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SAPC 15135 ✓  
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26 April 1957

MEMORANDUM FOR: Project Director

SUBJECT: Weight Reduction of the U-2

1. Per your request as to suggestions on how we may reduce the weight of the U-2 in order to increase its altitude capability, a preliminary study has been made. This study is primarily confined to weight reduction of installed equipment and accessories associated with the various design functions of the U-2. Other factors affecting ways and means of reducing weight have also been considered.

2. Going on the assumption that the U-2 will be employed primarily for visual photography using the A-2, B or C configuration, all equipment or accessories have been considered. There follows a list of the equipment and accessories with the weight saving which would result through elimination, weight reduction or substitution.

a. Landing lights--These could be eliminated with the accompanying adverse effect on the operational safety factors. Saving of an estimated 10 pounds.

b. AC generator--This accessory is necessary to supply power to the C camera, systems III and IV and the APQ-56. This could be eliminated except on those aircraft designated for use of the C camera. Saving of 39.7 pounds.

c. AN/ARC-34 (UHF transmitter receiver)--This could either be removed or substituted by a smaller and less reliable VHF system, but is not recommended. Saving 34.2 pounds if substituted and 73 pounds if removed.

d. Drag chute system including parachute--This could be eliminated as it has been proved to be unreliable and is not operationally required. Saving 30.4 pounds.

e. Destructor--Elimination of this unit would save 10 pounds.

f. Drift site--Considered an absolute operational necessity in order to efficiently accomplish visual photography and navigation with any degree of accuracy. If removed would save 40 pounds.

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g. Sextant--Considered operationally desirable and contributes considerably to navigational accuracy. Elimination would save 15 pounds.

h. Tracker camera--Considered valuable for ready confirmation of track flown for plotting of assumed coverage. Provides a complete photographic record of the flight and has limited target photographic value. If eliminated would save 55 pounds.

i. The primary cameras (A-2, B, C)--Weight reduction (through design changes ) should be investigated.

j. System I--Provides electronic intelligence, but does not contribute directly to visual photography. Could be eliminated for a saving of 17 pounds.

k. System III--Provides more complete electronic intelligence not contributing directly to visual photographic mission. Could be eliminated for a saving of an estimated 35 pounds.

l. System IV--Replaces primary photographic capability. Weight of permanently installed brackets, cable, etc., unknown.

25X1 m. [ ]--All permanently installed brackets, cabling, etc., could be removed. Weight saving unknown.

n. Auto pilot--This is considered to be an absolute operational necessity. Removal, however, would save 99.5 pounds.

25X1 o. [ ]--Any brackets, wiring, etc., peculiar to this installation could be eliminated. Weight saving unknown.

25X1 p. RADAN--Being an auxiliary to the APQ-56, the same comments apply as to the [ ]

q. Clocks--The aircraft is equipped with two clocks--one normal 8-day time clock and an elapsed time clock. One of these could be eliminated, but this is not considered operationally desirable since errors in time have a serious adverse effect on accurate navigation. Elimination of one clock would save .8 pounds.

r. Remote pogo drop control--Removal of all wiring and cabling incident to the remote drop control of the pogo could be eliminated. Current operations employs free fall of the pogos. If it is desired to retain pogos for any reason, the ground inserted pins can be left installed. Weight saving unknown.

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s. AN/ARN-6 radio compass--This is considered to be of operational necessity and should not be removed. Removal, however, would save 88.6 pounds.

t. Weather hatch--Any brackets, cabling, etc., could be eliminated. Weight saving unknown.

u. Personal equipment--It is understood the original concept was for personal equipment to be carried by the individual pilots and was to consist of small articles carried in the clothing of the person. However, individual selection of items to be included in survival kits has risen weight-wise to as much as 40 pounds in some instances. If possible, standardization with a view towards weight reduction and elimination of some items could be carried out. Weight saving unknown.

v. Future pilot recruitment or retention should be directed toward lighter weight men, all else being equal. Estimated average saving 25 pounds.

w. Fuel--On less than maximum range missions reduction in fuel load could be done in all cases with a saving of 6.5 pounds per gallon.

x. Rainbow--This project will undoubtedly result in weight addition as well as drag. The effects of these factors are unknown.

y. Removal of all extraneous brackets, cabling, etc., associated with other systems installations may save an estimated maximum of 50 pounds.

z. Weight saving could be realized further by reducing the film load. This is not recommended except under conditions where excessive duplicate coverage would occur if a full film load were used. For example: reducing the film load in the B camera by one half would save 70 pounds.

aa. The increase in altitude which will be realized as a result of increasing the allowable EGT to 630° is not known.

