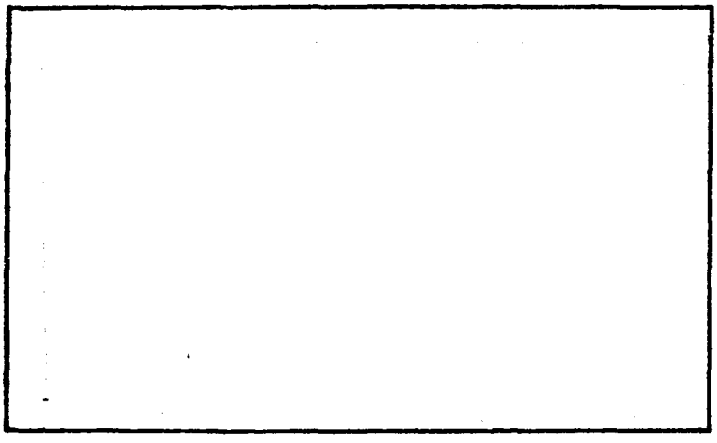

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8287

FOR ERRATA

AD 447814

THE FOLLOWING PAGES ARE CHANGES

TO BASIC DOCUMENT

AD-447 814

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PREPARED UNDER NAVY, BUREAU OF NAVAL WEAPONS
CONTRACT NO. NOw 63-0118-ci

MODEL X-22A

TITLE

DEMONSTRATION PLANNING AND PROGRESS REPORT

STATEMENT #2 UNCLASSIFIED

This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of Naval Air Systems Command attn: Code-AIR-604 Wash D.C. 20360

REPORT NO. 2127-931001T DATE: 30 Sept. 1967

BY: D. C. Ackroyd DATE 10/16/67

CHECKED: AV Coles DATE 10/16/67

APPROVED: AV Coles DATE 10/16/67

APPROVED: Vincent B Pagliuca DATE 16 Oct 67

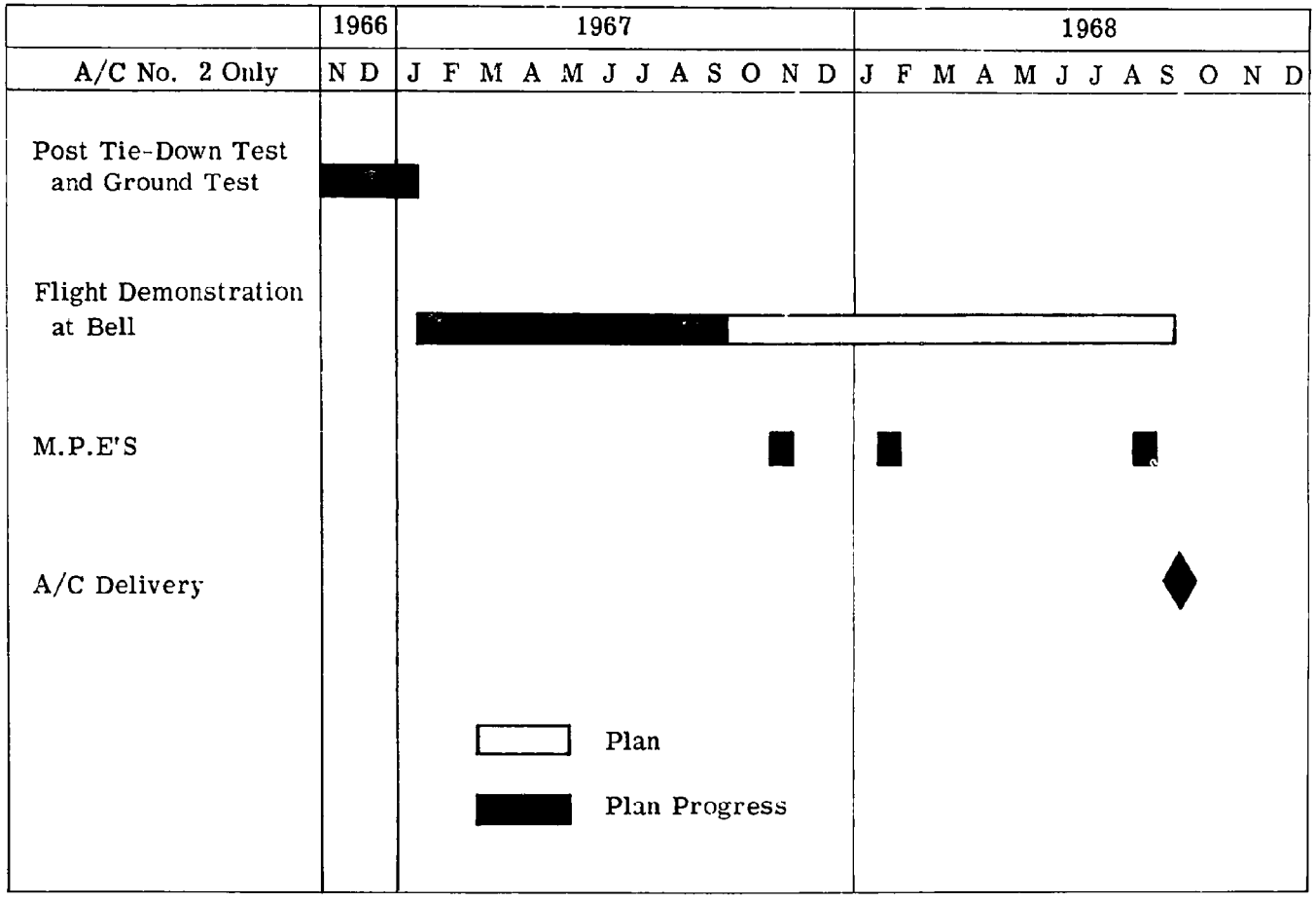
REVISIONS	DATE	PAGE NO.
		See Revisions - Page A-1

