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NAVAL AIR TEST CENTER TECHNICAL REPORT

FINAL REPORT

FLIGHT TEST EVALUATION OF THE UF-XS

JAPANESE STOL SEAPLANE (U)

by

LCDR Nicholas J. Vagianos, USN
Mr. Eugene C. Rooney

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NAVAL AIR TEST CENTER
U. S. NAVAL AIR STATION
PATUXENT RIVER, MARYLAND 20670

RA1200005
RAD3-5
FT2121-031R-64
25 AUG 1964

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From: Commander, Naval Air Test Center
To: Chief, Bureau of Naval Weapons

Subj: NATC Technical Report FT2121-031R-64, Flight Tes. Evaluation of the UF-XS Japanese STOL Seaplane, Final Report; transmittal of (U)

Ref: (a) WEPTASK Assignment RA 1200005/201 1/WS417AO-00 of 9 Jul 1963
(b) BUWEPS Problem Assignment RAD3-5 of 5 Mar 1964
(c) BUWEPS Problem Assignment RAD32-273 of 11 Oct 1963
(d) WEPTASK Assignment RA1200001/201 1/F012-01-12 of 18 Jun 1963
(e) NATC msg 090036Z of Jun 1964

1. Reference (a) authorized the Commander, Naval Air Test Center to conduct tests for Aircraft Systems Improvement as assigned by the Bureau of Naval Weapons under individual Problem Assignments. Reference (b) was established for flight test evaluation of the UF-XS Japanese STOL seaplane under reference (a). Reference (c) under reference (d) authorized NATC participation in and support of the Japanese STOL seaplane development program.

2. Reference (e) reported the preliminary results of UF-XS Japanese STOL seaplane evaluation. This report completes the problem assignment of reference (b) and contains information requested by reference (c).

JAMES R. LEE

W. D. EMERSON
By direction

[redacted]

FT2121-031R-64 NAVAL AIR TEST CENTER [redacted]

U. S. NAVAL AIR STATION

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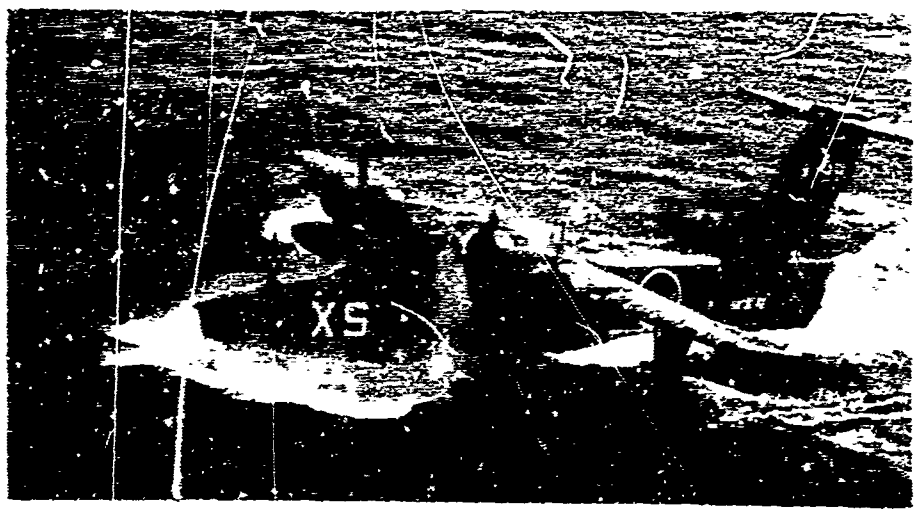

ABSTRACT

The UF-XS Japanese STOL Seaplane was evaluated to determine the flying qualities in configurations PA, L, and TO at approach speeds in the vicinity of 55 kt and the hydrodynamic characteristics while on the water. The NASA Ames simulator showed good correlation with the airplane's aerodynamic characteristics. The airplane has neutral to unstable static longitudinal stability, weak directional stability, large adverse yaw, a long period moderately damped Dutch Roll mode, a divergent spiral mode, and trims for flight in a 13° left sideslip. An automatic stabilization equipment (ASE) makes the static longitudinal stability and spiral modes positive but does not improve the remaining items. Take-off and landing touchdown speed is 50 kt. The airplane has a hydrodynamic stable elevator range of 20 to 35 degrees up elevator. A "digging in" and slight "porpoising" tendency is exhibited at elevator positions less than 20°. The airplane possesses good spray characteristics. The mission capability of a STOL seaplane should greatly improve with reduction in take-off and landing speed; however, evaluation of the airplane at lower speeds was not possible due to several airplane limitations. Monitoring of the Japanese STOL seaplane program should be continued and a reevaluation performed after required improvements have been accomplished.

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INTRODUCTION

BACKGROUND

1. The problem assignments were established to provide Naval Air Test Center participation in and support of the development of the Japanese STOL seaplanes, the UF-XS and P-XS including in-flight evaluation of the UF-XS seaplane to fulfill the requirements of the "Memorandum of Understanding" between the United States Navy and the Japanese Maritime Self Defense Forces (JMSDF), enclosure (2) to reference 1.

2. The Japanese government is sponsoring development of an improved ASW airplane. Under this program, Shin Meiwa Industries Company, Ltd, as contractor, is designing a STOL seaplane for JMSDF. This airplane, designated the P-XS, is in the design stage with a mock-up scheduled for completion in late 1964. The P-XS will be powered by four T64-GE-4 2850 ESHP turboprop engines and will have a design gross weight for STOL operation of 70,000 lb. The design features include a T58-8 1250 SHP engine for Boundary Layer Control (BLC) to allow take-off and landing speeds in the vicinity of 45 kt. Maximum sea level airspeed is expected to be 300 kt. The airplane is being designed for a sea state corresponding to 10 ft waves and for a limit normal load factor of 3.0. A three-view drawing of the P-XS is contained in Appendix III, figure 1. To meet the design objectives the contractor is incorporating significant design improvements to solve the problems of operating seaplanes in heavy sea states. These problems are load alleviation for take-off and landing, spray control, and pitch damping.

3. The UF-XS airplane is a 3/4 scale flying mock-up of the P-XS airplane containing many of its features and systems and was designed to investigate the hydrodynamic characteristics and STOL flying qualities of the P-XS. Since this flying test bed is an imaginative and important contribution to the state of the art in STOL aircraft and in seaplane hydrodynamics, all

possible U. S. Navy technical assistance has been provided the Japanese in return for all data, analyses, and conclusions resulting from development of the airplane.

4. The NASA Ames Research Center has been studying the STOL flight characteristics of the UF-XS by means of a simulator. The NATC pilot participated in this simulator program prior to the flight evaluation of the UF-XS for the dual purposes of providing pilot opinion on STOL flying qualities and of gaining familiarity with the anticipated flying qualities of the UF-XS airplane.

5. A quantitative and qualitative flight evaluation of the handling qualities and hydrodynamic characteristics of the UF-XS airplane was conducted at Omura, Japan, by a U. S. team composed of the authors and Mr. Robert C. Innis, project pilot, and Mr. Curt Holzhauser, project engineer, from NASA Ames Research Center.

PURPOSE

6. This report contains the results of the in-flight STOL regime handling qualities tests, the simulator tests and the hydrodynamic tests of the Japanese UF-XS STOL seaplane.

DESCRIPTION OF TEST AIRPLANE

Figure 1
UF-XS Airplane

7. The UF-XS airplane is an extensively altered HU-16 airplane modified to simulate the systems, hydrodynamic configuration, and aerodynamic configuration of the P-XS airplane. A three-view drawing of the UF-XS is contained in Appendix III, figure 2. General views of the test vehicle are shown in Appendix IV, figure 1. Geometric data are presented in Appendix V. The major modifications to the HU-16 airplane are discussed in the succeeding paragraphs.

<u>Airframe and Engines</u>

8. The empennage was replaced with a T-tail configuration and the hull was converted to a high length/beam ratio hull (11.3) with long afterbody. The wing float displacement was increased from 43.6 ft^3 to 60.0 ft^3. A spray suppressor was incorporated in the hull forebody, Appendix IV, figure 2. This device is a recessed slot in the chine about six in. wide and 25 in. deep. It starts at the hull bow and continues to the propeller disc plane where it ends as an exit for the trapped water. The configuration of the spray suppressor differs on each side of the airplane as shown in figure 2.

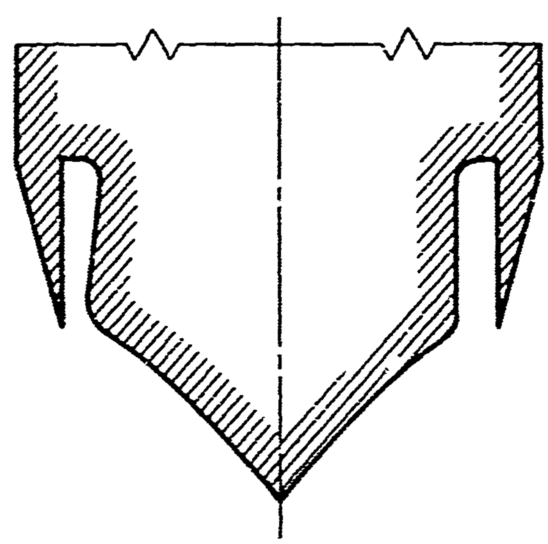


Figure 2
UF-XS Airplane Spray Suppressor Configuration, Looking Aft

9. The following high-lift devices were installed:

a. Fixed leading edge wing slats along the entire wing leading edge except between the inboard engines and the fuselage.

b. Fixed slat on the underside of the horizontal stabilizer to prevent negative horizontal tail stall.

c. Inboard and outboard wing flaps designed for maximum deflections of 80 degrees and 60 degrees, respectively.

10. Two Pratt and Whitney R-1340-AN-1 600 horsepower engines were installed outboard of the main HU-16 Wright R-1820-76B 1425 horsepower engines.

11. A hydrodamper for pitch damping in heavy seas had been incorporated in the test vehicle at the hull sternpost as shown in figure 3. The hydrodamper failed structurally during previous Japanese test flights and was removed prior to the evaluation.

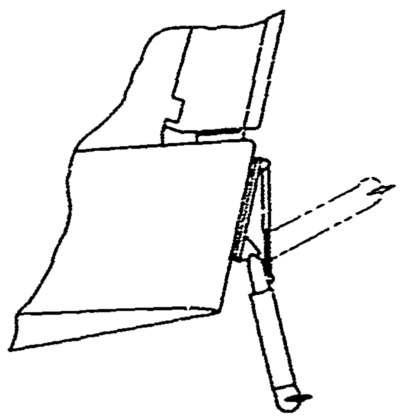


Figure 3
UF-XS Hydrodamper

<u>Boundary Layer Control (BLC) System</u>

12. A BLC system for slow speed operation was installed above the cockpit, Appendix IV, figure 3. The system supplies blowing air for the inboard and outboard flaps and all control surfaces. It is powered by two General Electric T58-GE-6A turboprop engines rated at 1250 SHP each driving an Isikawajima Harima Heavy Industries BLC-C-1 aft intake compressor. A schematic of the BLC system is contained in Appendix III, figure 3. The left engine/compressor supplies blowing air for the inboard flaps while the right engine/compressor supplies blowing air for the outboard flaps and all control surfaces. In the event of either BLC engine or compressor failure, the operative system will provide air to the outboard flaps and all control surfaces, and air to the inboard flaps is lost. Two types of blowing are utilized as indicated in Table I and illustrated in Appendix III, figure 3.

Table I

Types of BLC Blowing Utilized on UF-XS Airplane

Surface	Type of Blowing	BLC Surface
Inboard Flaps	Flap	Top
Outboard Flaps	Shroud	Top
Elevator	Shroud	Bottom
Ailerons	Shroud	Top
Rudder	Flap	Both Sides

Control System

13. The control system is modified to a dual, irreversible, power actuated, artificial feel system with extended surface deflections for low speed operation. Longitudinal and directional control is accomplished in the conventional manner. Lateral control is accomplished with ailerons at the wing tips, spoilers installed forward of the ailerons that deflect as indicated in Table II, and differential outboard flaps for slow speed (TO and Land) operation. The control surface deflections for cruise and slow speed (TO and Land) operation are shown in Table III.

Table II

Spoiler Deflection Characteristics

Spoiler	Lateral Control Wheel Deflection at Spoiler Pop-Up, Deg	Spoiler Deflection Deg
Left	46	57
Right	55	58

Table III

Maximum Control System Deflections

Control Axes	Cockpit Control Deflection	Control Surface Deflection	
		Cruise	TO and Land
Longitudinal	8.5 in. aft 4.1 in. fwd	26° up 10.5° down	40° up 22° down
Lateral	100° left 105° right	Aileron 25° up 19° down Spoilers (see Table II)	Aileron 25° up to 19° down Outboard flap* 25° up to 15° down Spoilers (see Table II)
Directional	2.5 in. left 2.4 in. right	18.5° left 21° right	44° left 36° right

*Differential outboard flap deflection is obtainable to a maximum of 45° down flap when flap deflections beyond 15° are selected.

Automatic Stabilization Equipment (ASE)

14. The ASE for the main rotor system of the UH-34 helicopter has been modified and adapted for use as an attitude stabilizing device. The system provides attitude stabilization and rate damping about the pitch and roll axes with an electrical aileron-rudder interconnect. The deflection of the control surfaces by the ASE is limited to approximately 20% of the maximum surface deflections from a pre-selected trim position. The elevator ASE trim position is controlled from the cockpit. Operation of the ASE provides no feedback to the cockpit flight controls, and the pilot can override the system.

Design Envelope

15. The airplane weight empty is approximately 28,600 lb. The basic flight design gross weight is 29,500 lb and maximum design gross weight is 35,400 lb. The structural CG limits are 15% MAC forward and 25% MAC aft. The CG limits for satisfactory flying qualities are 21% MAC forward and 25% MAC aft. The allowable airspeed-normal acceleration envelope of the UF-XS at 35,400 lb is presented in figure 4.

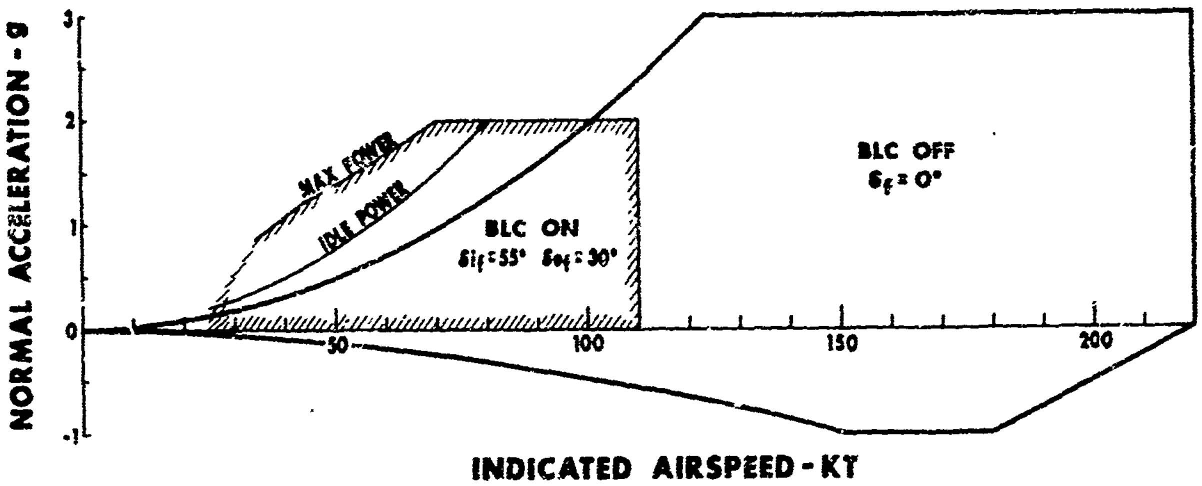


Figure 4
UF-XS Airspeed Versus Normal Acceleration

SCOPE OF TESTS

16. Nine flights and 13.9 flight hours were flown for quantitative and qualitative evaluation of the handling qualities and hydrodynamic characteristics of the UF-XS airplane within the BLC ON operating envelope shown in figure 4 for the stability configurations defined in Table IV.

Table IV

Definition of Stability Configurations

Inboard Flap Deflection - 55°
Outboard Flap Deflection - 30°
BLC Engine RPM - 18,000 (86%)

Configuration	Main Engine Power Settings: R-1820 Inbd Engines RPM/MAP-in.Hg	Main Engine Power Settings: R-1340 Outbd Engines RPM/MAP-in. Hg	Percent In-Flight Maximum Available Power
TO (Actual)	2700/50.5	2250/36.0	100
TO (Test)*	2400/39.0	2000/29.0	78
PA**	2300/33.0	2000/27.0	62
L	2000/20.0	2000/20.0	28

* Engine Powers in excess of those indicated were prohibited to prevent exceeding cylinder head temperature limits.
**Power required for level flight.