3. A resume of the maximum weight reduction possible is listed below. It is pointed out that this would leave only the basic capability of taking visual photography with either the A-2 or B cameras. The accuracy of photography and navigation as well as safety would be greatly impaired (in my opinion) to an unacceptable degree.

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a. Landing lights (removal)	10.0 (estimated)
b. AC generator--needed for C camera (removal)	39.7
c. AN/ARC-34 UHF radio (elimination)	73.0
d. Drag chute (removal)	30.4
e. Destructor (removal)	10.0 (estimated)
f. Drift site (removal)	40.0
g. Sextant (removal)	15.0
h. Tracker camera (removal)	55.0
i. System I (removal)	17.0
j. System III (removal)	35.0 (estimated)
k. Auto pilot (removal)	99.5
l. Clock (removal)	.8
m. AN/ARN-6 radio compass (removal)	88.6
n. Miscellaneous brackets, cabling, etc.	50.0 (estimated)
Maximum reduction possible	<u>582.6</u>

4. It is considered to be an absolute necessity that functions of the following equipment be retained if an acceptable degree of accuracy, safety and efficiency of operation is to be retained. Weight reduction of these functions without reduction of the scope of capability or reliability would, of course, be acceptable.

- a. Landing lights
- b. AC generator (when C camera is used)
- c. AN/ARC-34 UHF radio
- d. Drift site
- e. Sextant
- f. Auto pilot
- g. Both clocks
- h. AN/ARN-6 radio compass

5. There, therefore, remains the following equipment which can be removed without affecting the operational capability or reliability.

a. AC generator (when not using C camera)	39.7
b. Drag chute	30.4
c. Destructor	10.0 (estimated)
d. System I	17.0
e. System III	35.0
f. Tracker camera	55.0
g. Miscellaneous brackets and cabling	50.0 (estimated)
Weight which can be feasibly removed	<u>236.3</u>

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6. Weight-wise, at altitude, one pound affects the cruise-climb profile one foot. Removal of the items listed in paragraph 5 above would, therefore, increase the operational altitude by 236 feet. It can, therefore, be seen that removal of equipment will have an almost negligible affect on the operational altitude.

7. Reduction of the fuel load is considered to be the only area in which a substantial weight reduction is possible. The fuel used in the U-2 weighs 6.5 pounds per gallon. It can, therefore, be seen that reducing the fuel load by 300 gallons would increase the cruise-climb profile 1950 feet. At the same time it must be remembered, the operating time would be reduced from 10 hours to 8 hours and total mission length from [redacted] miles. By close fuel computation on less than maximum range missions an increase in the cruise profile can be realized directly proportional to the amount of the fuel load reduction.

a. The following represents a comparative range and altitude profile which would result under the listed conditions:

	Alt start cruise	Alt at zero fuel	Time flown	Range
Full fuel, equip para 5 installed, A-2 conf	65000	[redacted]	10:00	[redacted]
Full fuel, equip para 5 removed (236#) A-2 conf	65,236	[redacted]	10:00	[redacted]
36 gal fuel re- moved (236#) equip para 5 installed, A-2 conf	65,236	[redacted]	9:40	[redacted]

8. It has been noted that throughout the profiles of actual missions, occasional losses of altitude are experienced. This is caused primarily by the loss of lift while making turns. It may be possible to reduce the number and extent of turns through more careful and considerate initial as well as detailed flight planning. These losses may also be reduced by more careful attention to altitude by the pilots while making turns. It may also be possible to reduce these altitude losses by decreasing the airspeed schedule slightly while in a turn. This possibility is being investigated.

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9. In summary, it is concluded that:

a. A maximum of 236.3 pounds of equipment can be removed without affecting the accuracy or safety of operations.

b. Reduction of fuel load is the area wherein the greatest weight reduction is possible.

c. Excessive personal survival equipment is being carried in some instances.

d. Altitude losses occur as a result of turning.

10. It is recommended that:

a. The items listed in paragraph 5 above be removed when not required for a particular mission.

b. On all missions of less than maximum range, the fuel load in excess of that required be left off.

c. A survey of survival gear be undertaken with a view towards elimination of unnecessary items.

d. More attention be given to initial and detailed flight planning with a view towards reducing the number of turns required.

11. All weight figures quoted herein are drawn from Lockheed publications except for those which are qualified as an estimate.



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