Revisions	Date	
K	23 Nov. 1965	A-1, 3.25.2.2(2)(b) -1, through -3, 3.25.2.2(3)-1, 3.25.2.2(4)-1, and 3.25.2.2(5)-1.
L	16 Dec. 1965	3.25.4.5(b)-1 through 3.15.4.5(b)-16 (delete), 3.15.4.5(b)-1 through 3.15.4.5(b)-15 (New)
M	28 Jan. 1966	3.25.2.2(2)(a)-1, 3.25.2.2(2)(b)-1 3.25.2.2(2)(b)-2, 3.25.2.2(2)(b)-3 3.25.2.2(3)-1, 3.25.2.2(4)-1, 3.25.2.2(5)-1
N	23 Feb. 1966	Added pages 3.1.5-1 through 3.1.5-5 and changed page iii
O	22 Apr. 1966	3.25.2.2(2)(b)-1, 3.25.2.2(2)(b)-2, 3.25.2.2(2)(b)-3, 3.25.2.2(3)-1, 3.25.2.2(4)-1, 3.25.2.2(5)-1
P	22 June 1966	3.4.4.3-2, 3.4.4.3-3, 3.25.2.2(5)-1, 3.25.2.2(4)-1, 3.25.2.2(2)(b)-1, 3.25.2.2(2)(b)-2, 3.25.2.2(2)(b)-3, 3.25.2.2(3)-1, 3.19.1-7, 3.19.1-7a 4, 5, 5a, 7-14.
Q	15 Aug. 1966	A-1, iii, 3.4.4.2-2, added pages 3.4.4.2-3, 3.4.4.2-4, 3.13-1, 3.13-1a 3.13.2 through 3.13-14 and 3.15.4.5(b)2a. changed 3.15.4.5(b)-1, 3.15.4.5(b)-3, 3.15.4.5(b)-8, 3.15.4.5(b)-9, 3.15.4.5(b)-10, 3.15.4.5(b)-11, and 3.15.4.5(b)-12.
R	15 March 1967	A-1, ii, iii, iv, added pages 3.12-1 through 3.12-8, 3.17.4-1 through 3.17.4-3, changed pages 3.17.8-1, 3.18-2 through 3.18-7, 3.25.2.2(2)(a)-1, 3.25.2.2(4)-1, 3.25.2.2(5)-1, 3.25.2.2(3)-1, 3.25.2.2(2)(b)-1, 3.25.2.2(2)(b)-2, and 3.25.2.2(2)(b)-3
S	4 August 1967	A-1, v, vi, 3.25.2.2(3)-1, 3.25.2.2(4)-1, 3.25.-2.2(5)-1, 3.25.2.2(6)-1 through 3.25.2.2(6)-4, 3.25.2.2(7)-1, 3.25.2.2(9)-1 through 3.25.2.2-(10)-1 and 3.25.2.2(10)-2.

Revision

T	30 Sept. 1967	A-1, A-2, 3.25.2.2(3)-1, 3.25.2.2(4)-1, 3.25.2.2(6)-4, 3.25.2.2(6)-5, 3.25.2.2(7)-1 3.25.2.2(9)-6, 3.25.2.2(9)-6a, 3.25.2.2(9)-6b, 3.25.2.2(9)-7, 3.25.2.2(9)-9. 3.25.2.2(9)-10, 3.25.2.2(10-2.

