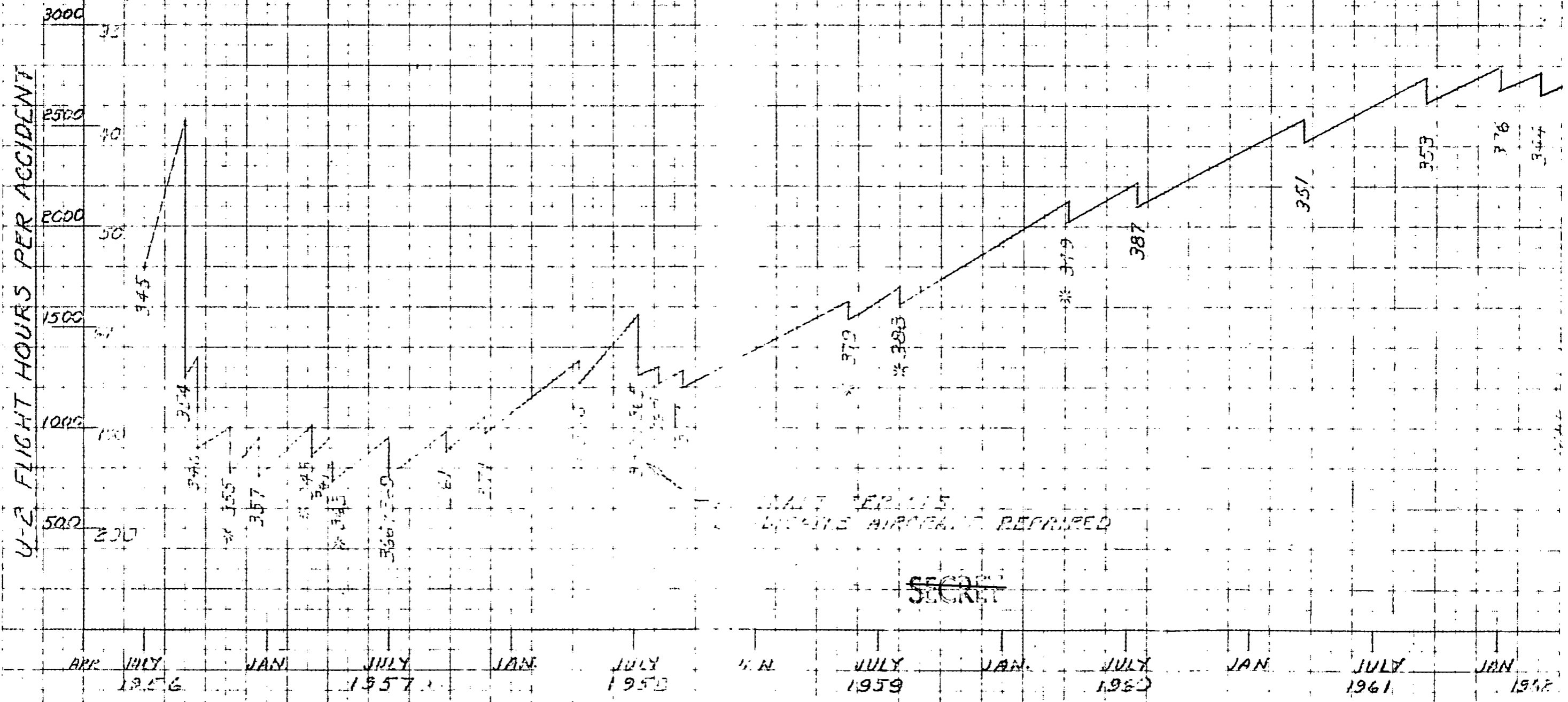
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U-2 FLIGHT HOURS PER MAJOR ACCIDENT & MAJOR ACCIDENT RATE PER 10000 FLIGHT HOURS

NOTE: ACCIDENT RATE IS QUANTITATIVE AS TO FIRST FLIGHT
FOR AIR FORCE RATES (QUANTITATIVE FOR CALENDAR
YEARS) SEE FIG. 3.