17. The following tests were performed during the evaluation:

a. Stalls. Stalls in configurations TO, PA and L with the ASE ON.

b. Longitudinal Stability and Control. Static and dynamic longitudinal stability and longitudinal trim changes at 55 kt IAS in configurations TO, PA, and L with the ASE both ON and OFF.

c. Lateral-Directional Stability and Control. Static and dynamic lateral-directional stability at 55 kt for configuration PA with the ASE both ON and OFF. Lateral control effectiveness and adverse yaw for configurations PA and L at 55 kt IAS and 70 kt IAS with ASE both ON and OFF.

d. Hydrodynamic Characteristics. Static longitudinal hydrodynamic stability and longitudinal control effectiveness with ASE ON. Spray tests were performed both for the TO configuration defined in Table IV and with the BLC system inoperative with inboard/outboard flap settings of 32°/18°.

e. Take-off and Landing Characteristics. Stability and control during take-off, approach to landing, and landing.

18. All tests were conducted over the airplane gross weight range 31,000 to 34,000 lb, at a CG position of 22% MAC and either at sea level or within the altitude band 4,000 to 6,000 ft. All tests were made with the BLC system operating except one portion of the spray characteristics investigation.

19. The range of main engine powers used for the flight tests are shown in Table IV. Main engine powers greater than 78% were prohibited because of excessive engine cylinder head temperatures at the low test airspeeds. Main engine powers of less than 28% were prohibited because of engine underboosting.

20. Tests were not performed below 55 kt IAS, except for stall tests, because of engine cylinder head temperature overheat, airplane instability, and stabilizer position approaching the full trailing edge down position.

21. The following restrictions were observed during the evaluation:

a. Flight below 55 kt IAS with ASE OFF not permitted.

b. Main engine out operation or flights with BLC system inoperative not permitted.

c. Bank angles not to exceed 60°.

d. Rough water operation permitted in wave heights up to 6 ft.

e. Flap deflections limited to a maximum of 55° on the inboard flaps and 30° on the outboard flaps.

f. Spins, inverted flight, and fishtailing not permitted.

22. Open sea tests could not be performed because rough water with waves of any significant height was not available during the evaluation. The maximum wave heights encountered during the evaluation were 1 1/2 ft.

METHOD OF TESTS

23. Stability and control test techniques were in accordance with reference 2. The airplane was instrumented to record the quantities listed in Appendix VI on a photopanel, an 18-channel Consolidated Engineering Corporation CEC-5-114-P3 oscillograph, and in the cockpit. The instrumentation was calibrated by Japanese personnel under guidance from the U. S. evaluation team prior to the commencement of the quantitative flight tests.

24. Airspeed, altitude, angle of attack, and angle of sideslip were measured from a pitot-static source and vanes located on an instrumentation mast on the bow of the airplane, Appendix IV, figure 4. The airspeed system was not calibrated for position error either during the evaluation or prior to the evaluation by the contractor. All airspeeds presented in this report are corrected only for the instrument error. The test airplane gross weights are based on the contractor's weight empty (approximately 28,600 lb), 1,000 lb for personnel aboard, and an estimate of the fuel quantity remaining at the time of the test. The contractor's CG position (22% MAC) was accepted.

25. The hydrodynamic test techniques were in accordance with reference 3. Still and motion picture cameras were used to obtain coverage of the spray envelopes on both sides of the hull. Since a waterspeed system was not incorporated in the test airplane, all hydrodynamic data are presented in terms of airspeed.

26. The airplane flying qualities and hydrodynamic characteristics were rated in accordance with the Cooper Rating System shown in Appendix VII.

CHRONOLOGY

27. The chronology of tests is as follows:

a. Problem assignment received - 24 Mar 1964

b. Simulator tests commenced at NASA Ames Research Laboratory - 4 May 1964

c. Simulator tests completed - 6 May 1964

d. Flight tests commenced - 15 May 1964

e. Flight tests completed - 27 May 1964

RESULTS AND DISCUSSION

NASA SIMULATOR AND STOL C-130 FLIGHT TESTS

28. The Navy pilot member of the UF-XS evaluation team participated in four hours of simulator operation at the NASA Ames Research Center, Moffett Field, California. The simulator was programmed for the UF-XS airplane characteristics in configuration PA at two different speeds and lift coefficients, 50 kt (C_L= 4.0) and 40 kt (C_L= 6.0). Both speeds were programmed for ASE ON and OFF operation. The simulator consisted of a typical multi-engine cockpit free to move in pitch and roll with a visual presentation of a lighted runway and approach lights projected on a screen. The simulator was programmed for an approach to the runway from an altitude of 500 ft. The first 300 feet of the descent was flown on instruments and the last 200 feet with visual reference to the screen display. Simulator deficiencies noted were the airplane motion feel simulation, common to all simulators of this type, lack of cockpit controlled lateral trim, and inadequate power level indications. Within the capacity of the simulator, the characteristics of the UF-XS airplane in the configurations tested were satisfactorily simulated. Detailed results of simulator tests will be reported by NASA Ames Research Center

29. The Navy pilot member of the UF-XS evaluation team obtained one flight in the NASA Ames Research Center BLC and variable stability equipped STOL C-130 airplane. The BLC air was supplied by two YT-56A-6 engines driving load-compressors mounted on outboard wing pods. Shroud type blowing BLC was provided on the high deflection wing flaps, drooped ailerons, elevator and enlarged rudder. Performance improvements over a standard C-130 included reduction of the landing approach speed from 106 to 67 knots and the landing ground distance from 1450 to 690 feet for a 100,000 lb airplane. The major problem area is the unsatisfactory lateral-directional dynamic characteristics. The large-amplitude, short-period directional oscillation results in runway line-up difficulty during the landing approach. Reference 4 reports on the

handling qualities and operational problems of the STOL C-130 airplane. Subsequent tests of the UF-XS airplane showed that the flying qualities of the UF-XS at 55 kt IAS are equal to or better than those of the NASA Ames STOL C-130 airplane at 70 kt IAS.

FLYING QUALITIES OF THE UF-XS AIRPLANE WITH ASE OFF

Static Longitudinal Stability

30. The quantitative static longitudinal stability tests were performed with ASE ON to expedite the testing since the results based on elevator position gradient would be unaffected. For configuration PA at a trim speed of 52.5 kt IAS, the elevator position gradient is slightly unstable (Cooper Rating 4). The airplane becomes stable at speeds above trim and unstable at speeds below trim down to stall (48 kt IAS). For configuration TO at a trim speed of 56 kt IAS, the gradient was neutral at trim, becoming stable above trim, and qualitatively unstable below trim to stall (approximately 46 kt) (Cooper Rating 3). For configuration L at a trim speed of 56 kt, the gradient was neutral at trim and down to stall (53 kt) and becoming stable above trim. The longitudinal control gradient, which is indicative of the elevator force gradient, is stable throughout the range tested about the 56 kt IAS trim point for configurations L and TO. For configuration PA, the control gradient is neutral at trim, becoming stable above trim and unstable below trim. The static stability in configurations TO, PA, and L below the trim speed of 55 kt IAS does not meet the requirements of paragraph 3.3.1 of reference 5.

31. For configurations TO, PA, and L at a trim speed of 55 kt IAS, the elevator was positioned at 4°, 7° and 16° TED respectively, as shown in Appendix VIII, figure 1. At higher speeds where the airplane becomes stable, the elevator position moves closer to the TED limit. For configuration L, the elevator reaches the TED limit at approximately 75 kt IAS. At speeds below 55 kt IAS, the airplane tends to become unstable and the elevator again moves toward the TED limit, although for the test conducted the limit was not reached.

Dynamic Longitudinal Stability

32. In configurations L, PA, and TO, airplane response to elevator pulse and step inputs indicates good airplane damping (Cooper Rating 2). In configurations L and PA, the dynamic

response is a moderate aperiodic pitch divergence. In configuration TO, a diverging phugoid was noted of approximately one minute period.

Static Lateral-Directional Stability

33. For configuration PA at a trim speed of 55 kt IAS, the static lateral and directional forces and deflections in steady heading sideslips are essentially linear throughout the range of full rudder travel, as shown in Appendix VIII, figure 2 (Cooper Rating 2). Trimmed in this configuration, with a bank angle of 2° to the right, a sideslip angle of 13° left, a rudder deflection of 25° right, and nearly full right rudder trim are required. With extended control throws (TO and Land) selected, full rudder deflections produce sideslip angles of 19° left and 26° right measured from the airplane centerline. The sideslip angle measuring vane is limited to 21° left and 12° right; therefore, larger sideslip angles are estimated by extrapolation. The rudder pedal forces are light for this type airplane. The dihedral effect is slightly positive. The sideslip angle, the rudder deflection, and rudder trim required for trim condition are excessive and unsatisfactory (Cooper Rating 4).

Directional Control Effectiveness

34. For configuration PA at a trim speed of 55 kt IAS, 1.3 inches of right rudder pedal deflection is required, resulting in rudder pedal deflection available of 1.2 inches right and 3.8 inches left. Directional control authority with extended control throw (TO and Land) selected is adequate to the left, permitting a sideslip angle displacement of approximately 39°, measured from the trim position. Authority to the right was considerably less, permitting a sideslip angle increment of only 6° from trim (Cooper Rating 4). The engine out case was not investigated; however, the limited right rudder may be inadequate. No indication is given to the pilot that extended control throw (TO and Land) has not been selected when the airspeed has decreased to the speeds where extended control throw is necessary. A provision should be made in production airplanes to provide either a warning that extended control throw is not selected or an automatic selection.

Lateral Control Effectiveness

35. Lateral control effectiveness was evaluated for configuration PA at trim speeds of 55 and 70 kt IAS by performing rudder fixed, abrupt aileron deflection rolls. For configuration PA

at 55 kt IAS, lateral control wheel displacements for the tests ranged from 17° to 57° out of the total of approximately 100° available. Larger control wheel deflections were not used to avoid excessive and possibly uncontrollable adverse yaw effects (paragraph 37). The roll rates developed are linear with control wheel deflection as shown in Appendix VIII, figures 3 and 4. Limited tests at 70 kt IAS show the lateral control effectiveness to be slightly improved. The maximum roll rate developed meets the requirements of paragraph 3.4.16 of reference 5 (Cooper Rating 2); however, the bank angle change on second after initiation of lateral control is less than the 8° suggested by reference 6. The bank angle changes obtained during the tests utilizing 1/3 to 2/3 lateral control wheel deflection varied between 4° and 7° at 55 kt IAS and 4° and 8° at 70 kt IAS (Cooper Rating 3).

36. The effectiveness of the spoilers is inadequate because of their location just forward of the ailerons and the 55° wheel deflection required for their operation. The contractor intends to move the spoilers inboard and forward of the outboard flap on the P-XS airplane to improve their effectiveness. It is believed that this should aid in increasing effectiveness; however, it is believed that actuation at aileron deflections of 3° to 5° should further improve effectiveness and aid in reducing the adverse yaw discussed in paragraphs 37 and 42.

Adverse Yaw

37. Adverse yaw is extremely large and lateral control wheel deflections should be limited to angles less than 60° to avoid excessive sideslip angles (Cooper Rating 5). Maximum sideslip angles could not be measured because the sideslip measuring vane was limited to a travel of 21° to the left and 12° to the right. It is estimated that sideslip angles measured from the airplane center line in excess of 7° left and 43° right are obtainable with 1/2 lateral control wheel deflection at 55 kt. The sideslip angles developed exceed the 15° maximum limit set forth in paragraph 3.4.9 of reference 5. It is felt that larger lateral control deflections and/or larger step inputs would result in greater yaw rates and sideslip angles with possible loss of aircraft control. At a trim speed of 70 kt IAS, the sideslip angles were reduced only slightly. Time histories of the adverse yaw characteristics with the ASE OFF at 55 and 70 kt IAS are presented in Appendix VIII, figures 5 and 6.

Dynamic Lateral-Directional Stability

38. Dutch Roll tests resulted in a predominantly directional oscillation with a long period and medium damping (Cooper Rating 5). The period is 6 to 6.5 seconds. Time to damp to 1/2 amplitude is 4 1/2 to 5 seconds and 3/4 cycle, as shown in Appendix VIII, figure 7. Spiral stability tests were performed by trimming the airplane in straight flight and then releasing from bank attitudes displaced approximately 2° from trim. The airplane has strongly divergent spiral stability (Cooper Rating 5) with time to double amplitude of 2.7 seconds to the left and 3.7 seconds to the right, as shown in Appendix VIII, figure 8.

General Characteristics ASE OFF

39. The most serious flying qualities deficiencies of the basic airplane (ASE OFF) in configuration PA at 55 kt IAS are its lateral-directional characteristics (Cooper Rating 6). The combination of high adverse yaw, long Dutch Roll period with medium damping, limited right rudder authority, large sideslip angle and spiral instability requires constant pilot attention to maintain control of the aircraft. Shallow bank angles (ten degrees) and slow roll rates attained with approximately ten degrees of wheel deflection are the maximum desirable for normal operation in landing approach maneuvers. Bank angles greater than ten degrees are not normally necessary due to the fast turn rates obtained at the slow approach speeds. Rudder coordination is a necessity to prevent excitation of the undesirable Dutch Roll oscillation. Bank angles larger than ten degrees also make longitudinal control and consequently altitude and speed control more difficult. Near wings level attitude, longitudinal control is relatively effortless for the pilot. Airspeed is easily controlled by elevator and pitch attitude. Altitude control is slightly more difficult since it is sensitive to airspeed and power. During an approach, small changes in airspeed, on the order of 2 to 3 kt, result in appreciable glide slope angle variation which must be compensated for with power. Qualitative evaluation of the flying qualities of the airplane in configuration PA indicates that general improvement occurs above 55 kt IAS and a deterioration below 55 kt IAS.

FLYING QUALITIES OF THE UF-XS AIRPLANE WITH ASE ON

Longitudinal Axis

40. The ASE provides both attitude stabilization and rate damping about the pitch axis and completely modifies the basic airplane longitudinal characteristics. With the controls released the ASE will hold the airplane in the pitch attitude established by the trim system. An elevator pulse input will momentarily displace the airplane in pitch; and upon release, the airplane will return to approximately the original attitude with a slight overshoot, as shown in figure 5. An elevator step

BLC ON

Trim Airspeed 55 kt IAS
Gross Weight 32,000 lb
CG Position 22% MAC
Altitude 5,000 ft

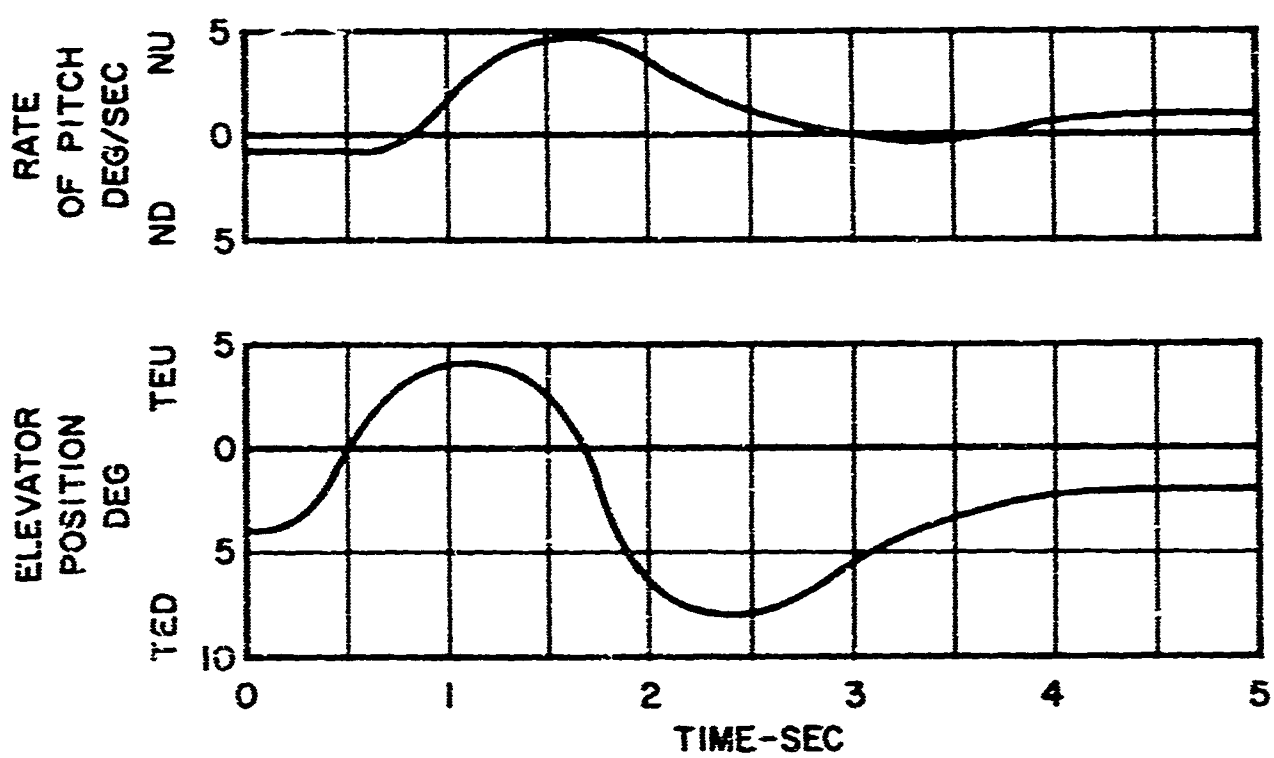


Figure 5
Airplane Short Period Oscillation with ASE ON

input will displace the airplane in pitch to a new attitude with a similar motion. The period of the response is such that it can lead to a pilot induced oscillation (PIO) during a pitch maneuver either in flight or on the water during take-off or landing. The attitude hold capability in pitch is poor, probably because of control system friction, resulting in some airspeed wander and trimming difficulty which makes the ASE poor as an attitude hold device (Cooper Rating 3). The attitude hold feature is also undesirable for maneuvering, since any displacement in pitch from the trim attitude requires either constant elevator control force or retrimming to relieve the force. The ASE authority over elevator travel includes only a 20 percent range of total elevator travel available. This 20 percent range amounts to approximately 14° centered about a position which is controlled from the cockpit, but normally remains fixed during flight. The authority is limited to 20 percent to prevent uncontrollable flight in case of a hard-over signal. The result is that the ASE stabilization capability is maximum when the elevator is positioned in the center of this fixed range. Stabilization is reduced in the direction of elevator motion when the elevator is displaced from center. This loss of stability becomes apparent at low airspeeds and high lift coefficients when the elevator position is close to the TED limit (Cooper Rating 4).

