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ARMY PRELIMINARY EVALUATION II
YO-3A AIRPLANE

FINAL REPORT

IVAR W. RUNDGREN
LTC, TC
US ARMY
PROJECT OFFICER

GREGORY W. CONDON
CPT, CE
US ARMY
PROJECT ENGINEER

WILLIAM J. CONNOR
CW4, AV
US ARMY
PROJECT PILOT

AUGUST 1970

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US ARMY AVIATION SYSTEMS TEST ACTIVITY
EDWARDS AIR FORCE BASE, CALIFORNIA 93523

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ABSTRACT

A second Army Preliminary Evaluation (APE II) of the YO-3A airplane was conducted from 2 through 6 February 1970. Nine test flights encompassing 6 flight hours were conducted from Crows Landing Naval Auxiliary Landing Field, California. Several simulated mission profiles were flown during day and night visual-flight-rule operations to determine if certain deficiencies and shortcomings found during APE I had been adequately corrected by the contractor. Additionally, personnel from the US Army Electronics Command and Night Vision Laboratory conducted an evaluation of the airplane mission equipment. Of the items that were reevaluated, nine deficiencies and four shortcomings were still evident. Five additional deficiencies were discovered: excessive precessing of the attitude gyro instrument; slippage of the longitudinal trim indicator; failure of the spoilers to fully close after emergency spoiler release actuation; improper location of the fuel-low warning lights; and improper location of the ID 663 Tacan indicator. The mission equipment portion of the YO-3A APE II was not completed due to mission equipment malfunctions.

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INTRODUCTION

BACKGROUND

1. The YO-3A airplane was developed by the Lockheed Missiles and Space Company (LMSC), Sunnyvale, California, under contract from the US Army Aviation Systems Command (USAAVSCOM).

2. Following the contractor Phase I demonstration testing, the US Army Aviation Systems Test Activity (USAASTA) conducted Army Preliminary Evaluation (APE) I. Engineering flight tests were initiated on 18 June 1969 and were completed on 9 July 1969 after 36 hours of flight testing. The APE I test results (ref 1, app I) revealed nine safety-of-flight deficiencies, 28 deficiencies for which correction was mandatory, and 23 shortcomings for which correction was desirable.

3. To verify correction of certain APE I deficiencies and shortcomings, the contractor was requested to schedule additional YO-3A APE testing. USAASTA was directed by USAAVSCOM (ref 2, app I) to conduct APE II.

TEST OBJECTIVES

4. The objectives of the YO-3A APE II were to qualitatively evaluate contractor corrections to certain deficiencies and shortcomings which were reported in the draft APE I test report and to evaluate the mission equipment installed in the airplane.

DESCRIPTION

5. The YO-3A is a fixed-wing, single-engine, two-place, observation airplane manufactured for the US Army by LMSC. The airframe is a modified Schweizer 2-32, all-metal fuselage sailplane with a low wing and a single vertical stabilizer ~~(see fig. 1)~~. The landing gear is conventional with a retractable main gear and a

steerable, nonretractable tail wheel. The cockpit is tandem configured with the observer's station forward of the pilot's station. Conventional, reversible flight controls are provided in both cockpits. The airplane is powered by one Continental 10-360-D reciprocating engine rated at 210 brake horsepower (bhp) at standard-day, sea-level (SL), static conditions. Power is transmitted through a fixed-pitch, low-speed, propeller having six wooden blades. A more detailed description of the YO-3A airplane is included in the Detail Specification (ref 3, app I).

SCOPE OF TEST

6. Flight tests were conducted at Crows Landing Naval Auxiliary Landing Field, Crows Landing, California. A total of nine test flights were flown encompassing 6 hours of flight time.

7. The flight restrictions and operating limitations issued by USAAVSCOM (ref 4, app I) were observed.

8. The flight testing qualitatively evaluated the adequacy of contractor installed changes of certain items found deficient in APE I.

9. The mission equipment evaluation, which was conducted by representatives from the US Army Electronics Command (USAECOM) and the Night Vision Laboratories (NVL), was performed as specified in reference 5, appendix I.

METHOD OF TEST

10. Several simulated mission profiles were flown during day and night operations using visual flight rules (VFR) and simulated (hooded) instrument flight rules (IFR) in order to make a qualitative analysis of handling qualities and human factors.