U-2 FLIGHT HOURS PER MAJOR ACCIDENT
& MAJOR ACCIDENT RATE PER 10000 FLIGHT HOURS

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SUMMARY (cont)

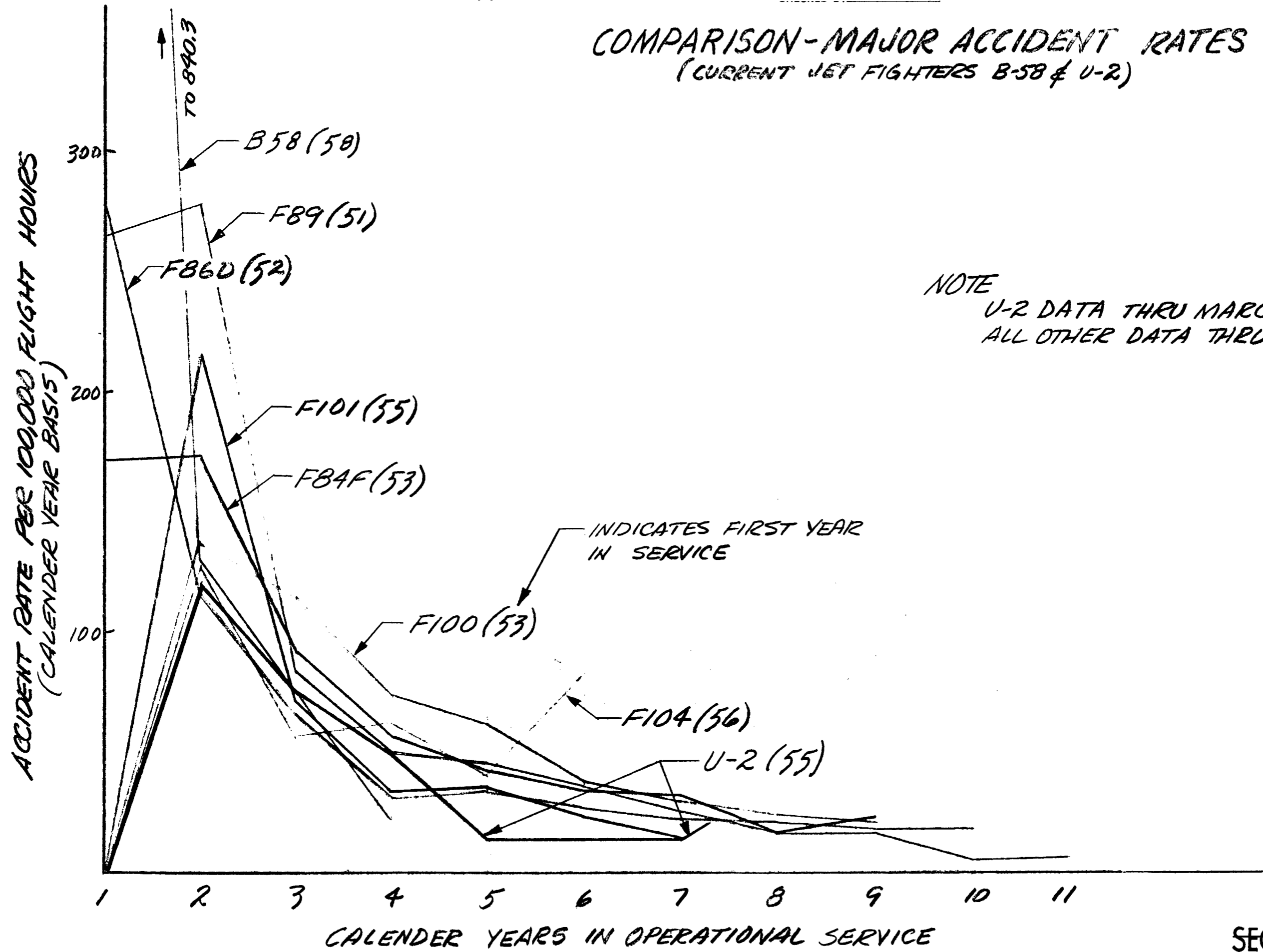
U-2 and other similar Air Force aircraft is shown on Figure 3. In this figure a valid comparison is made possible by eliminating calendar year differences and plotting accident rates against actual years that the aircraft are in the Air Force inventory.