<u>Lateral-Directional Axes</u>

41. The ASE provides attitude stabilization and rate damping about the roll axis plus an aileron rudder interconnect. The attitude stabilization feature tends to maintain a wings level attitude using 20 percent of the maximum lateral control authority available. For rolling maneuvers where bank angle is increasing, the aileron deflection selected by the pilot is reduced by the maximum amount of ASE authority. Conversely, for rolling maneuvers where bank angle is decreasing, the aileron deflection is increased. Records of rolling performance tests with ASE ON, showing the positions of the controls during the maneuver, are presented in Appendix VIII, figures 5 and 6, for 55 and 70 kt IAS (Cooper Rating 3). As a result of the roll attitude stabilization of the ASE, rolling performance and control power for increasing bank angles is reduced when compared with ASE OFF operation as shown in Appendix VIII, figures 3, 4, and 5. A further consequence of this system is the fact that lateral control wheel displacement and force must be maintained during steady banked maneuvers. Although control forces are acceptable for transient movements, the requirement to maintain the force and displacement while banked is unsatisfactory (Cooper Rating 4).

42. The aileron rudder interconnect does not sufficiently reduce the adverse yaw which is still excessive, as shown in

Appendix VIII, figures 5 and 6 (Cooper Rating 4). The sideslip angles developed exceed the requirements of paragraph 3.4.9 of reference 5. The period of the lateral-directional oscillation is increased and the damping is decreased with the ASE ON when compared to ASE OFF operation. This degradation may be caused by adverse yaw generated from ASE deflection of the ailerons that lag the sideslip angle by 90° and thus reinforce the oscillation, as shown in Appendix VIII, figure 9. A comparison of the lateral-directional characteristics with ASE ON and OFF is presented in Table VI.

Table VI

Comparison of Lateral-Directional Characteristics With ASE ON and OFF Operation

	ASE OFF	ASE ON
Period, sec	5.5 to 6	7 to 8
Time to 1/2 Amplitude, sec	4.5 to 5	8 to 9
Cycles to 1/2 Amplitude	0.75	1.2

The spiral instability is eliminated by the attitude stabilization. The lateral-directional characteristics of the basic airplane (ASE OFF) in configuration PA make artificial stability augmentation mandatory; however, the present attitude stabilization system is unsatisfactory (Cooper Rating 4).

Stall Characteristics

43. All stalls were performed in the altitude band of 4,000 to 6,000 ft with ASE ON. Little or no aerodynamic stall warning was indicated, although the stalls were mild and recovery rapidly accomplished (Cooper Rating 2). Control about all three axes, as indicated by airplane response, decreased with decreasing airspeed. At stall the nose yaws slightly right and gently pitches down with a slow roll to the right. Rapid recovery occurs upon easing the nose down, and bank angles can be limited to 15 degrees and altitude loss to less than 300 ft. A time history of a typical stall in configuration PA is shown in Appendix VIII, figure 10.

Trim Changes

44. Tests were performed to determine the magnitude of the trim

changes occurring with various changes in power and wing flap settings. Power changes had little or no effect on longitudinal trim. Flap deflection changes had to be performed in stages due to the various mechanical steps involved in their operation, the changes of BLC engine power performed during flap operation, and large changes in airspeeds occurring during flap operation. Since flap angle changes occurred over a relatively long period of time and a large speed range, the resulting trim changes were considered acceptable. In general, lowering of the flaps created a pitch up which was greater for the initial portion of flap deflection. Increasing power on the BLC engines created a slight pitch down.

HYDRODYNAMIC CHARACTERISTICS

Taxi Characteristics

45. All hydrodynamic tests were performed in winds of less than 15 kt and wave heights of less than 1.5 ft. Water taxi speed with engines at idle is approximately 8 kt. Reduction in speed is accomplished by either securing the outboard engines, reversing the inboard engines, or both. Turning radii are large if turns are accomplished by using rudder and increasing outboard engine power. Small diameter turns can be performed by reversing the inside inboard engine.

Take-Off and Landing Characteristics

46. The short take-off is performed with a flap selection of 55°/30° and BLC engines at maximum (85%). The take-off is performed in the conventional manner, applying military power to all reciprocating engines and maintaining directional and lateral control by use of the flight controls. Directional control can be augmented if required at the initial portion of the run by use of differential outboard engine power. A wings level attitude is easily achieved due to the enlarged floats which extend lower than the original floats. The BLC system and differential outboard flaps immersed in propeller slip stream greatly increase lateral control effectiveness. The elevator control is held aft of the zero elevator angle trim position in order to achieve a stable hull trim angle. All porpoising tendencies during the take-off tests were controllable with the elevator. Take-off occurs at approximately 50 kt after a 15 second run. After lift off the airplane yaws approximately ten degrees right to assume the sideslip angle discussed in paragraph 33. In addition the pitch attitude must be changed three to five degrees nose

down to permit the airspeed to increase. The landing approach and touchdown is performed in configuration PA. Airspeed on the base leg of the approach is 60 kt, the final approach is 55 kt, and the touchdown is at 50 to 55 kt. Rates of sink exceeding 500 fpm can be attained during the approach by reducing engine power. The pilot controls sink rate by power and airspeed by attitude. The optimum rate of sink on the final approach and touchdown is approximately 230 fpm. Sink rates less than this result in the airplane leveling off just above the surface due to ground effect with further power reduction necessary to effect the touchdown. Sink rates up to 300 fpm are considered satisfactory and above 300 fpm are excessive. At touchdown the airplane yaws approximately ten degrees to the left as the sideslip angle is eliminated, and the pitch attitude must be increased three to five degrees to avoid porpoising. Immediately following water contact, power on the main and BLC engines is reduced to avoid becoming airborne again. The initial landing shock is light with shocks increasing slightly to a maximum at the hump speed. In the maximum sea condition tested, 1.5 foot waves, the water impact shocks during take-offs and landings were light.

Hydrodynamic Longitudinal Stability and Control Characteristics

47. Limited hydrodynamic longitudinal stability tests were performed by making a series of take-offs in STOL operation with various fixed elevator settings, as shown in Appendix VIII, figure 11. The take-off run would continue until one of the following occurred: (1) two degree porpoise oscillation, (2) nose "dig-in," (3) speed stagnation, or (4) take-off. It was determined that the elevator range for stable take-off is 20 to 35 degrees up elevator. Elevator positions below 20 degrees result in the nose "digging in." Low elevator settings cause the "dig-in" to occur at lower speeds. At elevator settings ranging near neutral to 20 degrees, a porposing action with approximately a three second period occurs. Speeds at which tests were terminated ranged from approximately 40 kt IAS for full down elevator to 45 kt IAS for 15 degrees up elevator. The elevator control was always sufficient to counter the "dig-in" and porpoise when the take-off was terminated. At elevator settings above 35 degrees, the airplane did not take off but assumed a slightly nose high attitude, and the speed stagnated at approximately 45 kt IAS. The hydrodynamic longitudinal control characteristics are good (Cooper Rating 2). The hydrodynamic longitudinal control effectiveness, obtained from the data of Appendix VIII, figure 11, is presented in Appendix VIII, figure 12.

Spray Characteristics

48. The main spray characteristics were evaluated during constant speed runs in headwinds of 5 to 10 kt and wave heights of 0.5 to 1.0 ft for the following conditions:

a. ASE ON, BLC ON, flaps deflected 55°/30°, and over the speed range from taxi to 43 kt IAS.

b. ASE ON, BLC OFF, flaps deflected 32°/18°, and over the speed range from taxi to 57 kt IAS.

Data were obtained for both the left and right configuration of the spray suppressor illustrated in figure 2. Insufficient photographic coverage of the left side of the airplane was obtained, and data presented in this report pertain only to the right side of the airplane. Appendix III, figure 4 presents the results of the main spray envelope tests and shows that the spray envelope is increased slightly at the aft portion of the hull when the BLC is in operation. Appendix VIII, figure 13, shows the results of the non-dimensional analysis using the notation contained in Appendix II and compares the results with P5A, P5B, R3Y, and M270 seaplanes. The results indicate that the main spray characteristics of the UF-XS are superior to the P5A and P5B seaplanes. The spray characteristics are not as good as the R3Y and M270 at the forward portion of the hull, comparable at mid hull, and better at the aft portion of the hull. The overall spray characteristics are considered good.

49. When the BLC system is in operation on the water, the flow of air generated by the BLC system creates a water mist which circulates in rotary fashion about a transverse axis under the wing and extends spanwise the length of the flaps. The mist is light and does not pose a problem. At a constant speed of 38 kt IAS, with the BLC operating, medium spray was observed to pass through the propeller arcs with light spray passing over the wings. This spray characteristic also occurs during take-off but is less pronounced. The blunt shape of the bow caused some spray impingment on the windshield when taxiing into the wind in 1 1/2 ft waves.

CONCLUSIONS

50. The UF-XS airplane is intended only for investigation of the slow speed flight (STOL) and hydrodynamic characteristics of the Japanese open sea seaplane design (paragraph 3).

51. The UF-XS airplane has advanced the seaplane "state of the art" in the following areas (paragraph 3):

   a. Drastic reduction of take-off and landing run speeds, distances, and times (paragraph 46).

   b. Improvement in lateral control effectiveness during take-off and landing (paragraph 46).

   c. Improvement in hull spray characteristics (paragraph 48).

52. The characteristics of the UF-XS airplane in the configuration tested were satisfactorily simulated by the simulator at the NASA Ames Research Center (paragraph 28).

53. The flying qualities of the UF-XS airplane at 55 kt IAS are equal to or better than those of the NASA Ames STOL C-130 airplane at 70 kt (paragraph 29).

54. Static longitudinal stability, as indicated by elevator position gradient, is slightly unstable for configurations TO, PA and L at a trim airspeed of approximately 55 kt IAS (paragraph 30).

55. The airplane trims in straight and level flight at 55 kt IAS in a 2° right bank, 13° left sideslip with 25° right rudder deflection and nearly full right rudder trim (paragraph 33).

56. The sideslip angle, rudder deflection and rudder trim required for balanced flight at 55 kt IAS are excessive and unsatisfactory (paragraph 33).

57. Peak roll rates are satisfactory; however, the bank angle change one second after initiation of lateral control is less than the 8° suggested by reference 6 (paragraph 35).

58. The spoilers are ineffective (paragraph 36).

59. Adverse yaw is extremely large (paragraph 37).

60. The dutch roll mode with ASE OFF is predominantly a directional oscillation with a long period (6 to 6.5 sec) and medium damping (paragraph 38).

61. The spiral stability with ASE OFF is strongly divergent (paragraph 38).

62. The attitude hold feature of the ASE is undesirable for maneuvering (paragraphs 40 and 41).

63. ASE stabilization is reduced when the elevator is displaced from center of the ASE authority range (paragraph 40).

64. Rolling performance with ASE ON is reduced as compared to ASE OFF for equal lateral control displacements (paragraph 41).

65. The period of the lateral-directional oscillation is increased and the damping decreased with the ASE ON as compared with ASE OFF operation (paragraph 42).

66. The spiral instability is eliminated by the ASE (paragraph 42).

67. The lateral-directional characteristics of the airplane with ASE OFF in configuration PA make artificial stability augmentation mandatory; however, the present attitude stabilization system is unsatisfactory (paragraph 42).

68. Stalls are mild with little or no aerodynamic stall warning and rapid recovery (paragraph 43).

69. Take-off and landing occurs at approximately 50 kt IAS with a take-off run of 15 sec (paragraph 46).

70. The heading changes 10 degrees to the right on take-off and 10 degrees to the left on landing touchdown (paragraph 46).

71. The stable elevator range for hydrodynamic stability is 20 to 35 degrees TEU elevator (paragraph 47).

72. Hydrodynamic longitudinal control is good (paragraph 47).

73. The main spray characteristics are good (paragraph 48).

74. During the evaluation period, the design point of a 40 to 50 kt approach speed was not attained. The following deficiencies either prevented satisfactory operation of the UF-XS seaplane at the more desirable speeds below 55 kt IAS or adversely affected the flying qualities:

a. Limited down elevator control at speeds below 55 kt.

b. Excessive sideslip angle.

c. Excessive right rudder required for trim.

d. Excessive adverse yaw.

e. Inadequate effectiveness of the spoilers in increasing roll rate and decreasing adverse yaw.

f. Dutch roll period and damping.

g. ASE characteristics:

(1) Longitudinal PIO tendency.

(2) Poor attitude hold.

(3) Fixed elevator authority range limiting longitudinal stability augmentation at slow speeds.

(4) Reduction in lateral control displacement and roll performance when increasing bank angle.

(5) Necessity to hold lateral control to maintain bank angle.

(6) Lack of directional stability augmentation.

h. Excessive engine cylinder head temperatures at slow speeds.

RECOMMENDATIONS

75. Continue monitor of the Japanese STOL Seaplane program.

76. Provided modifications to the UF-XS airplane are made to permit satisfactory operation at approach speeds of 40 to 45 kts, evaluation is highly desirable to determine the following:

a. Flying qualities at the design landing approach speeds of 40 to 45 kts.

b. Maximum rough water and wind capability for take-off, landing and taxi.

77. Prior to further evaluation of the UF-XS, it is desirable to have the following accomplished:

a. Correction of deficiencies listed in paragraph 74.

b. Determination of BLC engine failure effects in configuration PA.

c. Determination of outboard engine failure and minimum control speeds in configuration PA.

REFERENCES

1. BUWEPS Confidential Letter RAAD-3/63:GLD serial 04223 of 2 Oct 1963

2. Pilot Techniques for Stability and Control Testing, USNTPS revised Summer 1958

3. Hydrodynamics Manual, NATC of May 1958

4. NASA TN D-1647 Handling Qualities and Operational Problems of a Large Four-Propeller STOL Transport Airplane, January 1963

5. Spec MIL-F-8785 (ASG) of 1 Sep 1954 amended 17 Apr 1959

6. NATC Report RA1200001(PTR AD-375) serial FT212-222 of 19 Jul 1963

DEFINITION OF SYMBOLS

ASE - Automatic stabilization equipment

b - Wing span or hull beam (ft)

BLC - Boundary layer control

C_L - Airplane lift coefficient

C_X - Longitudinal spray coefficient ($^X/_b$)

C_Z - Vertical spray coefficient ($^Z/_b$)

C_Δ - Load coefficient $\frac{\Delta}{wb^3}$

CG - Center of gravity

deg - Degrees

ft - Feet

fpm - Feet per minute

Hg - Mercury

IAS - Indicated airspeed (knots)

in. - Inches

kt - Knots

L - Landing configuration

lb - Pounds

LT - Left

MAC - Mean aerodynamic chord

MAP - Manifold absolute pressure (in. Hg)

ND - Nose down

NU - Nose up

p - Rate of roll (deg/sec)

PA - Power approach configuration

PIO - Pilot induced oscillation

$\frac{Pb}{2V_t}$ - Rolling helix angle (radians)

RPM - Revolutions per minute

RT - Right

sec - Second

STOL - Short take-off and landing

TED - Trailing edge down

TEU - Trailing edge up

TO - Take-off configuration

V_t - True airspeed (ft/sec)

w - Specific weight of water (lb/ft^3)