X-22A Flight Test Plan



3.25.2.2 (3). Demonstration Interim Schedule

3.25.2.2(4) MILITARY PRELIMINARY EVALUATION SCHEDULE DATES

Military Preliminary Evaluations

Phase I	Start 10-30-67
	Comp. 11-10-67
Phase II	Start 1-22-68
	Comp. 2-2-68
Phase III	Start 8-19-68
	Comp. 8-30-68

OPERATION NO.	WORK ACCOMPLISHED
2F50-179-0721	First field circuits with power control-mode.
2F51-184-0726	Hover practice (IGE and OGE).
2F52-185-0727	STOL and VTOL practice.
2F53-194-0810	STOL flight in collective mode.
2F54-195-0811	Short takeoffs and vertical landings over runway.
2F55-196-0811	Dynamic longitudinal stability tests.
2F56-197-0815	Dynamic longitudinal stability tests.
2F57-198-0816	Hover with landing gear cycling.
2F58-200-0817	Landing gear retraction at 80 knots.
2F59-204-0822	Master governor checks and hover practice.
2F60-205-0822	Master governor checks and VTOL practice.
2F61-206-0823	Static longitudinal stability tests and landing gear operation.
2F62-207-0824	Static longitudinal stability tests.
2F63-212-0828	Master governor checks and hover practice.
2F64-217-0831	Master governor checks.
2F65-222-0905	Master governor checks and hover practice.
2F66-223-0905	Master governor checks and STOL circuits.
2F67-224-0906	Long period static and dynamic longitudinal stability tests.
2F68-225-0907	Hover practice.
2F69-226-0908	Transitions and high duct angle stability investigation.
2F70-227-0908	Dynamic longitudinal and lateral stability tests.
2F71-228-0911	Static and dynamic stability tests.
2F72-231-0915	Gearbox temperature checks.
2F73-232-0919	Cowl temperature survey.
2F74-233-0920	Dynamic lateral stability tests and temperature survey.
2F75-234-0922	Temperature survey and landing gear operation at 100 knots.

OPERATION NO.	WORK ACCOMPLISHED
2F76-235-0925	Airspeed calibration and temperature survey.
2F77-236-0926	Landing gear operation, LORAS tests, and temperature tests.
2F78-237-0927	Temperature survey with upper cowling ram scoop incorporated.

3.25.2.2 (7) OPERATING LIMITATIONS

The operating limits in Report No. 2127-931001N, paragraphs 3.1.5.1 through 3.1.5.4 are in effect at the time of this report, supplemented by the following additional limitations:

1. Maximum airplane gross weight, all modes of flight, 15,700 lb. Reference A
2. Maximum pressure altitude 10,000 ft. Reference B
3. Maximum wind velocity 28 knots for vertical flight, 35 knots STOL and conventional flight below 31° duct angle. Reference B
4. Maximum airspeed 160 knots pending installation of revised pitch feel spring. Reference C
5. Propeller centerbody K strut alternating loads restricted to ±2500 lb for flight in "duct buzz" conditions to ensure infinite fatigue life of component parts. Reference D
6. Engine, propeller, and flight controls shall not be moved or operated so as to cause rapid or abrupt aircraft motions except as required for Table 3 testing. Reference E

References

A. NO w 63-0118-ci Ser 141, 8 Aug 1966 L. Cummings
B. NAVAIRSYSCOMHQ 1215332, May 1966.
C. BAC E.O. No. 103775B
D. BAC IOM 360:67:602-1: WHB 2 June 1967
E. NAVAIRSYSCOMHQ TWX R172049Z July 1967

The above limitations are deemed to apply to operation in both the pitch and power thrust control mode.

In transition +1.5 g pull-ups were made at critical duct angles of 40° and 27°. In conventional flight a 2.0 g pull-up was made at 0° and 130 knots. Symmetrical pushovers were made at 10°, 15° and 20° duct angles to a target of 0.5 g and in fact values of 0.4 and 0.2 g were realized. All the demonstrated test points were in build-up to final demonstration structural demonstrations.

All tests in pitch thrust control mode to date have been made with the landing gear down and at low altitudes, between Niagara Falls International Airport ground level (590 ft) and approximately 5,000 ft pressure-altitude. All indicated airspeeds plotted above 50 knots are from the pitot-static source without position error corrections.

The above demonstrations in pitch thrust control mode within the initial flight envelope are considered to constitute a usable current overall demonstration envelope for contractor and Navy pilots consistent with the current experience with the aircraft. No significant handling or control problems are known to exist which would further limit test operations in the pitch thrust control mode.

Test operations in the reporting period 6 August 1967 through 30 Sept. 1967 have been mainly devoted to exploring the initial flight envelopes in VTOL, transition and conventional flight modes with the thrust control in the power control mode. Six flights made between 8 August and 17 August were made in the pitch thrust control mode, owing to the lack of a usable master governor control unit.

All tests have been conducted at or near one C.G. position with test weights averaging 15,000 lb: from around 14,000 lb for some hovering tests, to up to 15,700 lb for some STOL and conventional-flight mode tests. These loadings correspond to the unballasted aircraft loading with the addition of two pilots and an instrumentation payload and sufficient fuel to reach a target gross weight.