It can be noted that the U-2 accident rate is far below the Air Force average for the first and second years of operation. In its third year of operation and up to the present, the U-2 accident rate is still lower than the Air Force average for similar aircraft.

In March 1959 the accident rate of the U-2 was approximately forty. By obtaining and maintaining good oxygen systems, this accident rate has been reduced below the March 1959 predicted rate of twenty-five per 100,000 hours. If the constant training program of new pilots in these aircraft continues as in the past it will be difficult to get the accident rate much below the present level of fourteen to twenty. This rate is reasonable in comparison to other aircraft in that the U-2 is basically a much simpler aircraft than the jet fighters.

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COMPARISON-MAJOR ACCIDENT RATES (CURRENT JET FIGHTERS B-58 & U-2)



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SECRET*Lockheed* **AIRCRAFT CORPORATION****CALIFORNIA DIVISION**ACCIDENT CAUSES

All of the U-2 aircraft involved in accidents or incidents are listed in Figures 4 & 5. All of the aircraft listed in Figure 4 were repaired whereas the aircraft listed in Figure 5 were destroyed.

The repaired aircraft have been classed as major or minor accidents by the rules of the Flying Safety Air Force Regulation No. 62-14. The classifications shown here agree with those decided upon by the accident boards. This report deals only with the twenty-five accidents classed as major and primarily with the eighteen accidents of that group which were completely destroyed.

The accident causes shown in Figure 5 form a pattern which indicates that most U-2 accidents fall into one of two categories:

1. Very high altitude accidents caused or aggravated by the environment and the malfunction of the oxygen respiratory system in some manner.
2. Very low altitude accidents incurred primarily in training operations.

The U-2 accidents are plotted as a function of altitude in Figure 6 wherein these two definite groups of accidents are apparent.

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U-2 AIRCRAFT REQUIRING REPAIR AS A RESULT OF ACCIDENTS

<u>Aircraft Serial</u>	<u>Date</u>	<u>Accident Category</u> *
342	3-27-56	Minor
357	11-09-56	Minor
355	11-09-56	Major
343	3-13-57	Major
363	4-11-57	Major
360	6-11-57	Minor
376	4-11-58	Major
389	6-11-58	Minor
343	7-16-58	Minor
350	7-30-58	Ground Crew
348	11-03-58	Minor
379	5-15-59	Major
388	8-03-59	Major
360	2- ? -60	Minor
349	4-05-60	Major

* Accident category as defined in Flying Safety Air Force
Regulation No. 62-14.

Figure 4
Page 7

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U-2 MAJOR ACCIDENTS (DESTROYED AIRCRAFT)

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A/C Serial	Base Location	Date	Pilot	Altitude	PRIMARY CAUSE		Contributory Cause
					Definite	Probable	
341	Ranch	4/4/57	[Redacted]	Max.	Face Plate Latch Failure		Accidental flameout during fuel pump tests.
344	Edwards	3/1/62	[Redacted]	35M	Aerial Refueling		
345	Ranch	7/1/56	Rose✓	Below 1000	Pilot error; hit ground		Hung pogo
346	Germany	9/17/56	Cary✓	35M		Fuel tank over pressure	
351	H	3/19/61	Chih Yao Hua✓	Ground	Pilot error		
353	Edwards	9/14/61	Eden✓	Ground	Pilot error		Fatigue; landed short, burned
354	Ranch	8/31/56	Grace✓	50 Ft.	Stall; night take-off		Night vision impaired due to pilot error and possibly use of approved drugs.
357	Ranch	12/19/56	Erickson✓	Max.	Oxygen		Pilot error; overspeed
* 360	B	5/1/60	Powers✓	Max.	Surface to Air Missile		Hostilities
361	Laughlin	9/26/57	[Redacted]	53M	Improper use of flaps		Pilot not recognizing trouble
364	Laughlin	8/6/58	[Redacted]	Pattern		Pilot error; stall	
365	Laughlin	7/9/58	[Redacted]	Max.		High oxygen dew point	
366	Laughlin	6/28/57	[Redacted]	Max.		Oxygen	
369	Laughlin	6/28/57	[Redacted]	Below 1000	Pilot error		Buzzing town
371	Laughlin	11/22/57	[Redacted]	Pattern	Cyro malfunction		Snow, Dark, IFR procedure
376	Laughlin	1/2/62	[Redacted]	Max.	Auto-pilot malfunction		
377	Edwards	9/11/58	[Redacted]	200 Ft.		Pilot error; stall on go-around	Rough landing
380	Laughlin	7/8/58	Walker	Max		High oxygen dew point	Overspeed
387	Laughlin	7/14/60	[Redacted]	24M	Oxygen		Primary pressure reducer malfunction.