X - Longitudinal point of tangency of main spray

Z - Vertical point of tangency of main spray

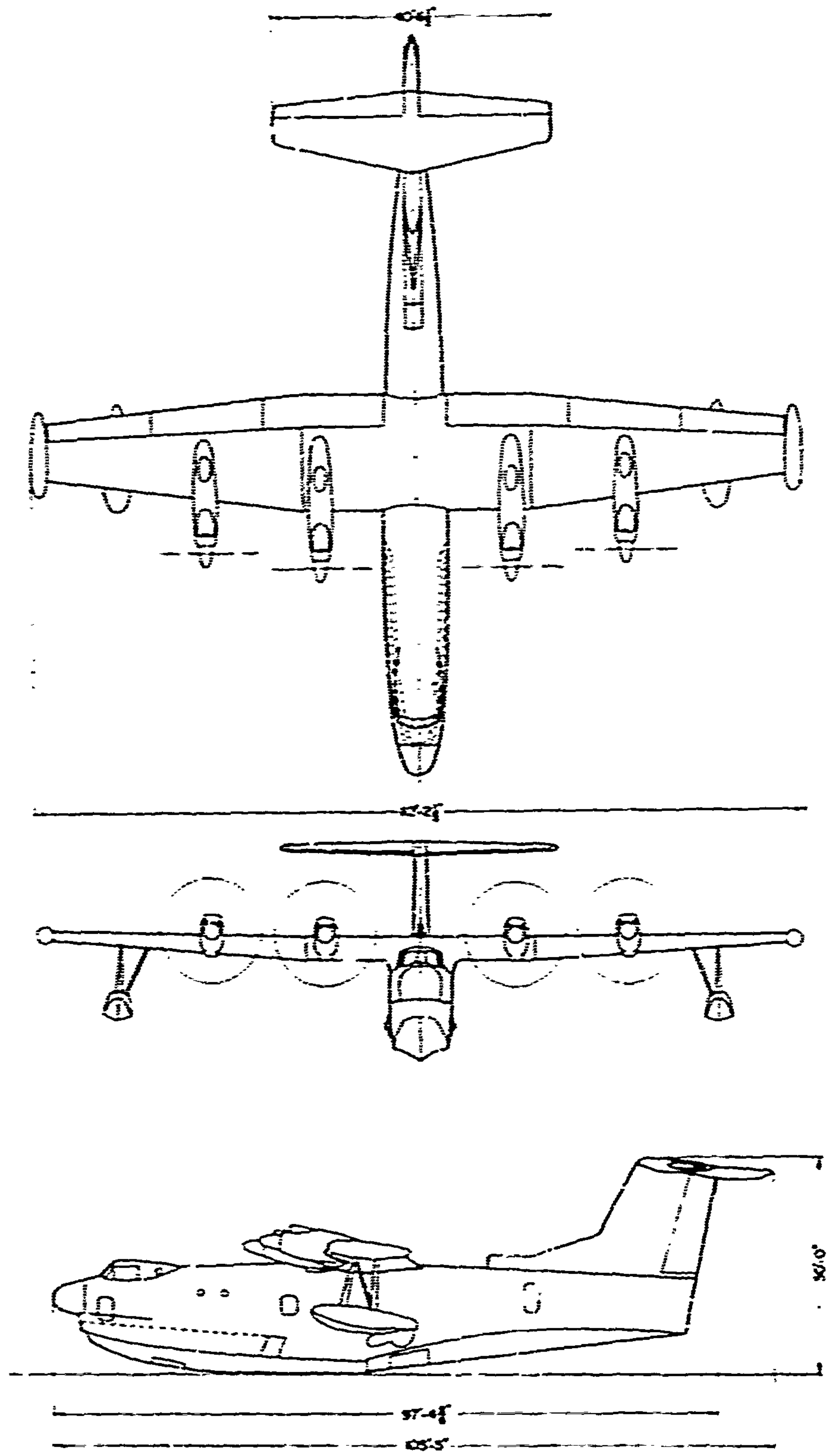
° - Degrees

Δ - Test gross weight (lb)

δ_e - Elevator position (deg)

τ - Hull trim angle

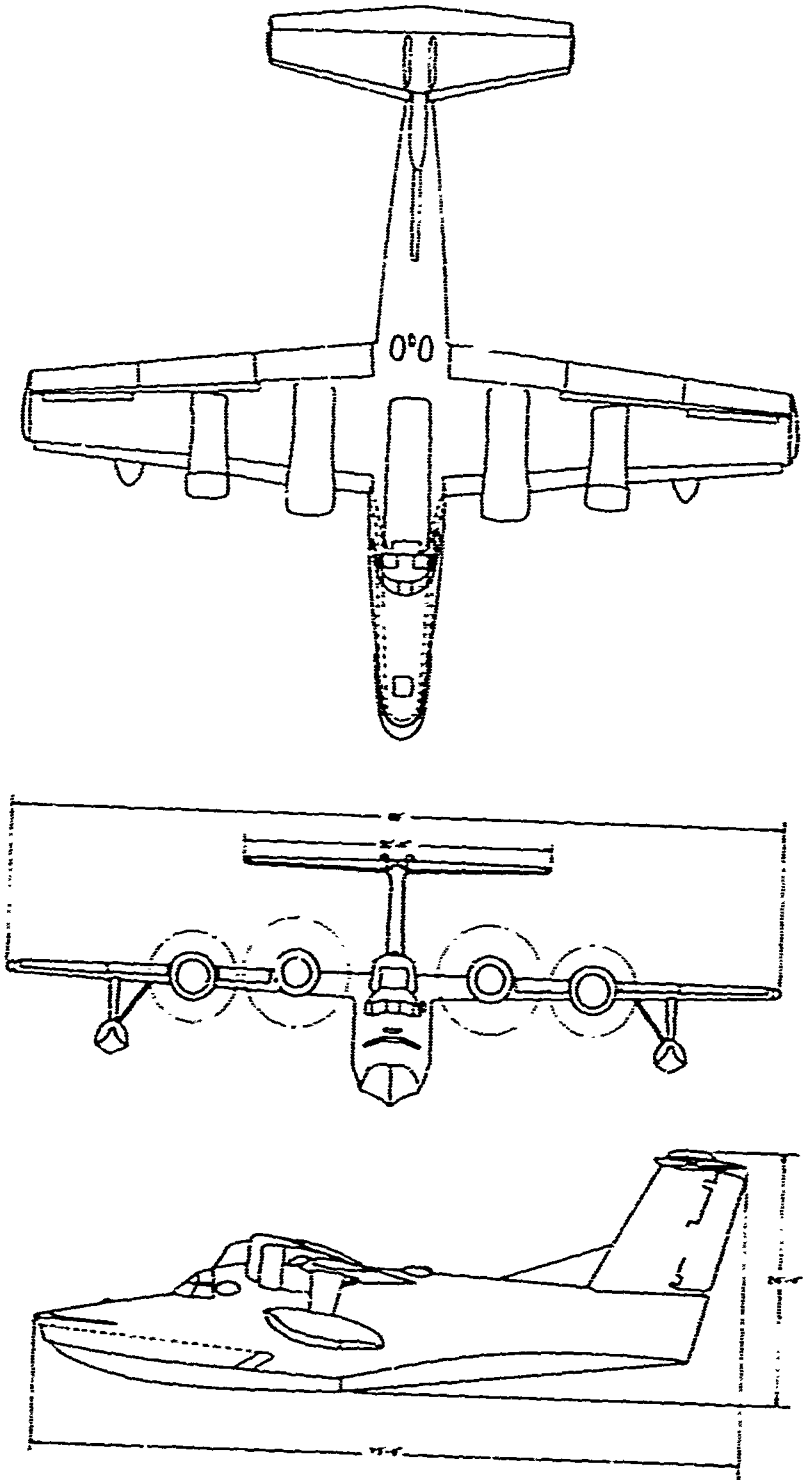
d - Derivative



P-XS Airplane

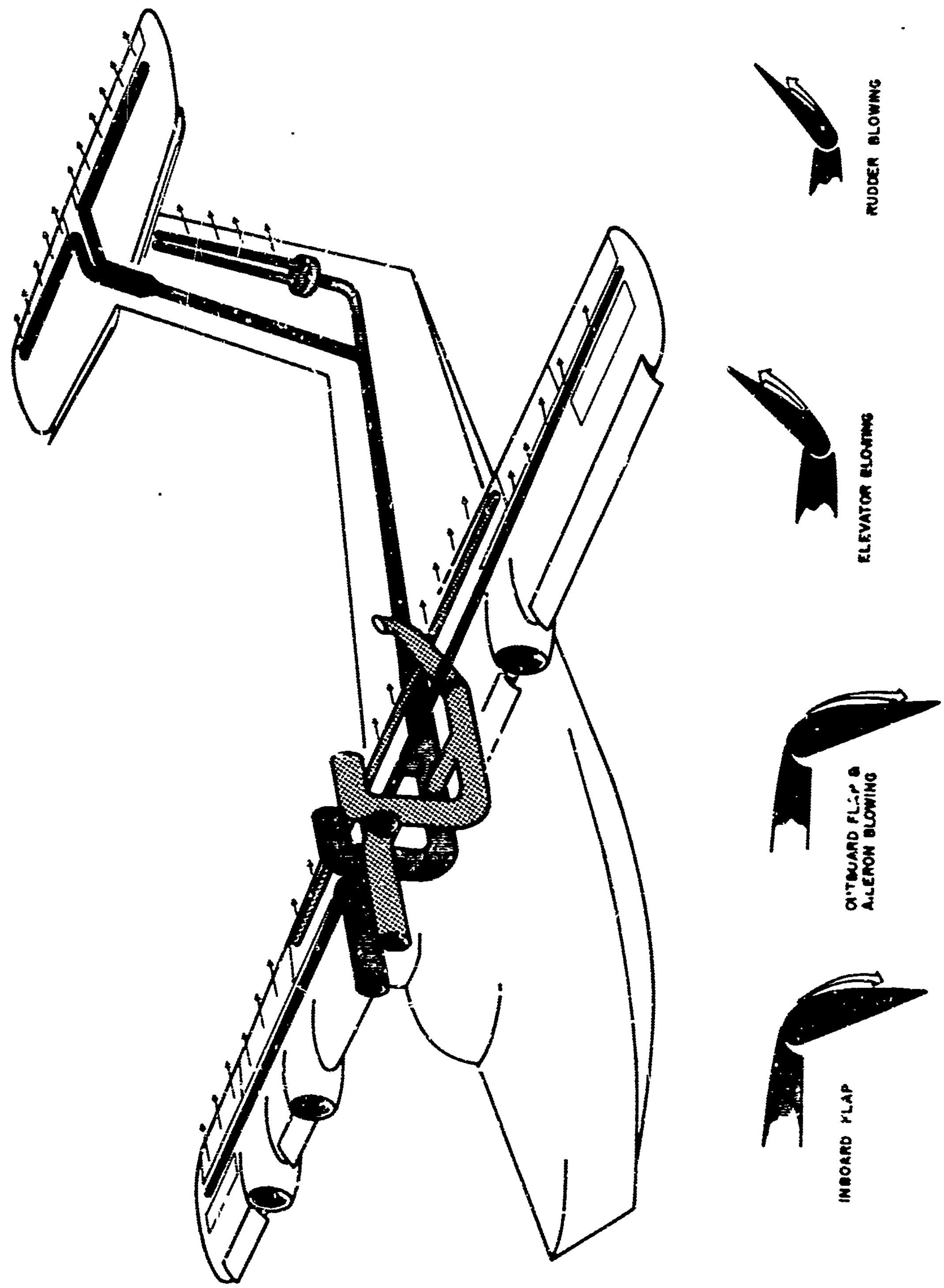
THREE VIEW DRAWING

Figure 1
APPENDIX III



UF-XS Airplane

THREE VIEW DRAWING

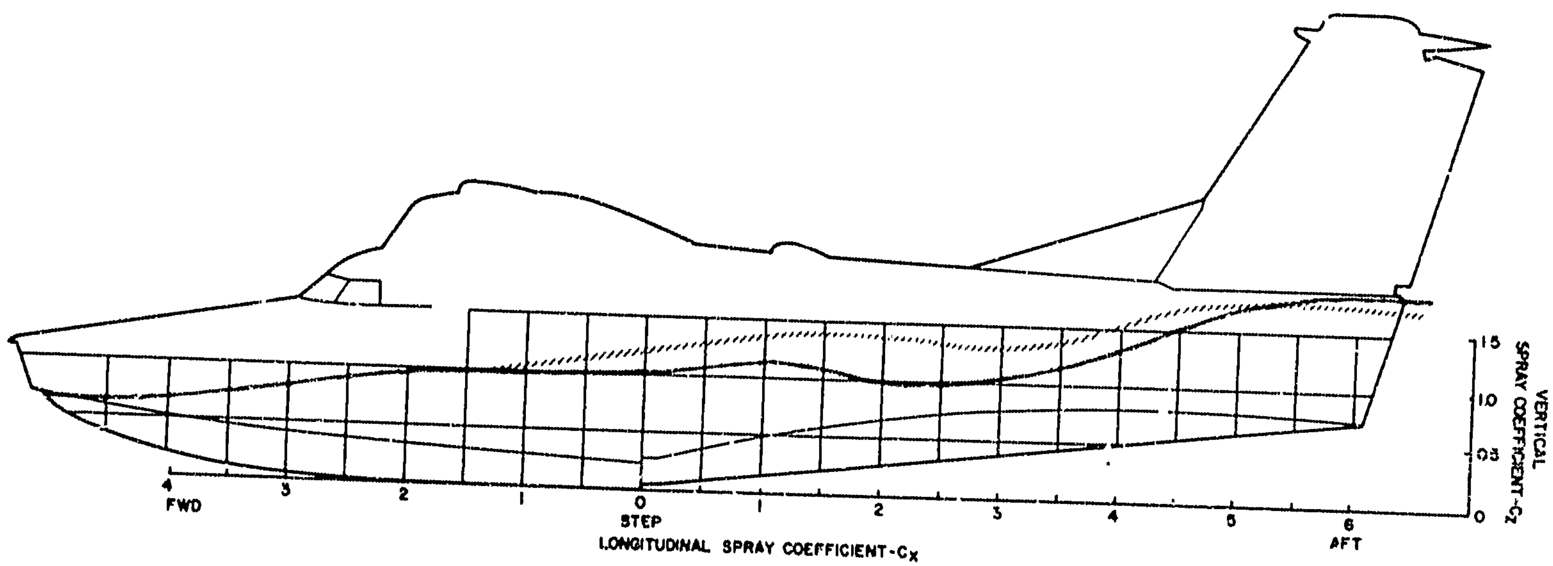


UF-XS Airplane
BOUNDARY LAYER CONTROL SYSTEM

Main Spray Envelope from Collapsed Spray Data

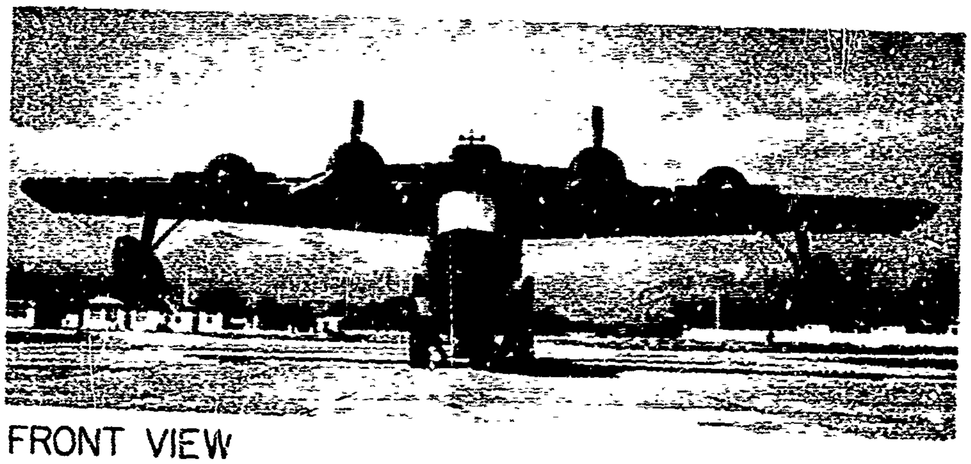
Headwind Component 5 to 10 kt
Wave Height 0.5 + 1.0 ft
Gross Weight 33,000 lb
CG Position 22% MAC