In VTOL-flight mode no flight tests were made which extend the forward and lateral airspeed data presented in Figure 1. Hovering flights were made in winds up to 18 knots without undue difficulty in maintaining height control during takeoff or landing. Tests in transition flight have been made at all duct angles from 90° to 0° with fixed operating point tests being made at each 15° increment of duct angle. Transitions from hovering to conventional flight and back have been made to develop pilot proficiency in the power thrust control mode. Figure 5 summarizes data points for tests flown in the transition flight envelope. The incorporation of stronger components in the propeller centerbody support structure has permitted a wide range of level flight airspeeds to be explored at duct angles above 45°, than was reported previously. At all transition data points flown, the propeller K struts alternating loads were found to be within the infinite load limits.

No additional structural demonstrations have been made in this latest reporting period, since it is believed that the data from the pitch thrust control tests performed previously would be applicable to similar maneuvers performed in the power thrust control mode.

The landing gear has been retracted in flight at speeds up to 100 knots but at present can not be satisfactorily retracted above 100 knots. No significant trim changes are evident during cycling of the landing gear up to 125 knots.

Tests have been made using a calibrated T-28 pacer aircraft to evaluate total airspeed system corrections for the speed range 80 to 150 knots at duct angles between 30° and 0°. From preliminary evaluation of test data the pilots airspeed indicator readout from the nose boom pitot-static pressure source appears to read some 6% low. The LORAS airspeed system has been modified to provide data readout up to 150 knots and the pace calibration indicates it reads within ±1% from 80 to 150 knots using a linear LORAS calibration based on ground tests performed between 0 and 60 knots.

The above demonstrations in power thrust control mode within the initial flight envelope are considered to contribute to a usable overall demonstration envelope for contractor and Navy test pilots consistent with current experience with the aircraft. When considered alongside the previously reported envelopes for operation in the pitch thrust control mode an overall aircraft capability has been demonstrated which largely fills out the initial flight envelopes, within the current Navy flight release limitations.

(b) No high-speed or low-speed rolling pullout tests have been attempted to date.

Steady sideslip maneuvers have been demonstrated as listed in Table 1. Tests involving continuous sideslip have been restricted to left sideslip (left bank) as the fuselage gear boxes have overheated during prolonged right sideslip (right bank) conditions. Subject to gearbox modifications to control the gearbox temperature, it is believed that similar test data and limits to operation should apply to both left and right sideslip as the airplane is basically symmetrical left to right. The extreme sideslip angles demonstrated to date have not reached the flight envelope permitted values, but have been limited to approximately 20° bank angles, well within available lateral and rudder control ranges.

TABLE 1

MAXIMUM DEMONSTRATED SIDESLIP ANGLES

Flight Mode	Duct Angle (Degs)	Indicated Airspeed (knots)	Maximum Sideslip (Degs)
Transition	32	85	16L
↕	32	72	6L
	30	77	10L
	18	116	5L and R
	17	119	8L
	16	112	9R
	15	120	8L and R
Transition	15	123	8L
Conventional	0	120	5L
↕	2	126	10L
	3	135	5L
Conventional	4	119	8L

(b) No high-speed or low-speed rolling pullout tests have been attempted to date.

Steady sideslip maneuvers have been demonstrated as listed in Table 1. Tests involving continuous sideslip have been restricted to left sideslip (left bank) as the fuselage gear boxes have overheated during prolonged right sideslip (right bank) conditions. Subject to gearbox modifications to control the gearbox temperature, it is believed that similar test data and limits to operation should apply to both left and right sideslip as the airplane is basically symmetrical left to right. The extreme sideslip angles demonstrated to date have not reached the flight envelope permitted values, but have been limited to approximately 20° bank angles, well within available lateral and rudder control ranges.

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	15	120	8L and R
Transition	15	123	8L
Conventional	0	120	5L
↕	2	126	10L
	3	135	5L
Conventional	4	119	8L

(c) Low-speed flight data points demonstrated in essentially steady level flight through the transition and conventional flight range of duct and angles are shown in Figure 2. Figure 4 shows the corresponding values of maximum lift coefficient (C_L) as a function of indicated airspeed.

No obvious conventional stall characteristics are predicted for the airplane, but the figure includes a predicted $C_{L_{max}}$ line base on a maximum angle of attack of 20°. This value of angle of attack has been used in place of a predicted stall boundary to generate flight minimum airspeed boundaries for test planning purposes. The angles of attack noted on the figure have been corrected from test data values using preliminary angle-of-attack error curves. The maximum indicated angles of attack recorded in flight vary between 18° and 15° depending upon configuration. No airspeed position error corrections have been made to the indicated airspeeds plotted, as adequate position error corrections have not been established to date.