11. A hand-held force gage was used to measure the longitudinal control system breakout-plus-friction forces and the longitudinal push/pull forces during takeoff.

12. Mission equipment tests were conducted during day and night VFR conditions while flying simulated mission profiles as specified in reference 5, appendix I.

CHRONOLOGY

13. The chronology of this APE is as follows:

Test directive received	20 October 1969
Supplemental test directive received	24 November 1969
Test plan submitted	5 December 1969
Test plan approved	5 January 1970
Tests initiated	2 February 1970
Tests completed	6 February 1970
Draft report submitted	May 1970

RESULTS AND DISCUSSION

GENERAL

14. The YO-3A APE II was conducted to determine that certain deficiencies and shortcomings found during APE I had been adequately corrected by the contractor. Of the items that were reevaluated, nine deficiencies and four shortcomings were still evident. In addition, five new deficiencies were discovered: excessive precession of the attitude gyro instrument; slippage of the longitudinal trim indicator; failure of the spoilers to fully close after emergency spoiler release actuation; improper location of the fuel-low warning lights; and improper location of the ID 663 Tacan indicator. The YO-3A airplane should be restricted from instrument flight until the attitude gyro precession is corrected. Further testing should be conducted to: qualitatively evaluate the LMSC proposed minimum static rpm/fuel pressure "go/no-go" limits at density altitudes other than sea level; and to determine any changes in range and endurance that may result from using the exhaust gas temperature/fuel mixture adjustment guide.

15. Flight tests were also conducted to evaluate the suitability of the installed mission equipment. This evaluation was conducted by personnel from the USAECOM and Night Vision Laboratory (NVL). ~~and the results are included in appendix II.~~ The mission equipment evaluation was not completed due to mission equipment malfunctions. Further testing of the mission equipment should be performed at the earliest practical date.

16. The results of the APE II testing are presented under the headings: Safety-of-Flight Deficiencies, Deficiencies, and Shortcomings. Corrected items are grouped separately from the uncorrected items. Deficiencies newly discovered during APE II testing are presented under the heading: Miscellaneous.

SAFETY-OF-FLIGHT DEFICIENCIES

Corrected

Operation of the Structurally Redesigned Fuel Tank Selector:

17. A redesigned fuel tank selector rod was installed. Although no structural determination could be made, the operation of the fuel tank selector was satisfactory.

Uncorrected

Excessive Cylinder Head and Engine Oil Temperatures During Normal Taxi, Run-up and Takeoff Operations:

18. During APE II, normal taxi, run-up and takeoff operations were conducted at the beginning of each test flight at ambient temperature conditions of 75°F or less. Maximum temperatures were 225°C for cylinder head and 85°C for engine oil and were 10°C and 30°C, respectively, below the published maximum limits. These temperatures were recorded following no warm-up, 5-minute taxi, and 4-minute run-up operation at placarded rpm. The results of this test are inconclusive because the test ambient temperature conditions were not representative of the total environment envisioned for the airplane's mission. Taxi and run-up operations at ambient temperature conditions of 95°F or above would probably result in excessive cylinder head temperatures. To determine if excessive cylinder head and oil temperatures would occur during taxi, run-up and takeoff operations, further testing should be conducted under representative hot day ambient temperature conditions.

Raw Gasoline Fumes in the Cockpit During Climbing Flight at 80 KIAS:

19. On the first of the nine flights conducted during this APE raw gasoline fumes were detected in the cockpit following level turns of 30 to 40 degrees of bank angle. No fumes were noted during climbing flight at 80 KIAS. No fumes were noted during the subsequent flights even though the same maneuvers were flown during each flight.

Lack of Emergency Control Device Identification:

20. The emergency control devices in both cockpits have been labeled and identified. The emergency device handles were red

instead of the standard yellow/black barber pole striping. Remarking of the emergency handles to the yellow/black striping is desirable.

DEFICIENCIES

Corrected

Inability to Achieve Full Left-Lateral Control Displacement Without the Control Stick Contacting the Pilot's Leg:

21. The gear ratio for the lateral control was changed and full lateral control displacements were accomplished without interference by the pilot's leg.

Excessive Engine Vibration During a Cruising Flight of 70 to 80 KIAS and During Idle Power Glides:

22. Excessive vibrations were again noted during the first few flights of this evaluation. The contractor stated that the probable reason was propeller imbalance caused by 3 weeks of exposure to rain and recommended changing the propeller. Following the propeller change the excessive vibrations were no longer evident.