BLC	FLAP DEFLECTION
ON (shaded)	55°/30°
////// OFF	32°/18°

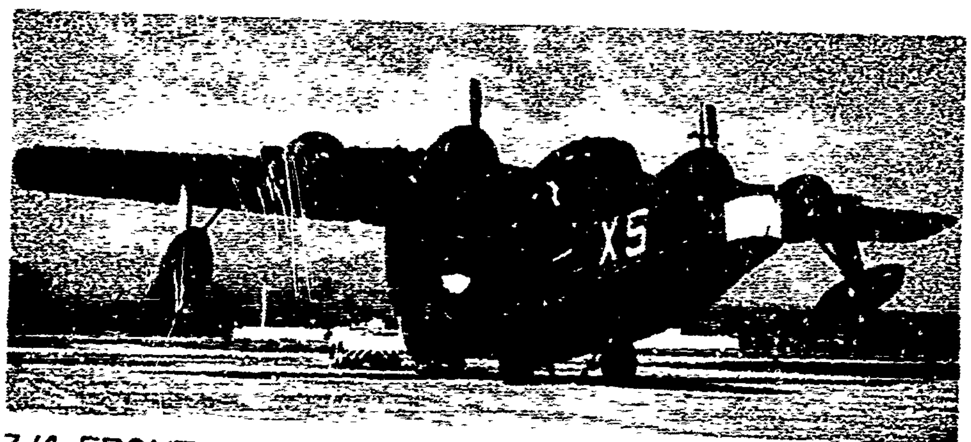


UF-XS Airplane

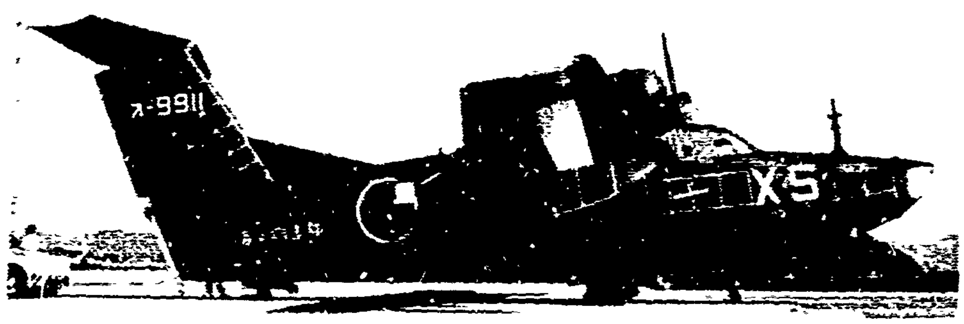
SPRAY CHARACTERISTICS



FRONT VIEW



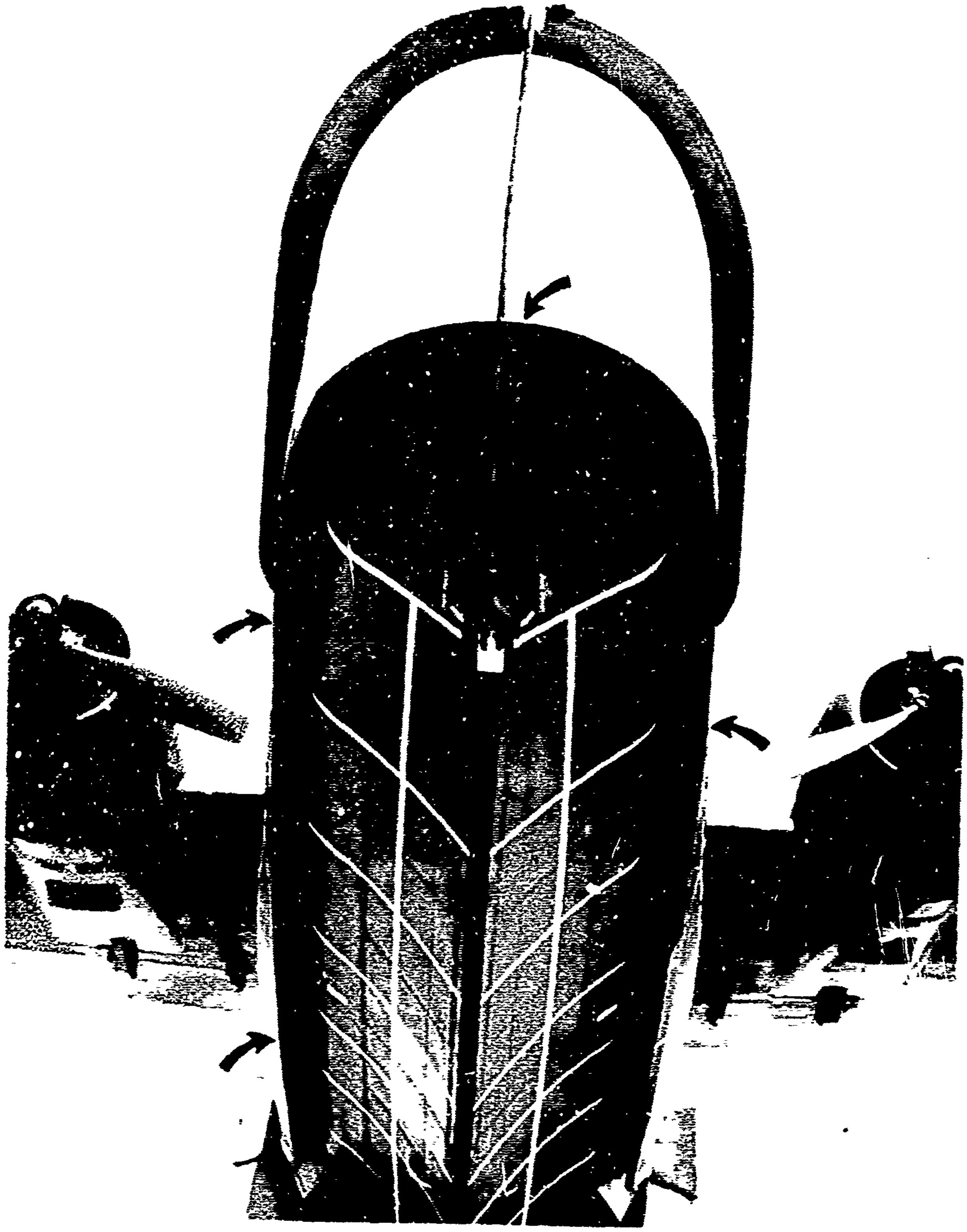
3/4 FRONT VIEW



SIDE VIEW

UF-XS Airplane

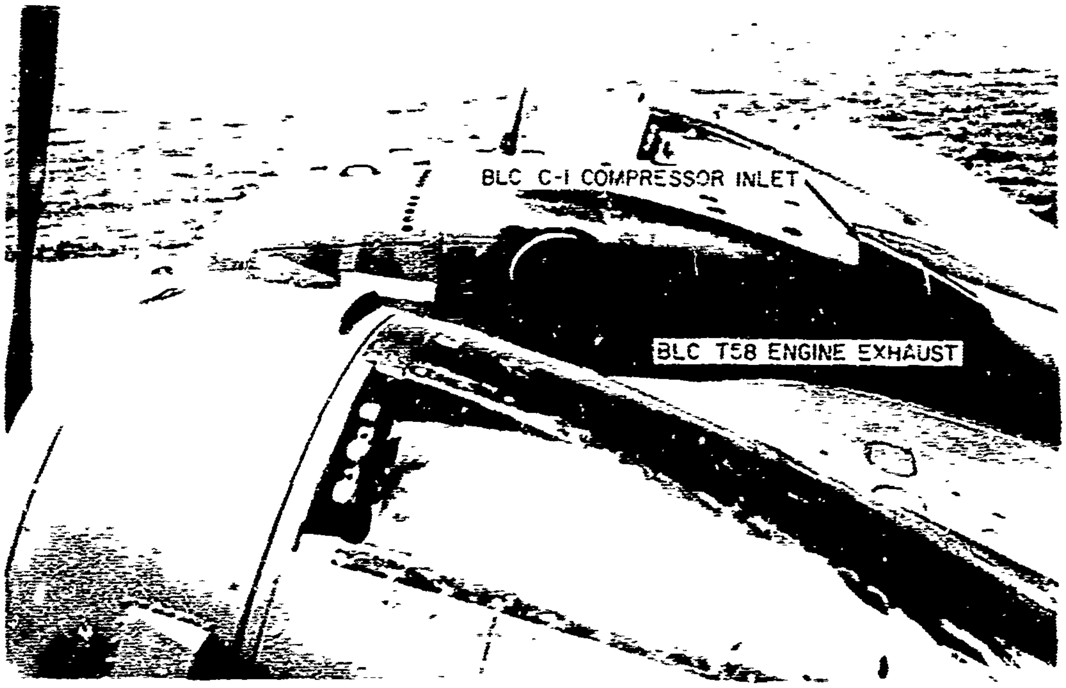
GENERAL VIEWS



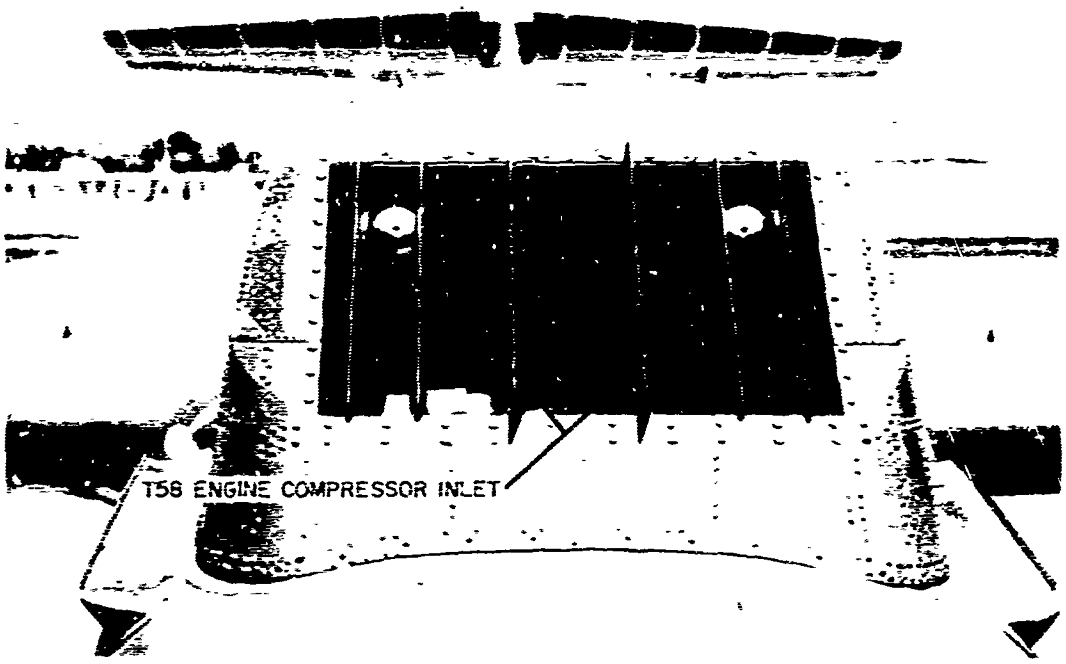
UF-XS Airplane

SPRAY SUPPRESSOR

Figure 2
APPENDIX IV



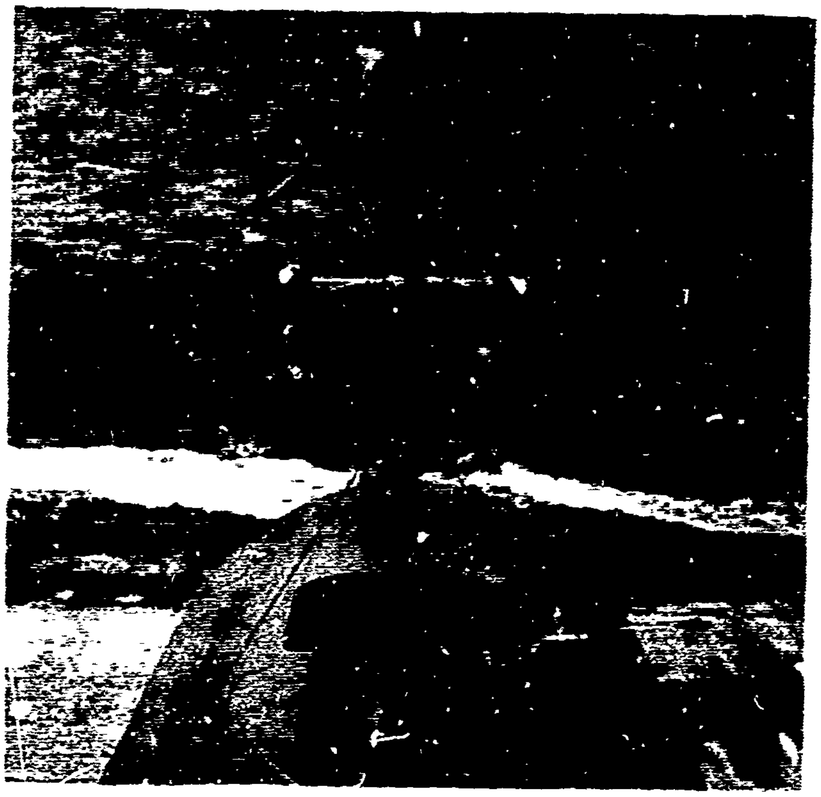
SIDE VIEW



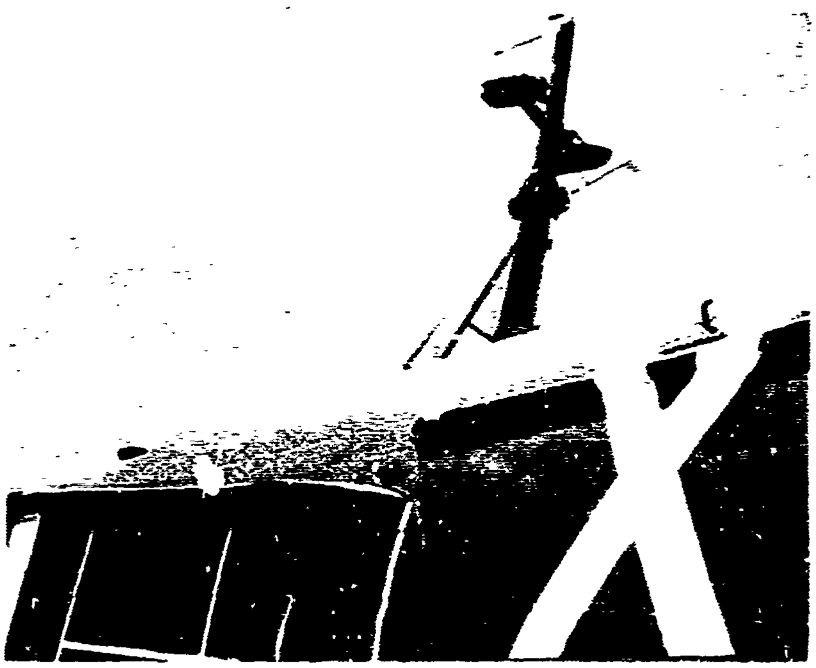
FRONT VIEW

UF-XS Airplane

BLC ENGINE/COMPRESSOR INSTALLATION



REAR VIEW



SIDE VIEW

UF-XS Airplane

INSTRUMENTATION MAST

UF-XS AIRPLANE GEOMETRIC DATA

Wing	
Total Area	835 sq ft
Span	80 ft
MAC	10 ft 9 in.
Taper Ratio	0.5
Aspect Ratio	7.69
Dihedral (lower surface)	2° 10'
Flaps	
Area	
Inboard	74 sq ft
Outboard	61 sq ft
Span (percent wing span)	
Inboard	30%
Outboard	30%
Chord (percent wing chord)	35%
Deflection (maximum)	
Inboard	80°
Outboard	60°
Aileron	
Area	46 sq ft
Span (percent wing span)	28%
Chord (percent wing chord)	25%
Spoiler	
Area	16 sq ft
Span (percent wing span)	11.7%
Chord (percent wing chord)	9.6%
Deflection (maximum)	58°
Horizontal Tail	
Area	200 sq ft
Span	31.5 ft
Elevator Area	60 sq ft

Vertical Tail	
Area	137.5 sq ft
Span	12.9 ft
Rudder Area	41.2 sq ft

TEST INSTRUMENTATION
Quantities Measured

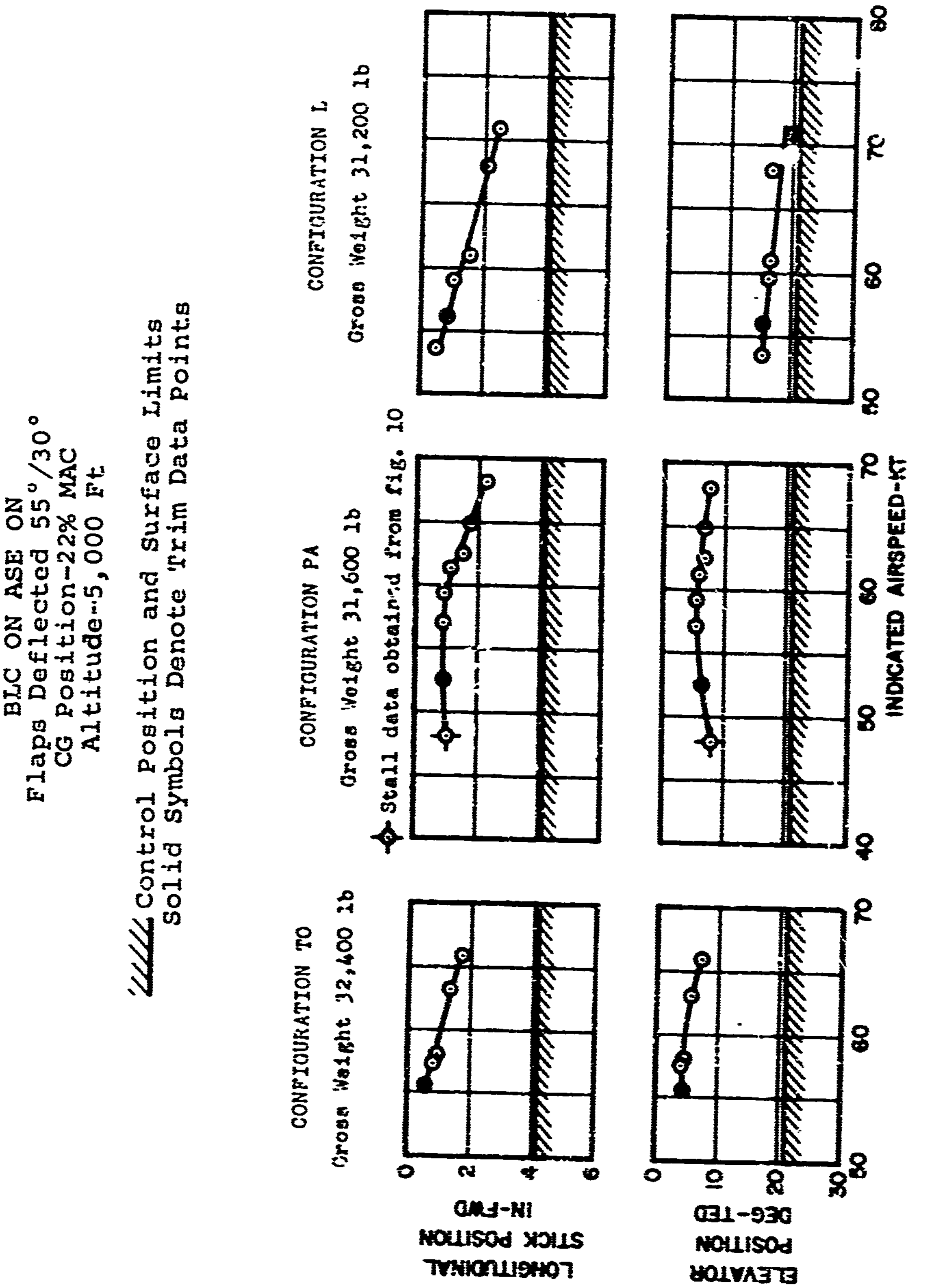
Oscillograph:	Angle of Pitch Angle of Bank Rate of Pitch Rate of Roll Rate of Yaw Angle of Attack Angle of Sideslip Elevator Position Right Aileron Position Rudder Position Longitudinal Stick Position Lateral Control Wheel Position Rudder Pedal Position Normal Acceleration at CG Lateral Acceleration at CG
Photopanel:	Airspeed Altitude Ambient Air Temperature Time of Day Main Engine RPM (No. 1, 2, 3 and 4 Engines) Main Engine MAP (No. 1, 2, 3 and 4 Engines) BLC Engine RPM
Pilot's Panel:	Airspeed Altitude Elevator Position Main Engine Pounds of Fuel Remaining BLC Engine Pounds of Fuel Remaining