BY _____ DATE _____
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MODEL _____ PAGE _____
SHIP _____ REPORT _____

Model X-22A BuNo. 151821 Date 30 SEPT 1967	Bell Aerosystems Company Flight Test and Operations	Page 3.25.2.2(9)-4 Report No. 2127-933-001
Title MAXIMUM C_L DEMONSTRATED AT MINIMUM SPEED ENVELOPE, APPROXIMATELY LEVEL FLIGHT		Demonstration Specification Item No.
Configuration Details Flight Mode TRANS Duct Angle NOTED Weight NOTED C.G. 308.8 INCHES Test Altitude 25,000 MP	Landing Gear Position, DOWN Thrust Control Mode, POWER Operation No. NA Test Sequence No. NA	Limits of Data Accuracy

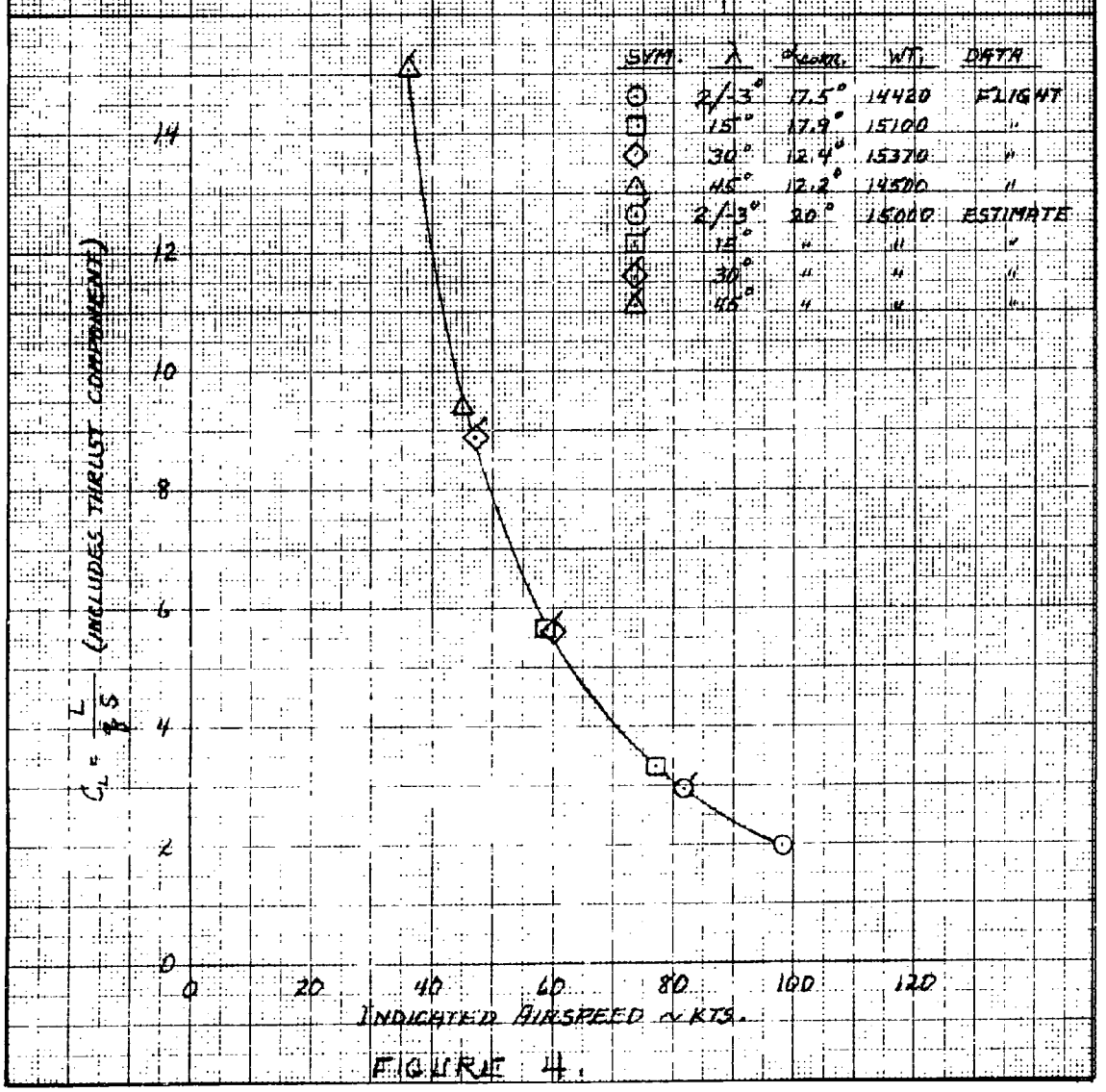

FIGURE 4.

