Cy #1

~~Lockheed Aircraft Corp. P.O. Box 105 Sun Valley, California~~	Engineering Study [X] Change Proposal [ ] STATINTL
No. LAC - 1 Rev. #1 / Date 3-5-59	Affected Activities: [X] WSPO [X] Project
Name of Major Component: Airplane	Part or Lowest Subassembly: Autopilot / Part No. & Model or Type:

Title of Proposal: AUTOPILOT CONTROL & RELIABILITY

STATINTL

Nature of Proposal:

LAC [redacted] instrument an airplane at EAFB for the purpose of determining autopilot malfunctions and fixes for same. This program will involve approximately 10 flights spread over 4 - 6 weeks. Included in the 4 - 6 weeks is one week required [redacted] to calibrate and check their system previous to start of flights.

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(cont. attached page)

Reason for Proposal:

In the past four years of flight operation [redacted] Autopilot has had inconsistent operating characteristics. The purpose of this study is to find ways and means of improving the autopilot stability and reliability.

We recommended that the following be jointly investigated by LAC [redacted]

(cont. on attached pages)

Estimated Cost and Time Involved $20,000.00 - See Cost Recap on Page 2
Additional Funding Required None

Estimated Cost for Kits or Parts
Additional Funding Required None

Items Affected by Proposal:

[X] Safety [X] Mission Effectiveness [X] Performance

[X] Operating Procedure [ ] Interchangeability [ ] Weight or Weight & Bal. [ ] Tools & Support Equipment

[X] Maintenance Procedure [X] Service Life [X] Pilots Handbook [X] E & M Manual [ ] O'Haul Manual [ ] Parts Catalog

Est. Man/Hrs. Req'd. to Accomplish Change in Field

Source Of Parts For Kit	Availability
Spares Affected	Disposition
Initiated By: LAC	Approved WSPO Project

Nature of Proposal (cont.)

STATINTL [redacted] LAC will have special Trim Servo control, mach amplifier, reworked roll trim servo and engineer ready to start this test on about March 23. Costs of in-plant engineering reworking above units are absorbed by STATINTL [redacted] as product improvement. Only cost additional to flight test is STATINTL [redacted] field engineer services for test.

~~Current overall flight test man hours and costs will not increase as a result of running these tests.~~

Cost Estimate

STATINTL [redacted]	$ 3,000
Design Coverage	2,500
Flight Test	14,500
Total	$20,000

Authorization required but no additional funding. Present SP-1918 funding seems sufficient to cover these costs. Propose that cost be divided between Customers 1 and 2.

Reason for Proposal (cont.)

1. All of the flight complaints and U.R. malfunctions.

2. Availability of better quality components and/or better quality control.

3. Improvement of circuit stability characteristics to provide consistent servo outputs.

4. Flight tests as required to accomplish task.

The pilots reported the following malfunctions:

1. PITCH: When the mach sensor is not engaged, the pitch trim must be constantly adjusted. It is easier to fly the airplane manually than to be continually readjusting the PITCH TRIM of the autopilot.

   Pilots estimate that pitch correction is required every 30 seconds. The autopilot apparently needs a better vertical reference since the airspeed will vary 2 or 3 knots.

2. ROLL: Airplane will not assume heading after a turn on autopilot without waiting 3 to 5 minutes.

   If the roll axis is trimmed by the pilot, in order to hasten recovery from the turn, then the autopilot will be maladjusted 5 minutes later.

3. CALIBRATION: Autopilot varies from day to day and during a flight. A pilot may report an airplane and autopilot as satisfactory, and then the next day the same pilot flying the same airplane and autopilot may report the autopilot as entirely unsatisfactory. The autopilots are not consistent and require calibration after 80% of all flights.

4. The recent Service Bulletin to improve the pitch trim servo did not "fix" the trouble. The service bulletin served only to make the installation less dangerous.

5. Even though the mach sensor helps the pitch trim of the autopilot, it too is inconsistent.

6. In some cases the autopilot would not stabilize in the early part of the flight but would improve after 2 or 3 hours of flight and would perform with near perfection for the remainder of the flight. On subsequent flights, the equipment would usually be erratic.

The following U.R.'s have been examined and the complaints and basic causes will be investigated.

Reason for Proposal (cont.)