DEFINITION OF COOPER RATING SYSTEM

OPERATING CONDITIONS	ADJECTIVE RATING	NUMERICAL RATING	DESCRIPTION	PRIMARY MISSION ACCOMPLISHED	CAN BE LANDED
NORMAL OPERATION	SATISFACTORY	1	EXCELLENT, INCLUDES OPTIMUM	YES	YES
		2	GOOD, PLEASANT TO FLY	YES	YES
		3	SATISFACTORY, BUT WITH SOME MILDLY UNPLEASANT CHARACTERISTICS	YES	YES
EMERGENCY OPERATION	UNSATISFACTORY	4	ACCEPTABLE, BUT WITH UNPLEASANT CHARACTERISTICS	YES	YES
		5	UNACCEPTABLE FOR NORMAL OPERATION	DOUBTFUL	YES
		6	ACCEPTABLE FOR EMERGENCY CONDITION ONLY[1]	DOUBTFUL	YES
NO OPERATION	UNACCEPTABLE	7	UNACCEPTABLE EVEN FOR EMERGENCY CONDITION[1]	NO	DOUBTFUL
		8	UNACCEPTABLE - DANGEROUS	NO	NO
		9	UNACCEPTABLE-UNCONTROLLABLE	NO	NO
	CATASTROPHIC	10	MOTIONS POSSIBLY VIOLENT ENOUGH TO PREVENT PILOT ESCAPE	NO	NO

[1] FAILURE OF A STABILITY AUGMENTER

INDEX TO APPENDIX VIII



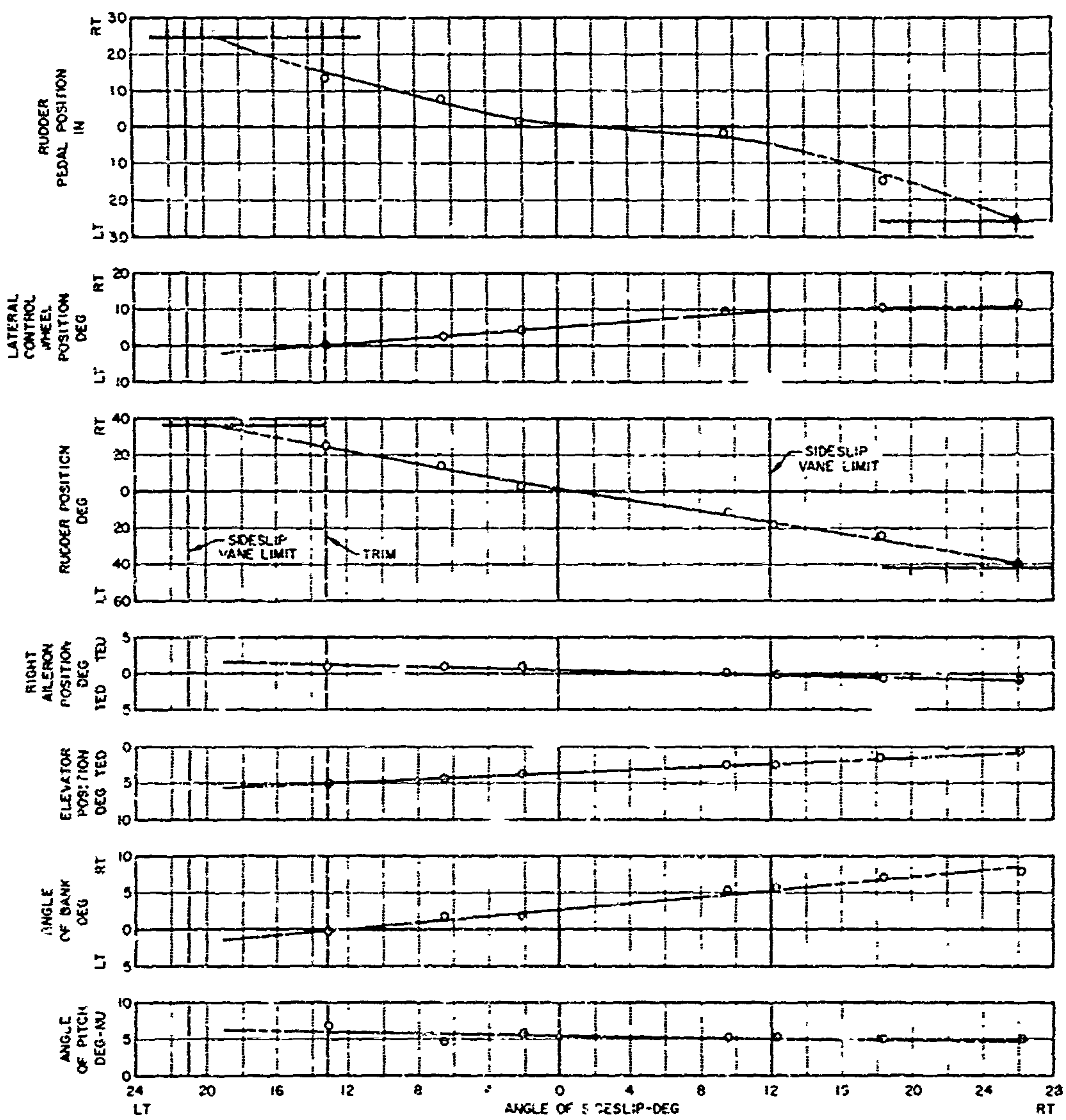
UF-XS Airplane

STATIC LONGITUDINAL STABILITY

Configuration ?A
Trim Airspeed - 55 Kt IAS

BLC ON ASE OFF
Flaps Deflected 55°/30°
Gross Weight - 32,900 Lb
CG Position - 22% MAC
Altitude - 5,800 Ft

Control Position and Surface Limits
Extrapolation



UF-XS Airplane

STATIC LATERAL-DIRECTIONAL STABILITY

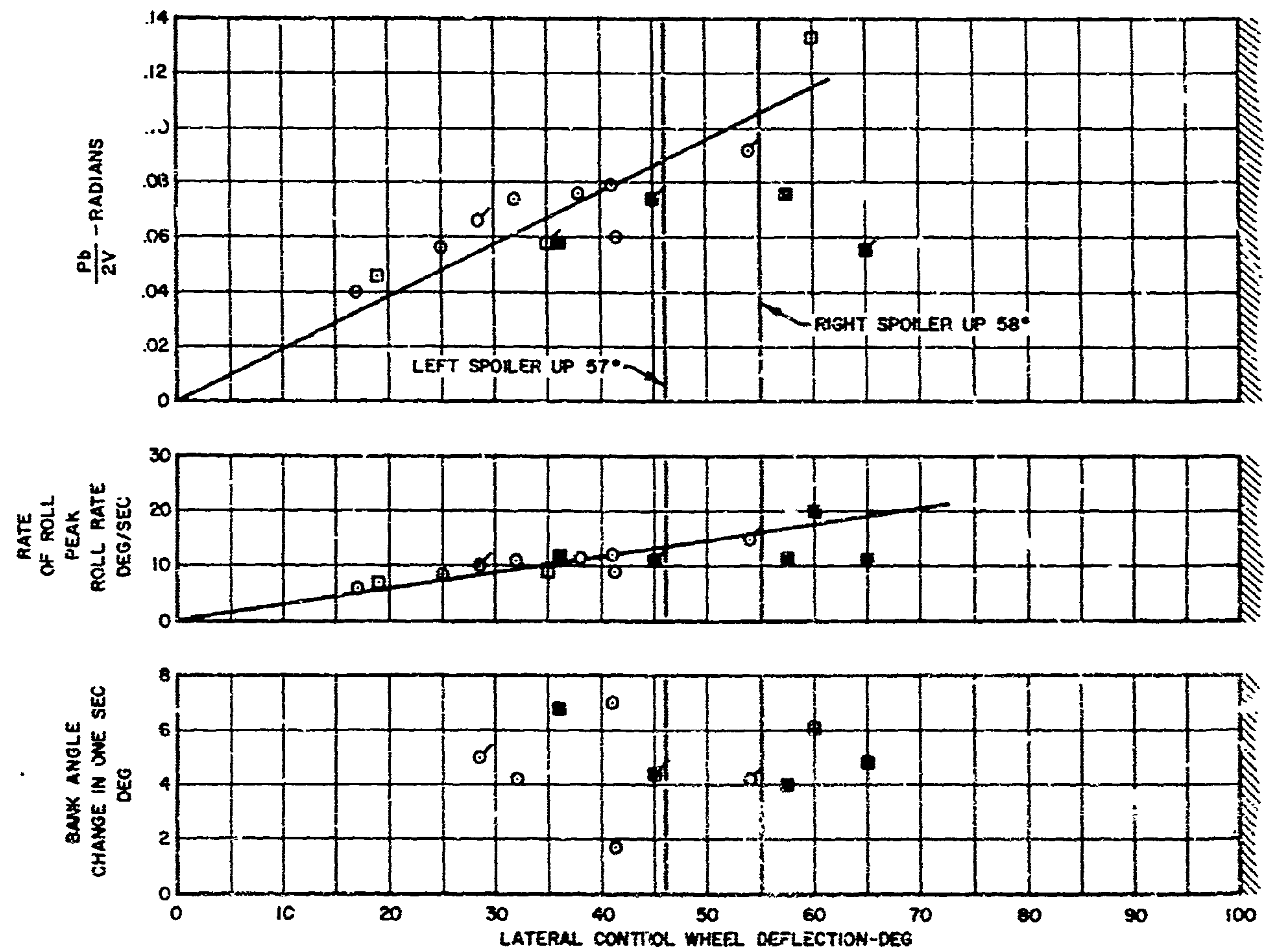
Configuration PA
Trim Airspeed-55 Kt IAS

BLC ON
Flaps Deflected 55°/30°
Gross Weight - 31,800 to 32,600 Lb
CG Position - 22% MAC
Altitude - 5,000 Ft

Symbol	Conditions
⊙	Rudder Fixed
⊡ ■	Rudder Coordinated
■	ASE ON
⊡	ASE OFF

Flagged Symbols Denote Left Rolls

//// Lateral Control Limit



UF-XS Airplane

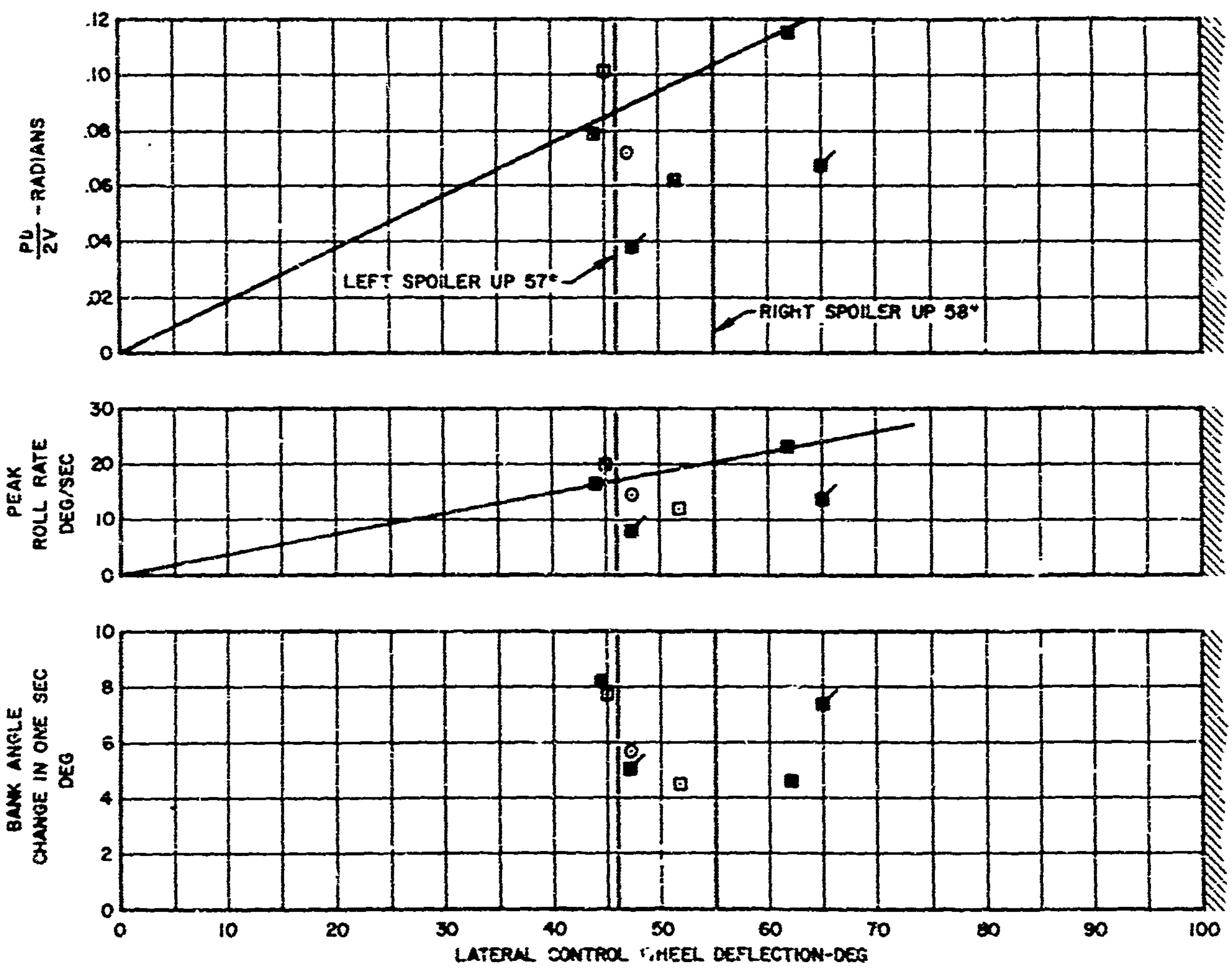
LATERAL CONTROL EFFECTIVENESS

Configuration PA
Trim Airspeed-70 Kt IAS

BLC ON
Flaps Deflected 55°/30°
Gross Weight - 31,800 to 32,600 Lb
CG Position - 22% MAC
Altitude - 5,000 Ft