The Lateral Control, Simulated Gust Response Characteristics:

23. This deficiency had been corrected by eliminating the excessive lateral control system friction. Following a rapid displacement the lateral control surfaces exhibit positive centering (HQRS 3).

Excessive Free Play in the Lateral Flight Control System:

24. Approximately three-eighths of an inch of free play was again measured in the lateral control system. Although not desirable, this amount of free play was not objectionable because the excessive amount of friction in the lateral control system had been eliminated (HQRS 4).

Insufficient Airspeed Margin Between the Aural Stall Warning Actuation and Airplane Stall Occurrence:

25. After several adjustments of the artificial stall warning device a 4-knot airspeed margin between artificial stall warning and actual aerodynamic stall was achieved. A 4-knot margin is acceptable for the intended mission (HQRS 2).

Lack of Installed Provisions for Towing of the Airplane:

26. Provisions for towing the airplane have been installed on the main landing gear. Towing was not accomplished during this APE but the installation provided appears satisfactory.

Lack of Full Aft Unrestricted Motion of the Control Stick:

27. Full aft longitudinal control was attained during ground tests without encountering any physical obstructions. During flight full aft longitudinal control was not attainable during the stall because of excessive stick forces; however, this characteristic is not objectionable.

Lack of a Spoiler Position Indicator:

28. A spoiler indicator has been installed on top of the pilot's instrument panel. The indicator was easily readable during night operations and appeared to indicate accurately.

Poor Lighting and Readability of the ID 1351/A *Compass Heading Card:*

29. Satisfactory night lighting has been provided.

Non-availability of a Canopy Shattering Instrument:

30. A canopy shattering instrument has been installed on the right side of the cockpit and can be reached by either crew member.

Unsatisfactory Night Lighting Capability for the Observer's Mission Equipment Panel:

31. Satisfactory night lighting has been provided.

Excessive Longitudinal Stick Push-Force Required to Achieve a Thrust-Line-Level Attitude During the Takeoff Roll:

32. With the longitudinal trim control set at the takeoff position, approximately 25 pounds of push-force was required to achieve a thrust-line-level attitude at 40 KIAS during the takeoff roll. The 25-pound push-force was approximately 4 pounds less than that required during APE I and was acceptable (HQRS 4).

Excessive Longitudinal Pull-Force Required to Rotate the Airplane at Takeoff:

33. The longitudinal pull-force required to rotate the airplane at a takeoff airspeed of 60 KIAS with the longitudinal trim set for

takeoff was approximately 10 pounds. The 10-pound pull-force was 18 pounds less than that required during APE I and is acceptable (HQRS 3).

Uncorrected

Unsatisfactory Operation of the Engine Exhaust Gas Temperature (EGT) Indicator as a Fuel Mixture Adjustment Guide for Optimum Cruise Control Performance:

34. An alcor EGT indicator has been installed in the cockpit. The recommended mixture adjustment procedure to obtain optimum cruise performance was used and appeared satisfactory. However, fuel flow was not measured during this APE; consequently, endurance could not be calculated. Further testing should be conducted in order to obtain cruise performance using the Alcor EGT/fuel mixture adjustment procedure.

Unsatisfactory Detent Positioning of the Newly Designed Fuel Tank Selector:

35. The detents for the left, right and both positions were still not positive and resulted in the pilot "hunting" for a selected position when changing fuel tanks. In addition, visual selection of a fuel tank was inaccurate because the detent positions were not in line with the fuel tank markings. Correction of this deficiency is mandatory.

Lack of a "Go/No-Go" List of Static Power Rpm Limits as a Function of Density Altitude:

36. Minimum propeller rpm/fuel pressure limits as a function of density altitude have been established by the contractor. The sea-level, density altitude limits were used during this APE and appeared satisfactory. The limits specified for higher density altitudes were not checked because of the limited density altitude variation available at the test site. The contractor stated that the rpm/fuel pressure limits were furnished by the engine manufacturer and that the density altitude limits, other than those specified for sea level, had not been flight tested. To verify the recommended rpm/fuel pressure "go/no-go" limits for higher density altitudes additional testing should be accomplished. Also, the recommended limits were not placarded in the cockpit, and correction is mandatory.