* 360 Listed as destroyed aircraft but not considered an accident.

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ACCIDENT CAUSES (cont)

The distribution of all U-2 accidents is shown in Figure 7 wherein the high and low altitude groups of accidents are readily noted.

High Altitude

The following common factors have been noted in the seven high altitude accidents:

1. Three aircraft slowly spiraled down from maximum altitude with apparently no control being exerted.
2. Three aircraft; apparently no attempt was made to escape at a reasonable altitude.

One aircraft; no attempt was ever made to escape.

Two aircraft; the attempt was made very close to the ground.

3. Five aircraft reached excessive speeds and broke up in the air.

One of these was the aircraft wherein no attempt was made to escape.

Four aircraft; pilots bailed out, three successfully.

4. In the first five high altitude accidents, the pilot lost control of the aircraft for an unknown reason; probably unconsciousness, temporary or permanent.

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PERCENT OF TOTAL MAJOR ACCIDENTS

U-2 MAJOR ACCIDENT DISTRIBUTION BY ALTITUDE WHEN ACCIDENT OCCURRED

100
80
60
40
20
0

13 (5 REPAIRED)

(REPAIRED) 1

3 (1 REPAIRED)

2

ACTUAL NUMBER OF ACCIDENTS

6

GROUND- 1,000 FT. 10,000 FT. 20,000 30,000 40,000 50,000 60,000
1,000 FT. 10,000 FT. 20,000 30,000 40,000 50,000 60,000 & UP

ALTITUDE WHEN ACCIDENT OCCURRED

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ACCIDENT CAUSES (cont)

5. Two of the aircraft that spiraled down and landed intact showed no signs of aircraft malfunctions whatsoever.

The cause of two of the high altitude accidents is fairly well known:

341 The exhalation valve on the face plate failed because of pin holes in the valve diaphragm. This valve thus did not seal in order to hold face plate pressure when cockpit pressure was lost as the result of an engine flameout. Pilot obviously unconscious - no attempt to bail out until too late.

357 A leaky fitting in the aircraft side of the oxygen system permitted pressure to drop rapidly. Pilot noticed it, but mild hypoxia resulted and aircraft oversped. Pilot successfully bailed out.

The other five high altitude accidents are not felt to be so definitely known:

365 & 380 Both of these are strongly suspected of having excessive moisture in their oxygen. This caused the pressure reducer to freeze up, partially or completely shutting off the oxygen supply to the pilot. This is completely covered in LAC Report SP-103.

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ACCIDENT CAUSES (cont)

In 365 absolutely no attempt was made to escape - obviously unconscious. In 380 the aircraft oversped and pilot later ejected - unsuccessfully.

366 Suspected of having exhalation valve, face plate lock or regulator trouble. No attempt made to escape until too late.

360 The result of hostilities. This was the highly publicized "Powers Incident".

344 Suspected of exceeding the structural limitations of the airplane due to extreme gust conditions encountered in the wake of another aircraft in close proximity. The pilot was unsuccessful in his attempt to eject.

The use of the terms "oxygen" and "oxygen system" indicates that some part of the respiratory system gave trouble which resulted in a deficiency of oxygen to the pilot and subsequent hypoxia.