Symbol	Conditions
⊙	Rudder Fixed
⊡ ■	Rudder Coordinated
■	ASE ON
⊡	ASE OFF

Flagged Symbols Denote Left Rolls
//// Lateral Control Limit

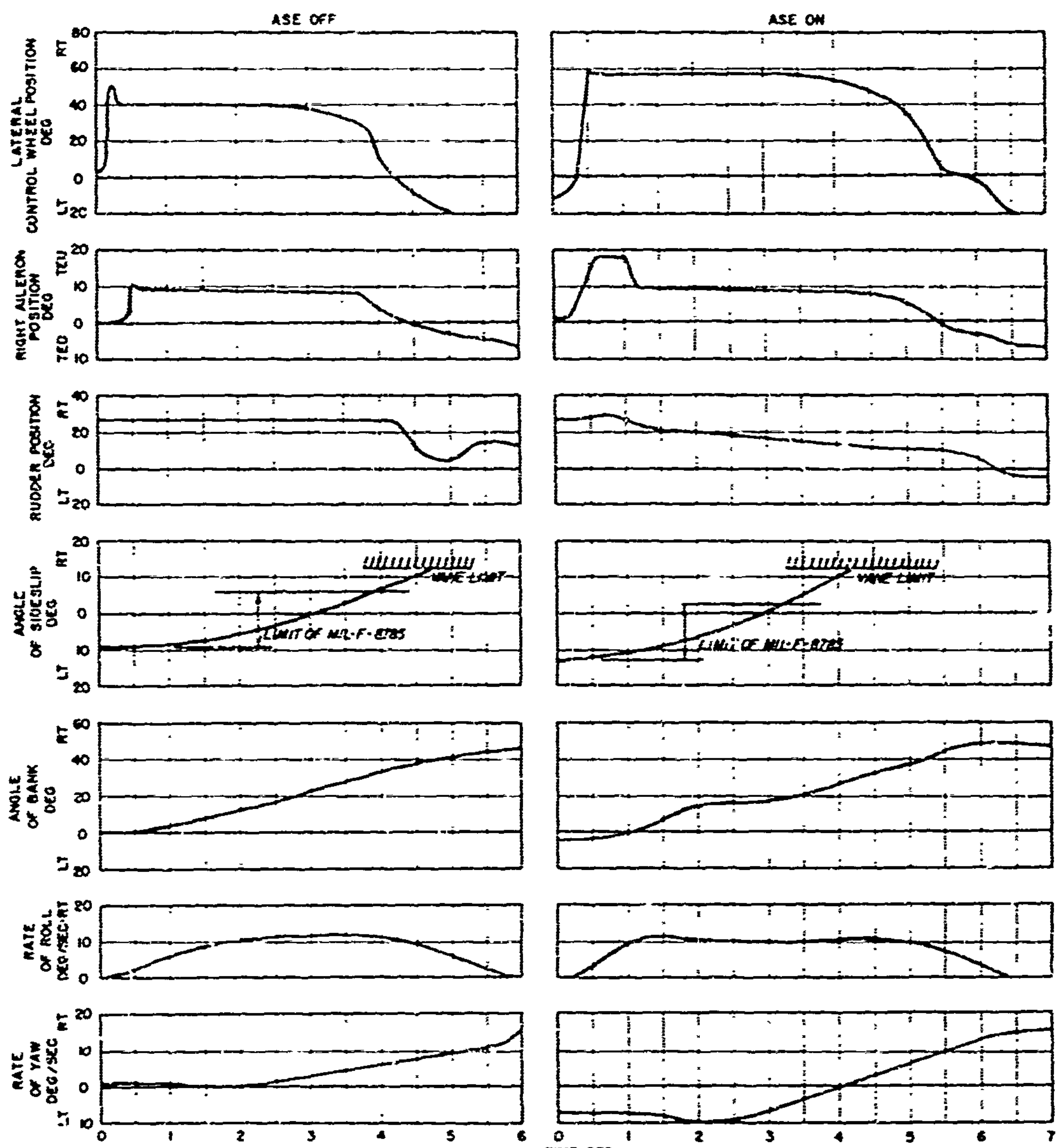


UF-XS Airplane

LATERAL CONTROL EFFECTIVENESS

Configuration PA
Trim Airspeed - 55 Kt IAS

BLC ON
Flaps Deflected 55°/30°
Gross Weight - 31,000 Lb
CG Position - 22% MAC
Altitude - 5,000 Ft

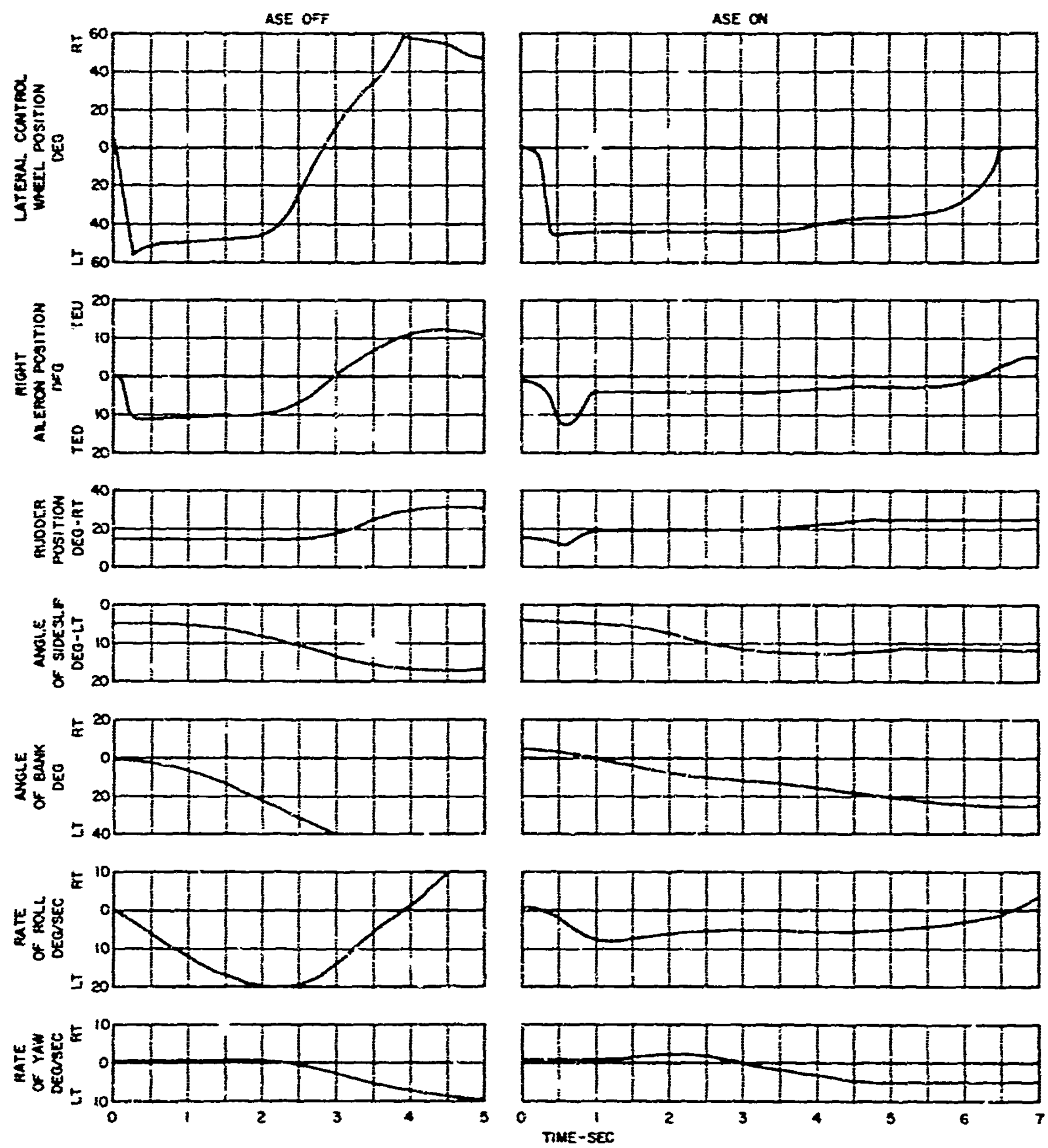


UF-XS Airplane

ADVERSE YAW DURING RUDDER-FIXED ROLLS

Configuration PA
Trim Airspeed - 70 Kt IAS

BLC ON
Flaps Deflected 55°/30°
Gross Weight - 31,000 Lb
CG Position - 22% MAC
Altitude - 5,000 Ft



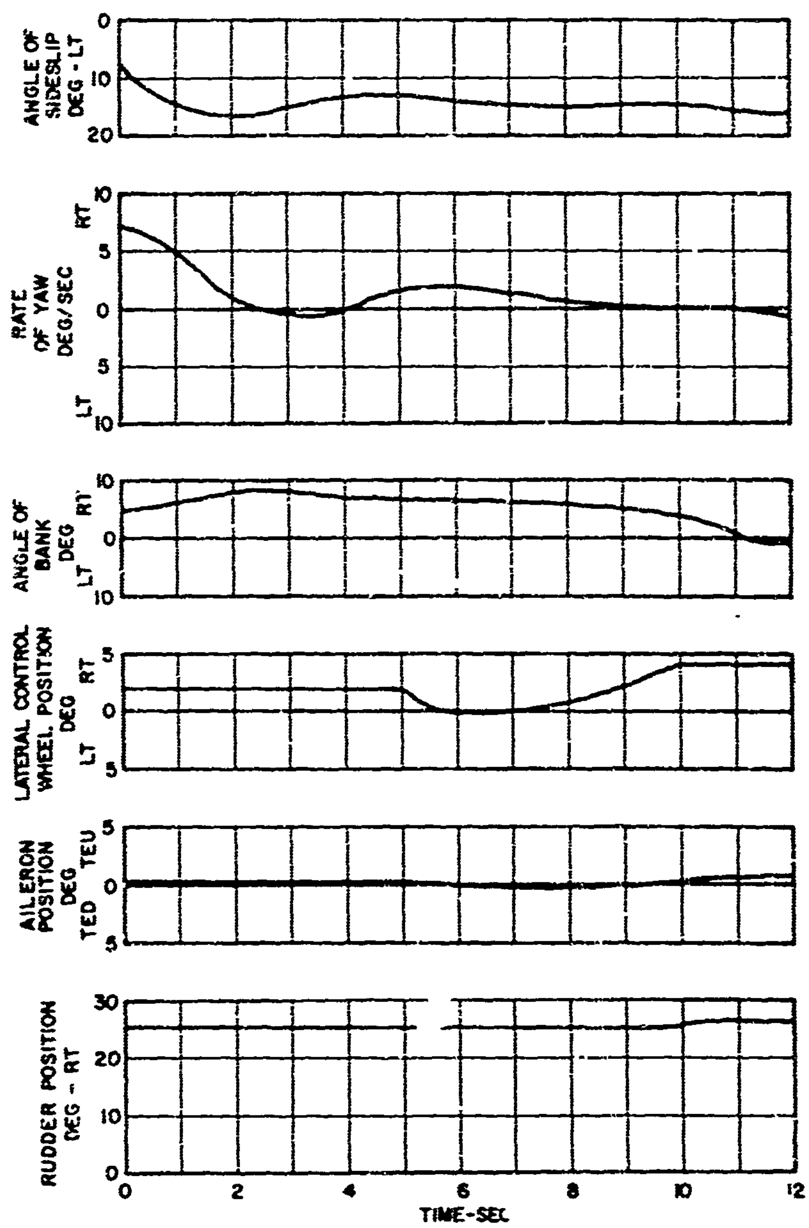
UF-XS Airplane

ADVERSE YAW DURING RUDDER-FIXED ROLLS

Figure 6
APPENDIX VIII

Configuration PA
Trim Airspeed - 55 Kt IAS

BLC ON
Flaps Deflected 55°/30°
Gross Weight - 32,300 Lb
CG Position - 22% MAC
Altitude - 5,000 Ft



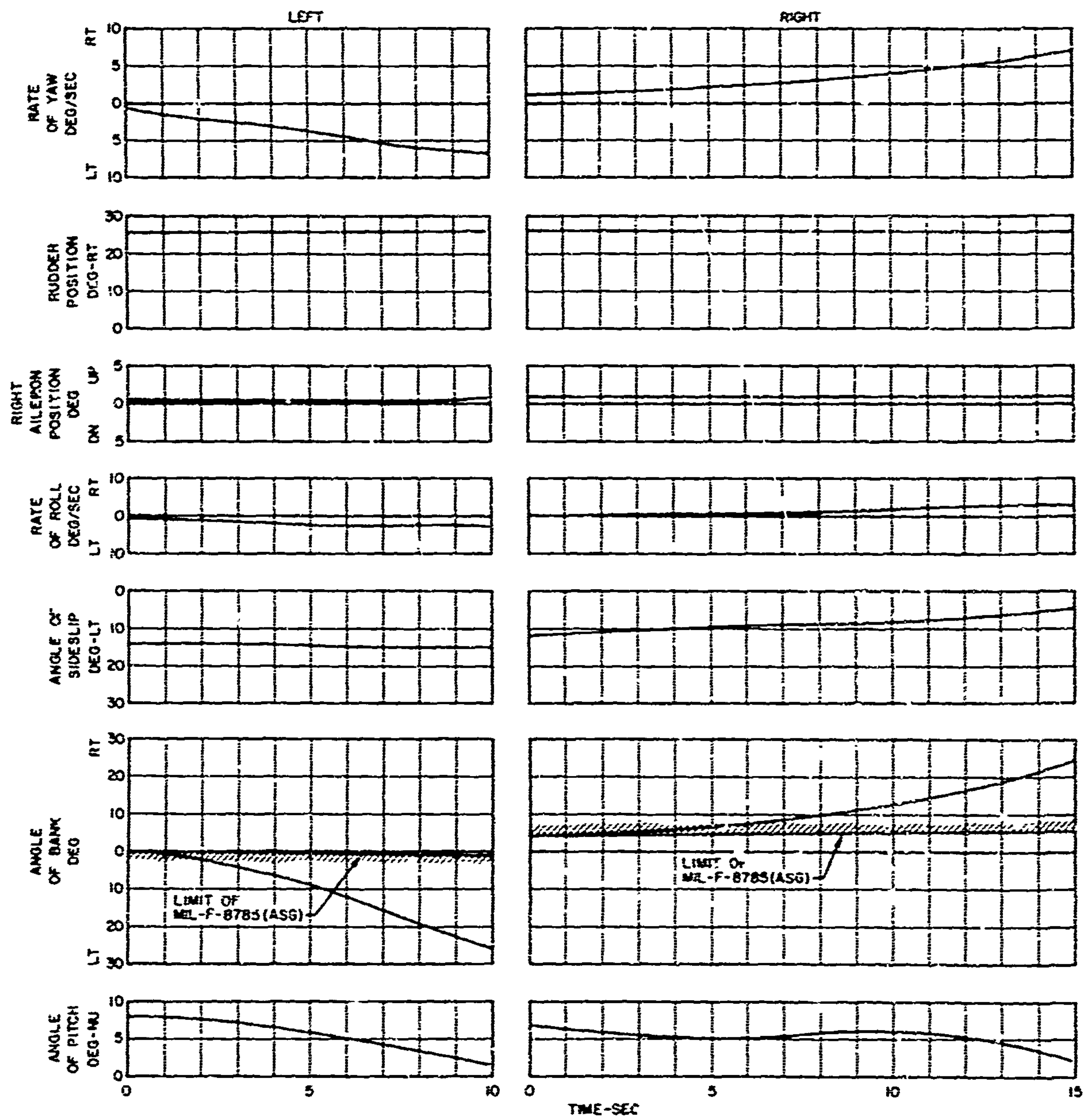
UF-XS Airplane

LATERAL-DIRECTIONAL OSCILLATION ASE OFF

Figure 7
APPENDIX VIII

Configuration PA
Trim Airspeed - 55 Kt IAS

BLC ON
Flaps Deflected 55°/30°
Gross Weight - 32,000 Lb
CG Position - 22% MAC
Altitude - 5,000 Ft



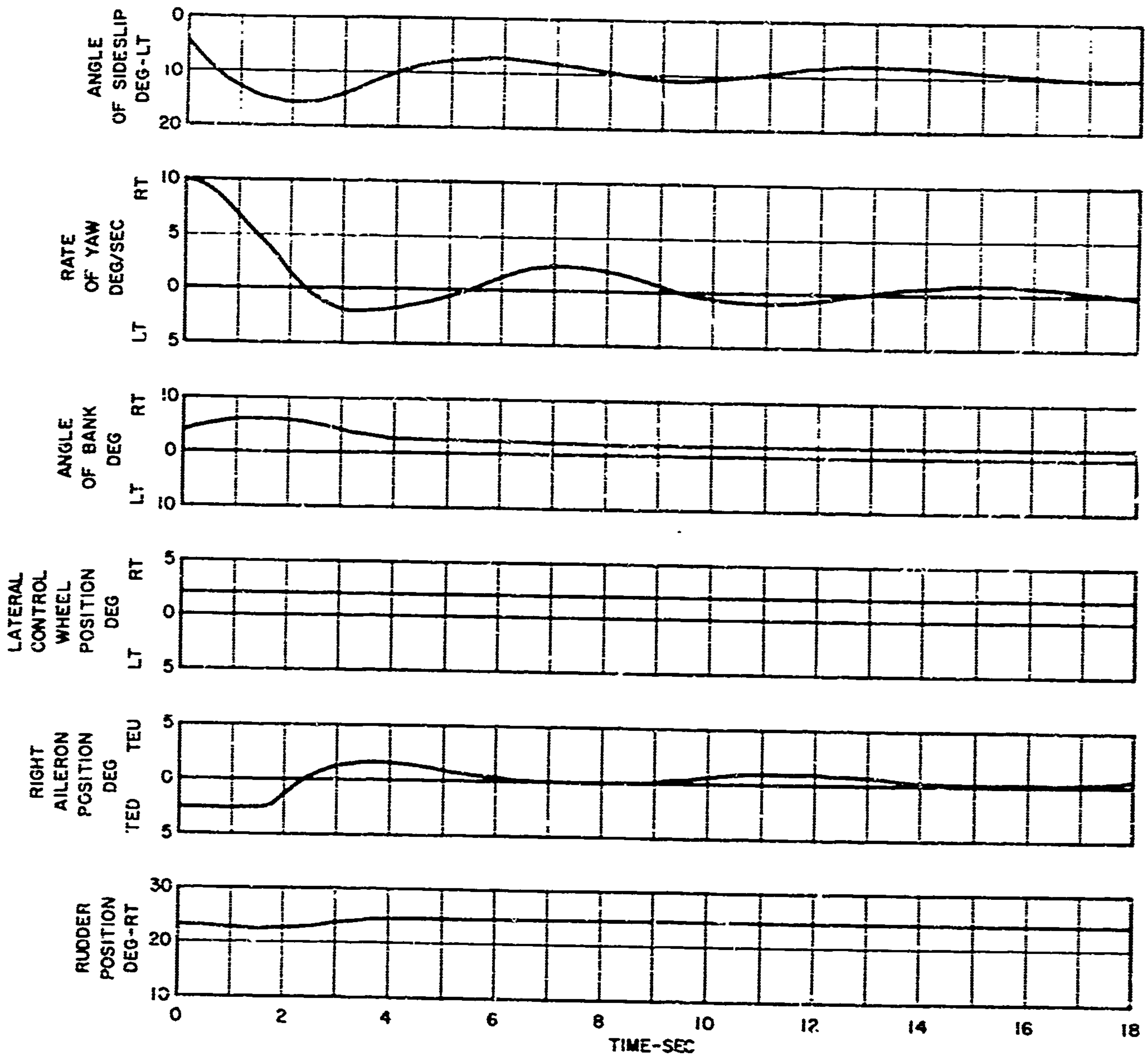
UF-XS Airplane

SPIRAL STABILITY

Figure 8
APPENDIX VIII

Configuration PA
Trim Airspeed - 55 Kt IAS

BLC ON
Flaps Deflected 55°/30°
Gross Weight - 32,300 Lb
CG Position - 22% MAC
Altitude - 5,000 Ft