BY _____ DATE _____
CHECKED _____ DATE _____

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MODEL _____ PAGE _____
SHIP _____ REPORT _____

Model X-22A BuNo. 151521 Date 20 SEPT 1967	Bell Aerosystems Company Flight Test and Operations	Page 3.2.5.2.2(9)-10 Report No. 2127-F310021T
Title INITIAL TRANSITION FLIGHT ENVELOPE INVESTIGATION		Demonstration Specification Item No. N/A
Configuration Details Flight Mode TRANS. Duct Angle ALL Weight ≈ 15,000 LBS. C.G. 308.5 INCHES Test Altitude ≈ 2000 Hp	Landing Gear Position DOWN Thrust Control Mode POWER Operation No. N/A Test Sequence No. N/A	Limits of Data Accuracy ± 2 %

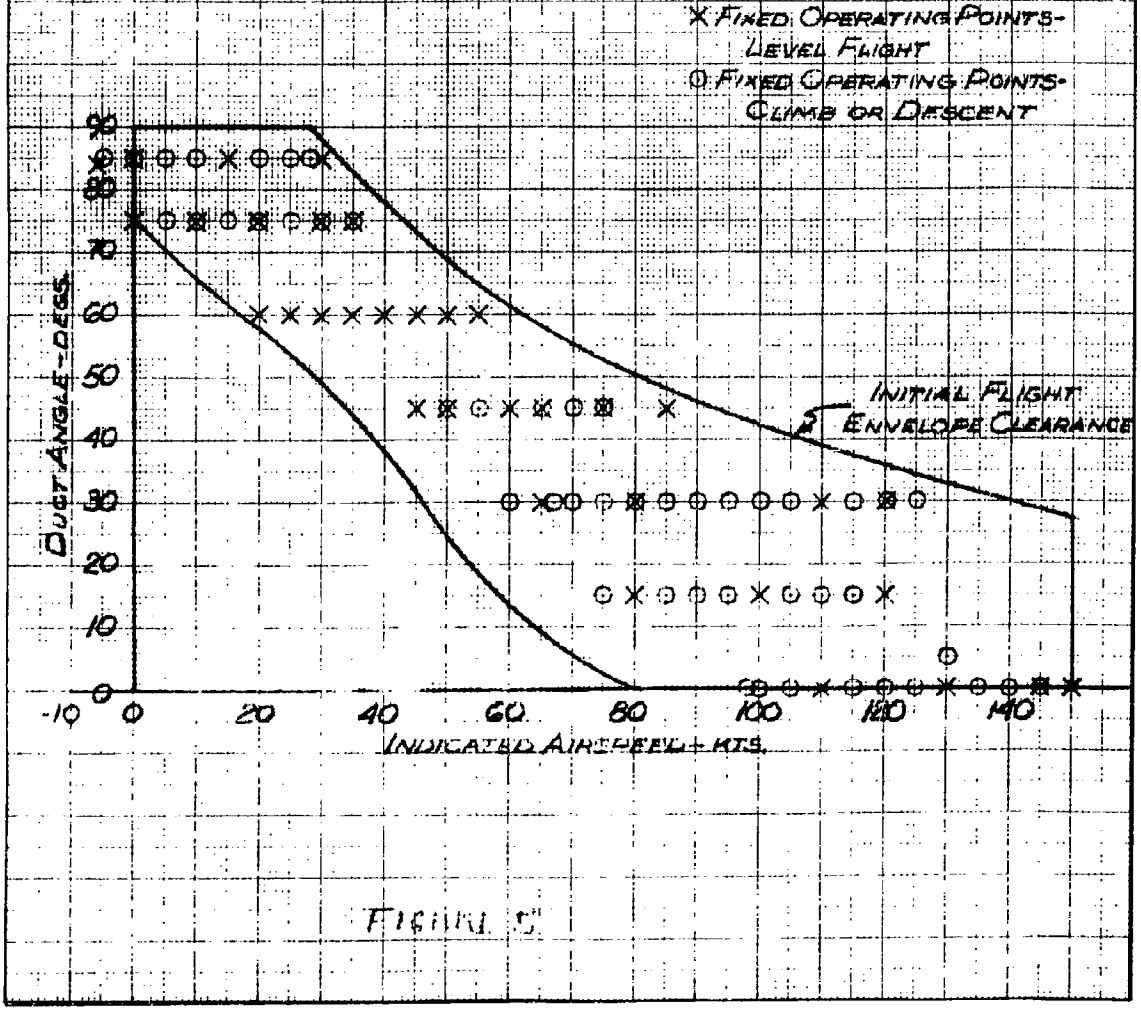

FIGURE 5

These modifications, and reducing the propeller speed in flight from 2550 to 2450 rpm have shown a consequent reduction in center body vibration levels.

Propeller centerbody vertical vibration levels are currently monitored to provide data to calculate the cumulative damage to centerbody support struts. Periodic inspections have been defined based on time accumulated at high vibration levels. Modifications have been incorporated to strengthen critical strut components, and subsequent flight tests have shown that alternating loads in the K struts remain within the loads set for infinite fatigue life.