The charts indicate that in all of the first five high altitude accidents, from August 1957 through July 1958, oxygen deficiency is suspected to have been a common factor.

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ACCIDENT CAUSES (cont)

Many improvements have been incorporated in the oxygen system since July 1958 so that none of the known malfunctions would ever recur. It is important to note that since these improvements have been incorporated, only one accident, occurring in July 1960, has been attributed to the oxygen system. The cause for this accident is known and has subsequently been corrected.

A total of eleven accidents, including ship 360, have occurred at altitudes where bail-out or ejection could reasonably be accomplished.

1. Five of the eleven occurred prior to the incorporation of the seat ejection system and resulted in three fatalities.
 - 346 No attempt to escape was made.
 - 341 & 366 The attempt to bail out was made too late, probably due to unconsciousness.
 - 357 & 361 Pilots successfully bailed out
2. The remaining six aircraft, equipped with ejection seats, resulted in three fatalities.
 - 365 The pilot of this aircraft made no attempt to escape due to unconsciousness.
 - 344 The attempted ejection was unsuccessful due probably to canopy restraint.

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ACCIDENT CAUSES (cont)

- 380 The pilot of this aircraft successfully ejected through the canopy and clear of the ship, but was trapped in the seat when the lap belt did not release. The pilot also received neck injuries rendering him unconscious and unable to manually release the lap belt.
- 360 This pilot successfully bailed out without attempting to fire the ejection seat.
- 376 The attempted ejection was unsuccessful due probably to canopy restraint, but the pilot, after manually releasing the canopy, fell from the ship in inverted flight and survived.
- 387 This ejection was completely successful. The canopy was released prior to ejection,

Low Altitude

The low altitude accidents are the result of the extensive pilot training operations conducted with the U-2. It is a different airplane to land and take-off, requiring techniques similar to the B-47.

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ACCIDENT CAUSES (cont)

While the U-2 has experienced many incidents in which the bicycle type landing gear has been a contributing factor, the type of gear has at no time been suspected of contributing to any of the major or minor accidents.

Training

The extent of training type accidents can be seen by the list of total U-2 pilot hours shown in Figure 8. This list indicates that:

1. Thirteen of these accidents occurred during training operations. Of these:
Two occurred on the pilot's first U-2 flight.
One occurred on the first high altitude flight.
2. Four of these accidents occurred while conducting an operational mission.
3. One occurred during a Lockheed flight test.

The U-2 major accident distribution by pilot hours is shown in Figure 9. The larger percent of U-2 accidents with pilots who have little U-2 time is apparent in this figure.


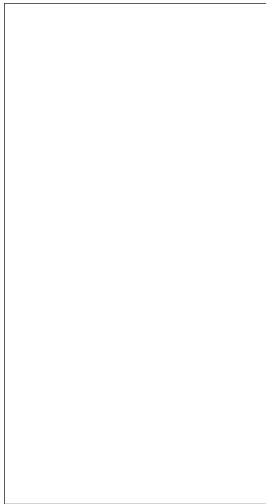

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TOTAL U-2 PILOT HOURS AT TIME OF ACCIDENT