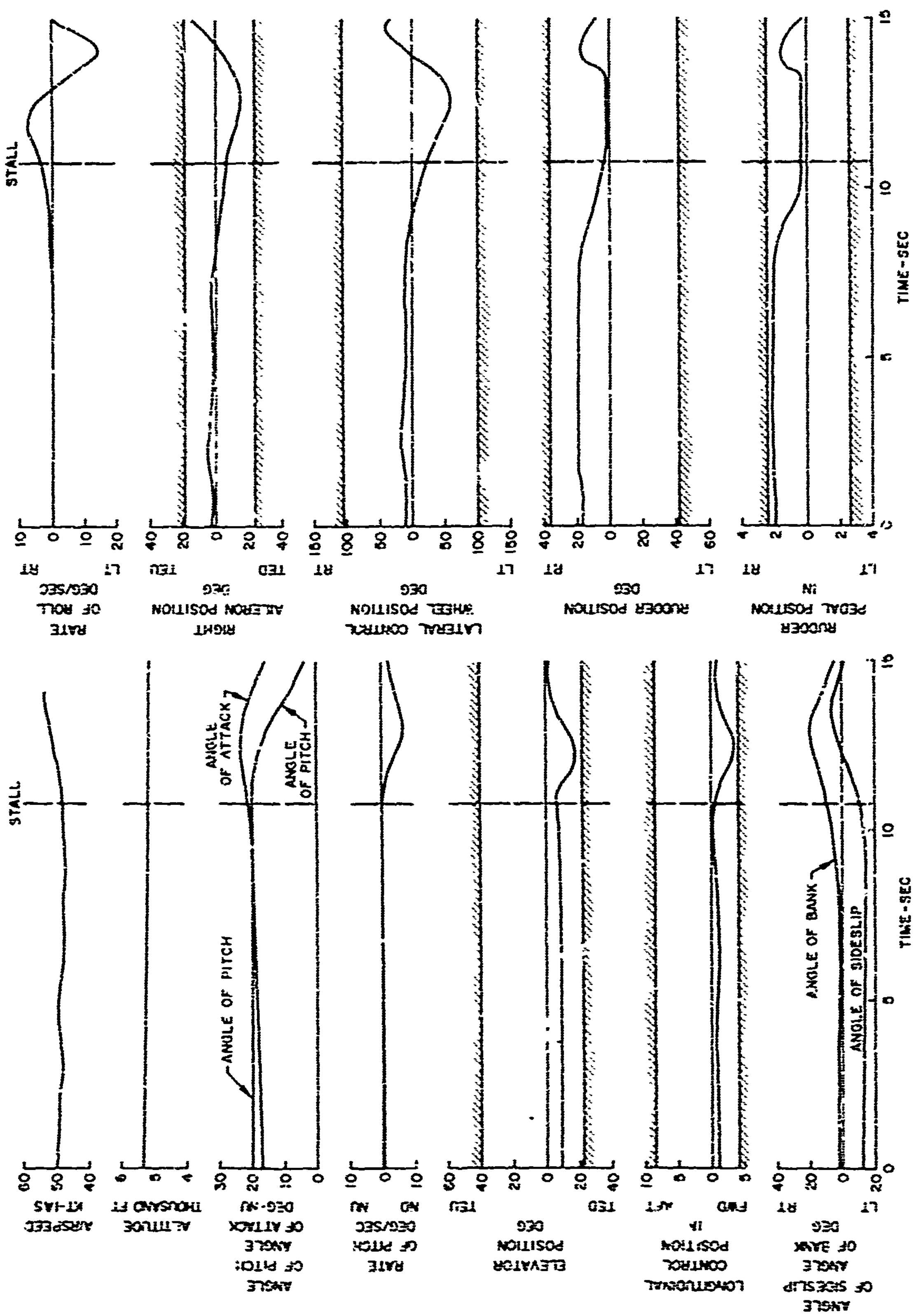


UF-XS Airplane

LATERAL-DIRECTIONAL OSCILLATION ASE ON

DLC ON ASE ON
Flaps Deflected 55°/30°
Gross Weight - 33,150 Lb

Control Position and Surface Limits

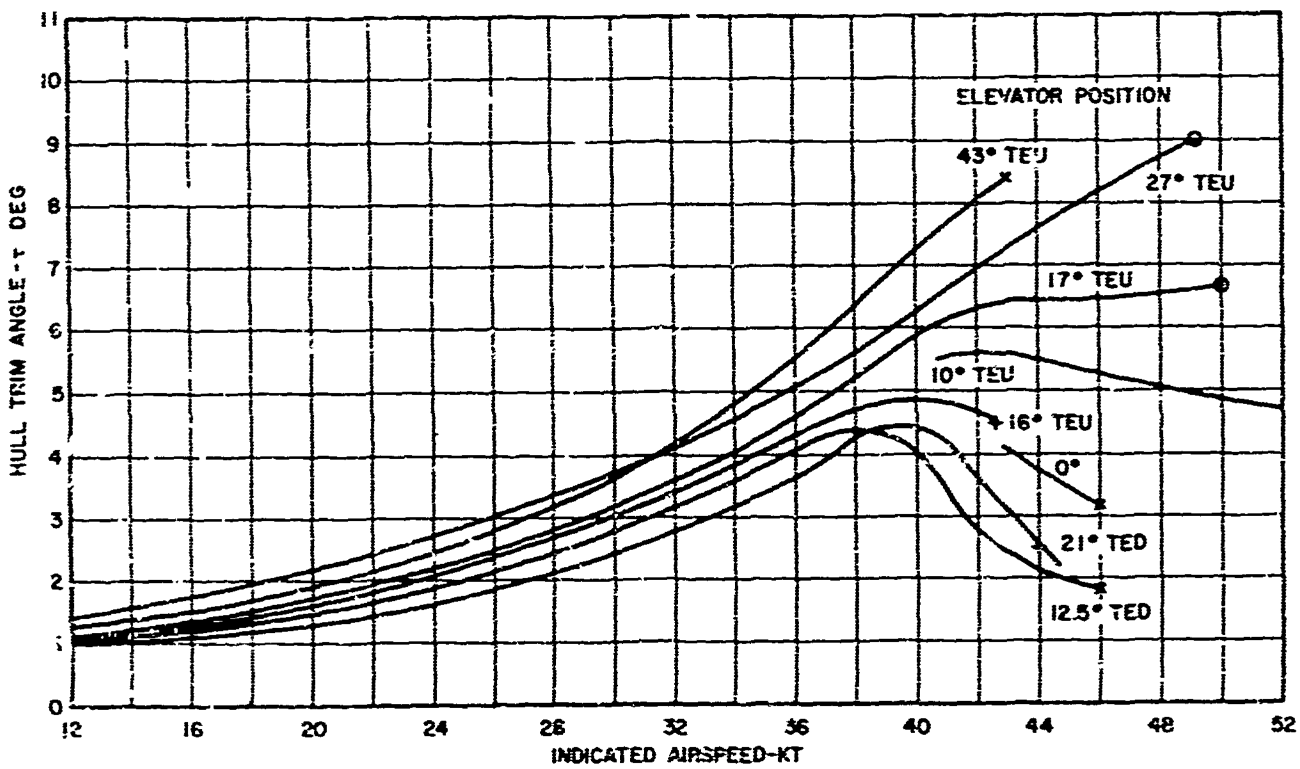


UF-XS Airplane

PA CONFIGURATION STALL TIME HISTORY

BLC ON ASE ON

Flaps Deflected 55°/30°
Gross Weight 33,000 lb
CG Position 22% MAC
× Power Cut
⊙ Take-Off
+ Abrupt Elevator Change



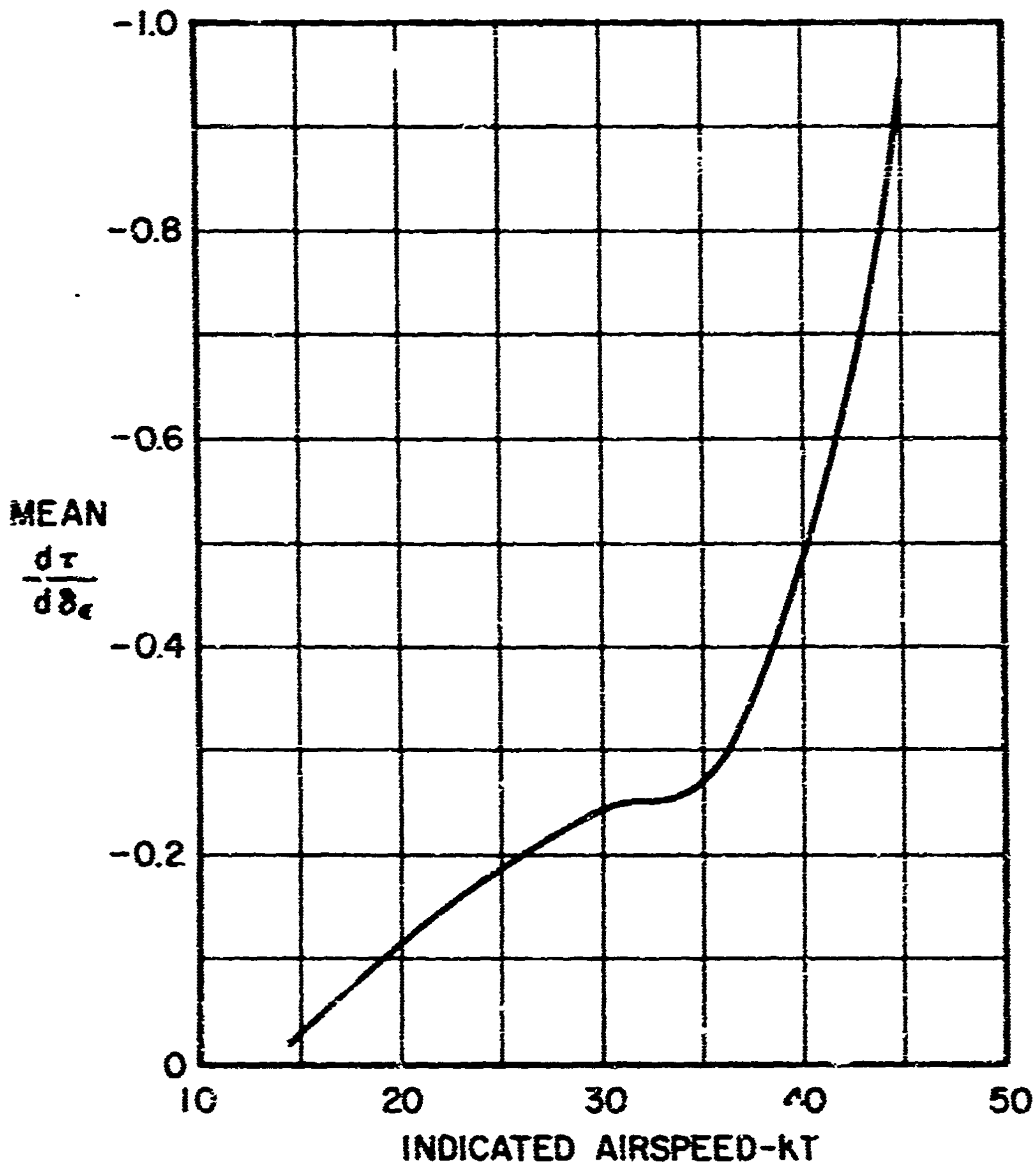
UF-XS Airplane

HYDRODYNAMIC LONGITUDINAL STABILITY

Figure 11
APPENDIX VIII

BLC ON ASE ON

Flaps Deflected 55°/30°
Gross Weight 33,000 lb
CG Position 22% MAC



UF-XS Airplane

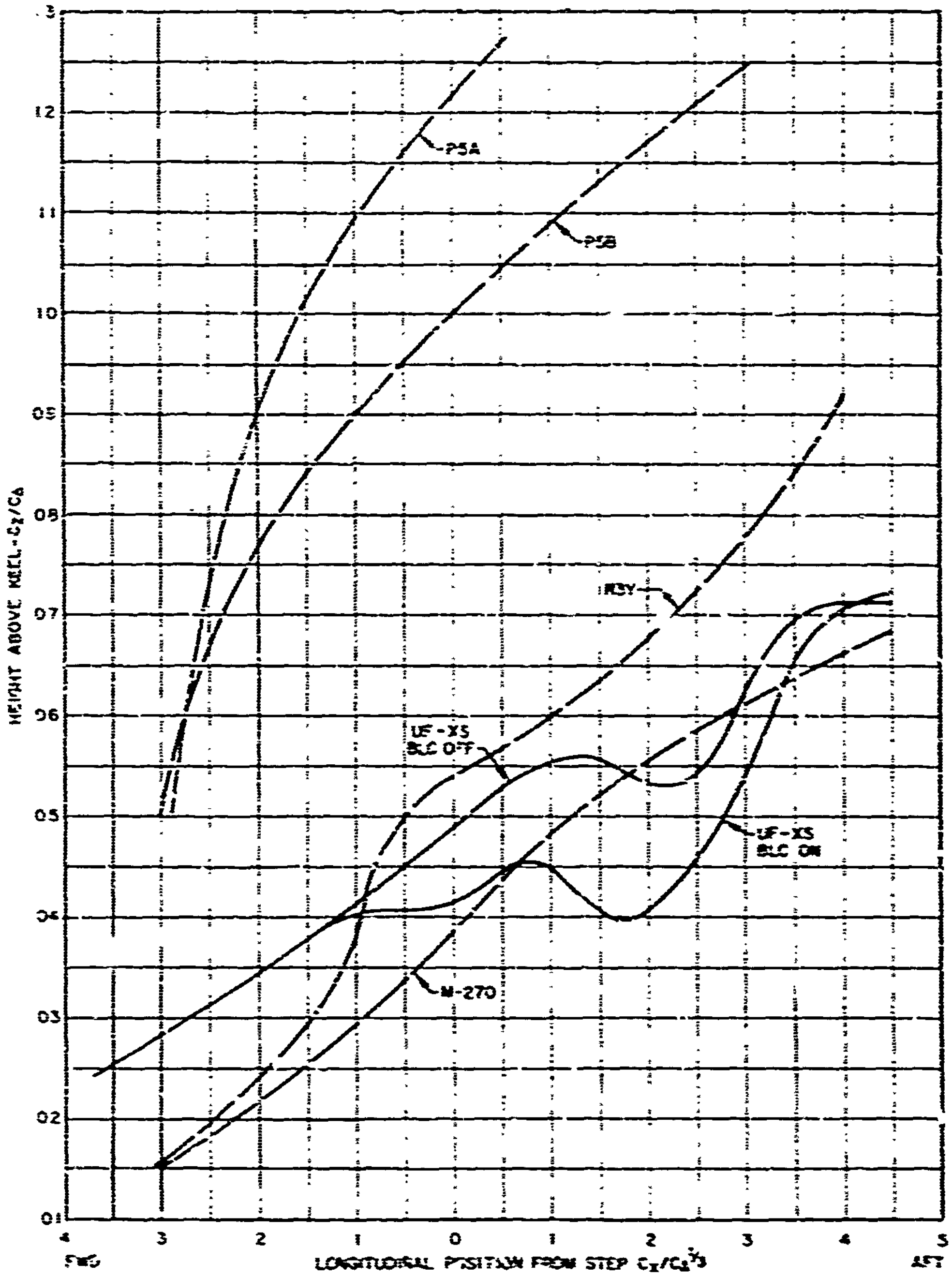
HYDRODYNAMIC LONGITUDINAL CONTROL EFFECTIVENESS

Figure 12
APPENDIX VIII

UF-XS Airplane

Gross Weight - 33,000 Lb
CG Position - 22% MAC

BLC	Flap Deflection
ON	55°/30°
OFF	32°/18°



COMPARISON OF COLLAPSED SPRAY CHARACTERISTICS

Figure 13
APPENDIX VIII