AD 447814

END CHANGE PAGES

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PREPARED UNDER NAVY, BUREAU OF NAVAL WEAPONS
CONTRACT NO. NOw 63-0118-c

MODEL X-22A

TITLE

DEMONSTRATION PLANNING AND PROGRESS REPORT

REPORT NO. 2127-931001 DATE: 21 January 1964

BY: W. R. Dwyer DATE 1/21/64
CHECKED: R. E. Kelly DATE 1/21/64
APPROVED: R. E. Kelly DATE 1/21/64
APPROVED: Vincent B. Pugliese DATE 1/21/64
Technical Director

REVISIONS	DATE	PAGE NO.

ABSTRACT

Included herein is the initial submittal of the demonstration planning and progress report as specified in paragraph 3.25.2.2 of MIL-D-8708A (WEPS).

This report represents the latest planning for the demonstration of the two X-22A aircraft as well as proof of design tests and submittal dates for contract design data.

To keep submittal material up to date, additional and/or revised pages shall be included at intervals not exceeding two months.

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 GENERAL

This Demonstration Planning and Progress Report for the X-22A VTOL Research Airplane will fulfill the requirements of Military Specification MIL-D-8708A (WEPS) Addendum 32 paragraph 3.25.2.2. Bi-monthly revision of the report until both airplanes are delivered will update the report to the latest information concerning the planning for, and the performance of, the flight demonstration program.

The bulk of this report shall follow the paragraphing of the basic specification. Detailed descriptions of systems, equipment or other specific airplane information will be included under the applicable demonstration specification paragraph along with the demonstration requirements, procedures and results, the details being added as they become available.

Tables will be included which will provide ready access to information concerning status of tests scheduled or completed, the applicable Bureau Number, test configuration and any special remarks. Appendices will be employed to handle information of a general nature or which does not conveniently fall under specific paragraphs.

Items one through twelve called out in paragraph 3.25.2.2. DEMONSTRATION PLANNING AND PROGRESS REPORT of MIL-D-8708A will be inserted under that paragraph in this report or the location of the information elsewhere in the report shall be given.

Pages marked revised will have the revised information for the data of the revision identified by a solid vertical line in the outboard margin opposite the line in which the revision occurs.

1.2 GENERAL AIRPLANE DESCRIPTION

1.2.1 GENERAL ARRANGEMENT

The X-22A is a dual tandem configuration equipped with four rotatable ducted propellers driven by four T58-GE-8 turboshaft engines. The diameter of each propeller is 84 inches. Standard aircraft characteristics are presented in paragraph 1.2.8. The general arrangement drawing is given in paragraph 1.2.9. Multi-engine reliability for all modes of flight is provided through a common power transmission shaft to which the engines are coupled through overriding clutches. The power transmission system prevents the occurrence of asymmetrical propeller forces when operating on fewer than four engines or in the event of engine failure.

Aircraft span is 39.2 feet, the length is 36.3 feet, and the height is 16.3 feet. Weight empty is 10,635 pounds. Design gross weight is 14,364 pounds and maximum STO gross weight is 17,237 pounds. The fuel capacity is 500 gallons of JP-5 fuel which is contained in a single cell close to the aircraft center of gravity.

Total forward lifting surface area is 155 square feet, comprising the forward ducts, elevons, and fuselage carrythrough. Aft lifting surface area is 253 square feet.

The vertical fin is a directional stabilizing surface with an area of 68.5 square feet.

The cabin compartment is 5.5 feet wide, 4.3 feet high, and 15.5 feet long. The cabin is designed to carry 1200 pounds of payload consisting of passengers, cargo, instrumentation or combinations thereof. Cabin space is available for six passengers, seat mounting provisions only are provided.

1 2.2 PROPULSION SYSTEM

Four T58-GE-8 turboshaft engines power the X-22A airplane. The engines are in dual nacelle pods either side of the fuselage in the aft wing. Military rating of these engines is 1250 shaft horsepower at sea level standard conditions.

Engine power is fed directly into an aft cross-shaft through overrunning clutches and bevel gear reduction gearboxes. The power is delivered to shafting which drives all propellers in synchronism. An accessory gearbox located on the aft transverse shaft provides mechanical power for hydraulic, electrical, lubrication and equipment cooling systems.

The fuel system utilizes a tank located near the aircraft center of gravity. Fuel is drawn from a single sump to the engines by suction. A boost pump is provided to meet maximum altitude and speed mission requirements.

An electric starter is provided on each engine. Normally, engine starting will be accomplished by means of a ground cart. A limited number of ground starts and air restarts may be accomplished with the aircraft battery.

1 2 3 FLIGHT CONTROL SYSTEM

The flight control forces are realized at the ducts through the use of thrust modulation obtained by selective propeller pitch change of the four propellers and the use of elevons in the propeller slipstream. These controls are integrated for modes of flight from vertical to level to achieve the correct direction and amount of control. Altitude control in vertical flight is normally achieved by power lever control in the engine power control mode. A collective pitch stick is supplied for this control for certain test phases in which engine speed control is used.