Magnitude of the Directional Control Forces:

37. Approximately 35 pounds of right rudder force was required to keep the ball of the turn and bank indicator centered during climbing flight. In cruising flight at 80 KIAS, approximately 10 to 15 pounds of right rudder force was required for balanced flight. While these forces are acceptable for daytime VFR flight, extensive pilot compensation is required for adequate performance under simulated IFR conditions (HQRS 7). Correction is mandatory for satisfactory mission accomplishment under marginal weather conditions. No apparent action had been taken by the contractor to correct this deficiency.

Unsatisfactory Longitudinal Control System Breakout-Plus-Friction Force Band:

38. The breakout-plus-friction force band was found to be identical to APE I test results. This characteristic compromised the trimming for a precise airspeed, and resulted in an excessive trim speed band. Relocation of the downspring changed the phugoid mode from slightly divergent to stable, thereby reducing the pilot effort while trimming for a pricise airspeed. However, the breakout-plus-friction force band deficiency has not been corrected. Correction of this deficiency is mandatory for the satisfactory accomplishment of the intended mission. No apparent action had been taken by the contractor to correct this deficiency.

Longitudinal Trim Tab Control Permitted Trimming Into a Stall:

39. The longitudinal control forces were trimmed to zero force at airspeeds of 2 to 3 knots above the stall airspeed. At this trimmed airspeed, approximately three complete turns of the longitudinal trim wheel (in the nose-up direction) were remaining. No apparent action had been taken by the contractor to correct this deficiency, and correction is mandatory for the satisfactory accomplishment of the intended mission.

Unintentional Braking with Rudder Application During Takeoff Roll:

40. Unintentional braking during the takeoff roll appears to be a function of pilot percentile. A 95-percentile pilot caused unintentional braking whereas a 40-percentile pilot did not. Although the 40-percentile pilot did not cause unintentional braking, the pilot commented that the rudder pedal geometry contributed to a tendency toward unintentional braking during the takeoff roll. Elimination of the unintentional braking characteristic is mandatory for satisfactory mission accomplishment.

Inadequate Canopy Defogging System:

41. Very little air flow and heat was realized from the defogging outlets during in-flight or ground operation of the canopy defogging system. Although the flow rate was not measured, the defogging system was ineffective. Correction is mandatory.

Unsatisfactory Control Harmony Characteristics:

42. The control harmony characteristics were still unsatisfactory because of the large rudder forces required in relation to the longitudinal and lateral stick forces. Poor control harmony was particularly evident during maneuvering flight. Correction is mandatory for satisfactory mission accomplishment. No apparent action was taken by the contractor to correct this deficiency.

SHORTCOMINGS

Corrected

Inaccurate Readings Presented by the Fuel Quantity Indicators:

43. The left fuel tank quantity indicator was inoperative during this test. The right fuel tank quantity indicator was checked with ground refueling data, and acceptable accuracy was achieved.

Unsatisfactory Operation of the Rotating Beacon (Grimes Light):

44. The Grimes light operated satisfactorily during all APE II flights.

Poor Longitudinal Trimmability Characteristics:

45. Relocation of the downspring changed the phugoid mode from slightly divergent to stable. As a result, the pilot compensation required to trim the airplane at a desired airspeed has been reduced to an acceptable level (HQRS 4).

Intermittent Operation of the Cowl Flap Indicator Light:

46. The cowl flap indicator light operated satisfactorily during all APE II flights.

Inadequate Instrument Lighting for the Fuel Selector, Auxiliary Fuel Pump Switch, Alternator Switch, Buss Trim Switch and Master Switch:

47. Adequate night lighting has been provided through use of the relocated map light.

Improper Location of the Cockpit Map Light:

48. The map light can now be repositioned to the center top of the instrument panel. This new location is satisfactory.

Uncorrected

Inadequate Length of the Map Light Cord:

49. The map light cord is approximately 6 inches too short for comfortable use of the map light on the right side of the cockpit. Correction is desirable for improved mission effectiveness. No apparent action was taken by the contractor to correct this shortcoming.

Unsatisfactory Inboard Wing Section Nonskid Walkway:

50. An inboard wing section nonskid walkway had been provided on the APE test airplane; however, the major portion of the walkway had peeled off with the camouflaged paint because of a primer/paint incompatibility. The nonskid surface will be reevaluated on production airplanes.