R. NO.	DATE	DESCRIPTION	COMPLAINT	CAUSE	HOURS
58-402 Serial	3/26/58	Amplifier - Gyro Control 2681	Yaw signal appeared with no yaw displacement.	Potentiometer R101, R104 & R107 not grounded. R115 was not installed.	4:00
58-588	5/23/58	Amplifier - Gyro Control 2007	Would not fly level. Ship went Nose UP or Nose DOWN	Defective vertical gyro.	Unk.
58-82	5/29/58	Control Amplifier	Could not keep wings level - not enough roll trim.	Internal failure A.P. cont. amp.	Unk.
58-835	6/17/58	Control Amplifier	Turn Knob - inoperative.	Defective turn motor.	60:10
58-839	6/18/58	Control Amplifier	During P.E. inspection. Goes hard over in roll.	Defective control A.P. amp.	8:00 since re-condition.
58-844	7/23/58	Control Amplifier	Goes hard over in roll.	Defective roll control followup.	330:10
-846	7/23/58	Control Amplifier	Would not hold heading.	Defective control A.P. & Gyro.	110:20
58-57	4/7/58	Flight Controller	A.P. would not stay engaged in "ON" position.	Unknown	Unk.
58-60	4/18/58	Flight Controller	No PITCH synchronization.	Unknown	New
58-61	4/18/58	Flight Controller	A.P. would not engage.	Unknown	Unk.
58-403 Serial	3/26/58	Flight Controller 26946	No signal from pitch command knob.	Open rotor in pitch learsyn.	New
58-404 Serial	3/26/58	Flight Controller 27065	No pitch synchronization.	Presume gear train malfunction.	Unk.
58-611 Serial	5/8/58	Flight Controller 27021	No pitch synchronization.	Presume gear train malfunction.	315:00
58-69	4/30/58	Trim Control	Automatic trim runs away.	Unknown	Unk.

Reason for Proposal (cont.)

T.R. NO.	DATE	DESCRIPTION	COMPLAINT	CAUSE	HOURS
58-692 Serial	6/20/58	Trim Control 2681	During Bench Check sticking K102 Relay was found.	Unknown	New
58-693 Serial	5/29/58	Trim Control 10015	During Bench Check, Down Trim Relay stuch in open position.	Unknown	00:00
58-22	2/7/58	Trim Control	Caused elevator trim tab to drive full Nose UP. A.P. engaged 4 times - each time full Nose UP trim.	Up Trim Relay sticking.	30:00
58-70	5/5/58	Control Mach Sensor	Mach Sensor inoperative.	Unknown	Unk.
58-30	3/7/58	Mach Controller	Mach Sensor had no affect in flight.	Found to be completely dead.	140:00
58-40	3/28/58	Mach Amplifier	A.P. could not be engaged. Mach amp caused A.P. 2 amp "A" phase fuse blow.	Unknown	Unk.
58-452	4/4/58	Vertical Gyro	Hard over in roll.	Vertical gyro would not fully erect.	Unk.
58-252	2/13/58	Rate Gyro	Aircraft pitches with A.P. engaged.	Rate Gyro was leaking fluid badly. Needs better sealing methods.	202:00
58-36	4/3/58	Rate Gyro	Cause aircraft to oscillate in pitch axis - oscillation large and slow.	Pitch rate gyro completely inoperative.	220:00
58-453	4/4/58	Rate Gyro	Low output. Made excessive noise.	Faulty motor.	Unk.
58-251	2/12/58	Follow-up Rate and Displacement.	Stator Shaft of follow-up would not rotate freely.	Water in cannon plug. Gearing dirty & corroded. Trouble in YAW axis only.	377:75

Reason for Proposal (cont.)

M.R. NO.	DATE	DESCRIPTION	COMPLAINT	CAUSE	HOURS
58-451	4/4/58	Control - Follow-up	Oscillation in roll axis in both faired and gust.	Continuity checks O.K. Oscillation was intermittent.	495:00
58-450	4/4/58	Control - Follow-up	Intermittent low output.	Follow-up Rotor intermittently open.	148:15
-4	8/6/57	Control - Follow-up	Required full left roll.	Open circuit in 1450D-1	54:20
-8	8/25/57	Control - Follow-up	Too sensitive. Oscillates.	1450D-1 output erratic.	28:50
-10	1/2/58	Control - Follow-up	Inoperative.	Open circuit in 1450D-1	38:05
58-1	2/10/58	Control - Follow-up	Hard over in roll axis gust position.	Open rotor.	Unk.
58-837	6/17/58	C-2 Transmitter	Compass off 5°. NS and EW adjust. screws would not correct error.	Defective C-2 Transmitter	346:10
58-838	6/17/58	Motor and Drive Assembly	Excessive noise from servo.	Defective motor and drive assembly.	313:10
58-63	4/21/58	Amplifier Altitude Cont.	Mach Sensor inoperative.	Internal failures.	Unk.