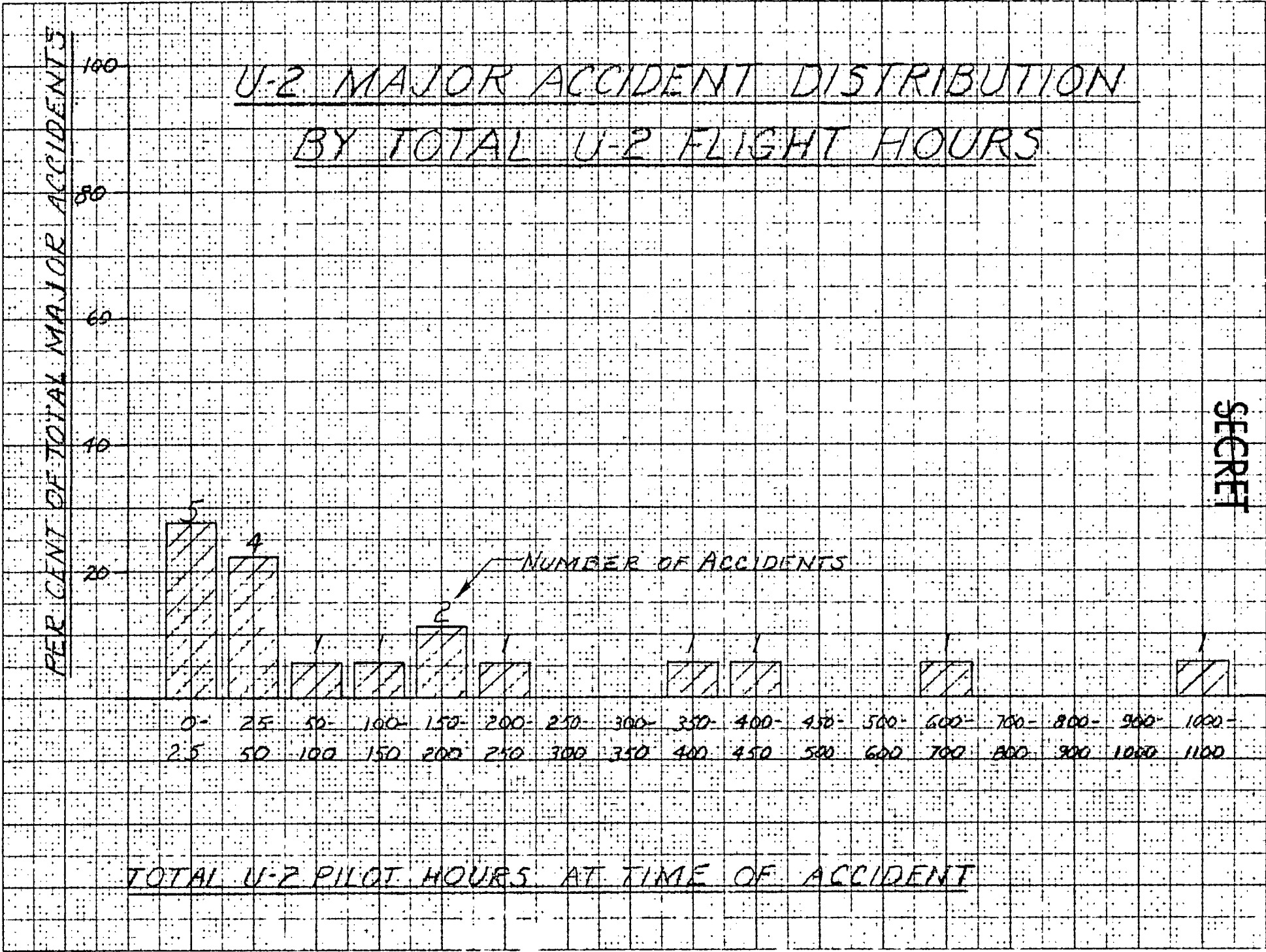
<u>PILOT</u>	<u>TOTAL HRS:</u>	
	385:59	(b)(3)
	1090:10	
Rose	11:30	
Cary	150:00	
Chih Yao Hua	27:25	
Eden	630:00	
Grace	22:40	
Erickson	40:00	
	41:05	(b)(3)
	1:30	
	218:15	
	9:10	
	1:45	
	155:30	
	442:00	
	179:25	
Walker	27:50	
	96:50	(b)(3)

This list for the eighteen destroyed U-2 only. Seven repaired aircraft not shown here.

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FIGURE 9 PAGE 18

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UTILIZATION

Another facet which indirectly affects the number of accidents and would perhaps make the rate seem high for a small group of aircraft is a high utilization factor. The U-2 has an above average utilization factor for single engine jet aircraft.

Since utilization is defined as the number of hours flown per aircraft per month, this means that the aircraft must be available and not grounded for malfunctions, inspections, etc. The U-2 has a high percent availability record compared to other Air Force aircraft.

These good utilization and availability factors are actually what would be expected from the U-2; a basically simple aircraft with cable controls and the tried and proven J57-31 engine with no afterburner.

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