Improper Drain/Vent Provisions in Fabric-Covered Surfaces:

51. The drain holes provided for the fabric-covered surfaces are not located at the lowest position of the surfaces. As a result, complete drainage of accumulated moisture does not occur. Relocation of the drain holes is desirable. No apparent action was taken by the contractor to correct this shortcoming.

The Neutral to Slightly Positive Stick Force Versus Airspeed Gradient at Airspeeds Below Trim During Flight in the Region From Stall to the Minimum Power Required:

52. The longitudinal stick force gradient is essentially neutral from 10 knots above stall to stall. Approximately 4 pounds of aft stick force is required to maintain any airspeed within this 10-knot airspeed band. This characteristic eliminates stick force as a cue to approaching a stall, and correction is desirable (HQRS 4). No apparent action had been taken by the contractor to correct this shortcoming.

MISCELLANEOUS

Excessive Precession of the Attitude Gyro

53. Following a 90-degree standard rate turn (3 deg/sec), the attitude gyro precessed 3 to 5 degrees in bank angle. The precession in bank angle appeared more pronounced in right turns. In addition, the attitude gyro precessed up to 15 degrees in pitch attitude following a normal pull-up (e.g. a return to glide path). The resulting inaccuracy of the attitude gyro made instrument flying difficult and was confusing to the pilot. Correction is mandatory. Until this deficiency is corrected, the YO-3A airplane should be restricted from actual instrument flight.

Slippage of Longitudinal Trim Indicator

54. The longitudinal trim indicator dial is fastened to the trim system by means of a single screw/nut lock. Little force is required to overpower the screw/nut lock and turn the dial independently of the trim system. Unintentional rotation of the dial occurred during this APE when the pilot grasped the dial instead of the trim wheel while attempting to trim out longitudinal control forces. This could easily reoccur because the dial is located immediately forward of the trim wheel. When the dial is turned independent of the trim system or the screw/nut lock is loose, the dial is no longer rigged properly and is useless as a trim indicator. Resetting of the indicator dial to its proper position can only be accomplished on the ground. Extremely high control forces were encountered during one takeoff because the dial had been moved so that it did not indicate properly. The push-force required to achieve a thrust-line-level attitude was approximately 50 to 60 pounds. The location of the trim wheel (right side of cockpit) prevents trimming during takeoff, thus the control forces must be accepted or the takeoff aborted. A positive lock for the trim indicator dial is mandatory.

Failure of the Spoilers to Fully Close Upon Actuation of the Emergency Spoiler Device

55. Actuation of the emergency spoiler device resulted in the spoilers partially closing and the trailing edge of the top spoiler remaining open approximately 2 inches. Attempts to fully close the spoilers by increasing airspeed were unsuccessful. Complete closing of the spoilers by emergency means is necessary for acceptable performance, and correction is mandatory.

Improper Location of the Fuel-Low Warning Lights

56. The fuel-low warning lights are installed face upward on top of the instrument panel. During daylight conditions, illumination of the warning lights cannot be detected by the pilot unless the lights are temporarily shaded by some means such as the pilot's hand. Relocation of the fuel-low warning lights to the pilot's instrument panel is mandatory.

Improper Location of the ID 663 Tacan Indicator

57. The location of the Tacan indicator, mounted below the lower right portion of the instrument panel, results in a high pilot workload during instrument approaches. The distance from the Tacan indicator to the airspeed, vertical speed and altimeter display is approximately 16 inches. The pilot's cross-check must traverse this 16-inch distance resulting in increased pilot workload. Relocation of the ID 663 Tacan indicator is mandatory for satisfactory mission accomplishment.

Improper Marking of the Emergency Control Devices

58. The emergency control devices, although identified and colored red, did not conform with the applicable military specification requirements, i.e. the black and yellow barber pole marking. Proper marking of the emergency control devices is desirable.

CONCLUSIONS

59. The following were concluded upon completion of the YO-3A Army Preliminary Evaluation II:

a. The performance and handling qualities of the YO-3A, within the scope of this test, are acceptable for its intended, limited mission.

b. The performance and handling qualities of the YO-3A are not acceptable for extended operational use, without correction of the deficiencies mentioned in this report and those reported in the APE I report.

c. Of the items reevaluated, nine deficiencies and four shortcomings were still evident.

d. Five new deficiencies were also noted.

60. Correction of the following deficiencies is mandatory:

a. Excessive cylinder head and engine oil temperatures during normal taxi, run-up and takeoff operations (para 34).

b. Unsatisfactory detent positioning of the fuel tank selector (para 35).

c. Lack of a cockpit placard for static power rpm limits as a function of density altitude (para 36).

d. Excessive directional control forces during climbs and under instrument flight conditions (para 37).

e. Excessive breakout-plus-friction force characteristic of the longitudinal control system (para 38).

f. Longitudinal trim tab control permitted trimming into the stall (para 39).

g. Unintentional braking during rudder applications on the takeoff roll (para 40).

h. Ineffective operation of the canopy defogging system (para 41).

i. Unsatisfactory control harmony characteristics (para 42).

j. Excessive precessing of the attitude gyro (para 53).

k. Slippage of the longitudinal trim indicator wheel (para 54).

l. Failure of the spoilers to retract to the fully closed position following application of the emergency spoiler control device (para 55).

m. Improper location of the fuel-low warning lights (para 56).

n. Improper location of the ID 663 Tacan indicator (para 57).

61. Correction of the following shortcomings is desirable:

a. Insufficient map light cord length (para 49).

b. Unsatisfactory inboard wing section nonskid walkway (para 50).

c. Improper location of drain/vent provisions on fabric-covered control surfaces (para 51).

d. The neutral to slightly positive stick force versus airspeed gradient at airspeeds below trim during flight in the region from stall to minimum power required (para 52).

e. Improper marking of the emergency control handles (para 58).

RECOMMENDATIONS

62. Deficiencies, for which correction is mandatory, should be corrected prior to operational deployment.

63. Shortcomings, for which correction is desirable, should be corrected at the earliest possible date.

64. Further testing should be conducted under representative hot-day operational conditions to determine if excessive cylinder head and oil temperatures will occur during taxi, run-up and takeoff operations (para 18).

65. Further testing should be accomplished to verify the contractor-recommended rpm/fuel pressure "go/no-go" limits for higher density altitudes, e.g. 2000, 4000 and 6000 feet (para 36).

66. Further testing should be accomplished to obtain cruise performance using the Alcor EGT/fuel mixture adjustment procedure (para 34).

67. Additional testing of the mission equipment should be performed at the earliest practical date (para 15).

APPENDIX I. REFERENCES

1. Report, USAASTA, Project No. 68-47, *Army Preliminary Evaluation, YO-3A Airplane,* May 1970.

2. Letter, AMSAV-R-F, HQ, USAAVSCOM, 15 October 1969, subject: Test Request for YO-3A Army Preliminary Evaluation (APE) II.

3. Specification Report, Lockheed Missiles and Space Company, LMSC No. 5580127, *Detail Specification, YO-3A Aircraft,* 15 November 1968, (CONFIDENTIAL).

4. TWX, AMSAV-R-F, HQ, USAAVSCOM, 2 December 1969, subject: Safety of Flight Release.

5. Test Plan, USAASTA, Project No. 69-14, *Army Preliminary Evaluation II, YO-3A Observation Aircraft,* January 1970.

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5. AUTHOR(S) (First name, middle initial, last name)

IVAR W. RUNDGREN, LTC, TC, US Army, Project Officer
GREGORY W. CONDON, CPT, CE, US Army, Project Engineer
WILLIAM J. CONNOR, CW4, AV, US Army, Project Pilot

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13. ABSTRACT

A second Army Preliminary Evaluation (APE II) of the YO-3A airplane was conducted from 2 through 6 February 1970. Nine test flights encompassing 6 flight hours were conducted from Crows Landing Naval Auxiliary Landing Field, California. Several simulated mission profiles were flown during day and night visual-flight-rule operations to determine if certain deficiencies and shortcomings found during APE I had been adequately corrected by the contractor. Additionally, personnel from the US Army Electronics Command and Night Vision Laboratory conducted an evaluation of the airplane mission equipment. Of the items that were reevaluated, nine deficiencies and four shortcomings were still evident. Five additional deficiencies were discovered: excessive precessing of the attitude gyro instrument; slippage of the longitudinal trim indicator; failure of the spoilers to fully close after emergency spoiler release actuation; improper location of the fuel-low warning lights; and improper location of the ID 663 Tacan indicator. The mission equipment portion of the YO-3A APE II was not completed due to mission equipment malfunctions.

14. KEY WORDS	LINK A		LINK B		LINK C	
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Army Preliminary Evaluation (APE II) YO-3A airplane Simulated mission profiles Mission equipment evaluation						