The propeller pitch and the elevon controls are operated by dual hydraulic power systems. The pilot's flight controls consist of a conventional stick and rudder pedals, plus a removable collective pitch stick.

During transition, when the duct units are at angular locations between those used for hover and those for level flight, the control stick and pedals produce mixed propeller pitch and elevon deflections in proportions governed by duct position.

Through inputs to the normal flight controls Stability Augmentation is provided

A variable stability control system is provided. Its purpose is to provide the capability to evaluate a wide range of handling qualities in order to investigate optimum and minimum handling qualities for V/STOL aircraft and to eventually simulate other V/STOL aircraft.

1.2.4 ELECTRICAL SYSTEM

The electrical system in the X-22A is used to power communication and navigation equipment, instruments, flight controls, propulsion, lighting, and flight instrumentation systems.

The propulsion system supplies input power to the accessory drive gearbox which powers one hydraulic constant speed drive and one direct drive unit. A clutch is provided in the accessory gearbox for the generator power takeoff. This clutch shifts the gear ratio for this pad and provides a usable input speed for the constant speed drive during ground idling operations.

Electrical power is furnished by the following:

(1) 20 kva, a-c generator

(1) 10 kva, a-c generator

(2) 200 ampere transformer rectifiers to provide d-c power

(1) 30 ampere-hour, 24 volt silver-zinc battery

1.2.5 ELECTRONIC SYSTEM

The electronic system is an integrated design providing the necessary elements required for the functions of communication, navigation and identification.

The following units are included:

(1) Interphone system - AN/AIC-14/Intercom

(1) Radio communications set - AN/ARC 51

(1) Automatic direction finder - Collins Radio DF-203

(1) Tacan radio set - AN/ARN - 52 (V)

(1) Compass system - MA-1

(1) Radar altimeter - Minneapolis Honeywell YG 709/A1

The three station AN/AIC-14 interphone system has controls which are installed on the right and left side consoles for use by the pilot and copilot, respectively. An additional interphone station is installed opposite the side entrance door in the cabin.

Voice communications for the pilot and copilot are provided by an AN/ARC 51 UHF radio set. Channel selection facilities are installed on the center console. The set operates in the frequency range of 225 to 399 mc.

1.2.6 HYDRAULIC SYSTEM

Two hydraulic systems are provided for flight control and utility functions, designated primary and secondary. Each is

separate and self-contained, and consists of a hydraulic pump, reservoir, filters, valves, and lines. The pumps are driven from the accessory gearbox. Each system is provided with ground test connections from which all hydraulically actuated items can be operated.

All flight control actuated items are powered by dual or tandem systems. Both the primary and secondary systems (operating in parallel), supply power for propeller pitch control, duct rotation, elevon control, and stability augmentation systems. The secondary system also supplies power for the variable stability system and landing gear, extension and retraction.

Provisions are made for emergency operation as required for the actuated items. The elevon actuators, duct rotation mechanism, propeller pitch control, and flight control damper actuators are supplied with power from the two hydraulic systems and have four-engine drive capability on both systems. Landing gear emergency extension is by means of pneumatic power. Brake operation is provided by a master cylinder and reservoir system.

1 2.7 INSTRUMENTATION

Flight test instrumentation to document the demonstration program will be installed during manufacture of the two X-22A aircraft.

Airborne magnetic tape will be the basic recording device for data acquisition, a 50 channel oscillograph will be used for the variable stability program.

A central patch board system will be provided for parameter selection.

BAC report No. 2127-936001 Demonstration Instrumentation Report details the instrumentation system.

Form 9345 Rev. 1248

1.2.8 STANDARD AIRCRAFT CHARACTERISTICS

Model X-22A
Date 21 January 1964
BELL AEROSYSTEMS COMPANY
Page 7
Report 2127-931001

Form 9345 Rev. 1248

POWER PLANT	MISSION AND DESCRIPTION	WEIGHTS
No. & Model: (4) T58-GE-8B Mfr: General Electric Co. Type: Free Power Turbine Red. Gear Ratio: 0.133 Prop. Mfr: Hamilton Standard Prop. Dia. 84 in.	The mission of this aircraft is to provide a vehicle with which to explore the mechanical and aerodynamic problems associated with the design, construction and test of the dual-tandem, ducted propeller design and to evaluate its military potential including carrier flight deck operation and compatibility with the civil airways system.	Loading: Pounds Empty 10,635 Basic 10,733 Design 14,364 Max. take-off (Overload) 17,237 Max. take-off (Normal) 14,364 Max. landing 14,364

Model
Date 21 Janu

separate and self-contained, and consists of a hydraulic pump, reservoir, filters, valves, and lines. The pumps are driven from the accessory gearbox Each system is provided with ground test connections from which all hydraulically actuated items can be operated.

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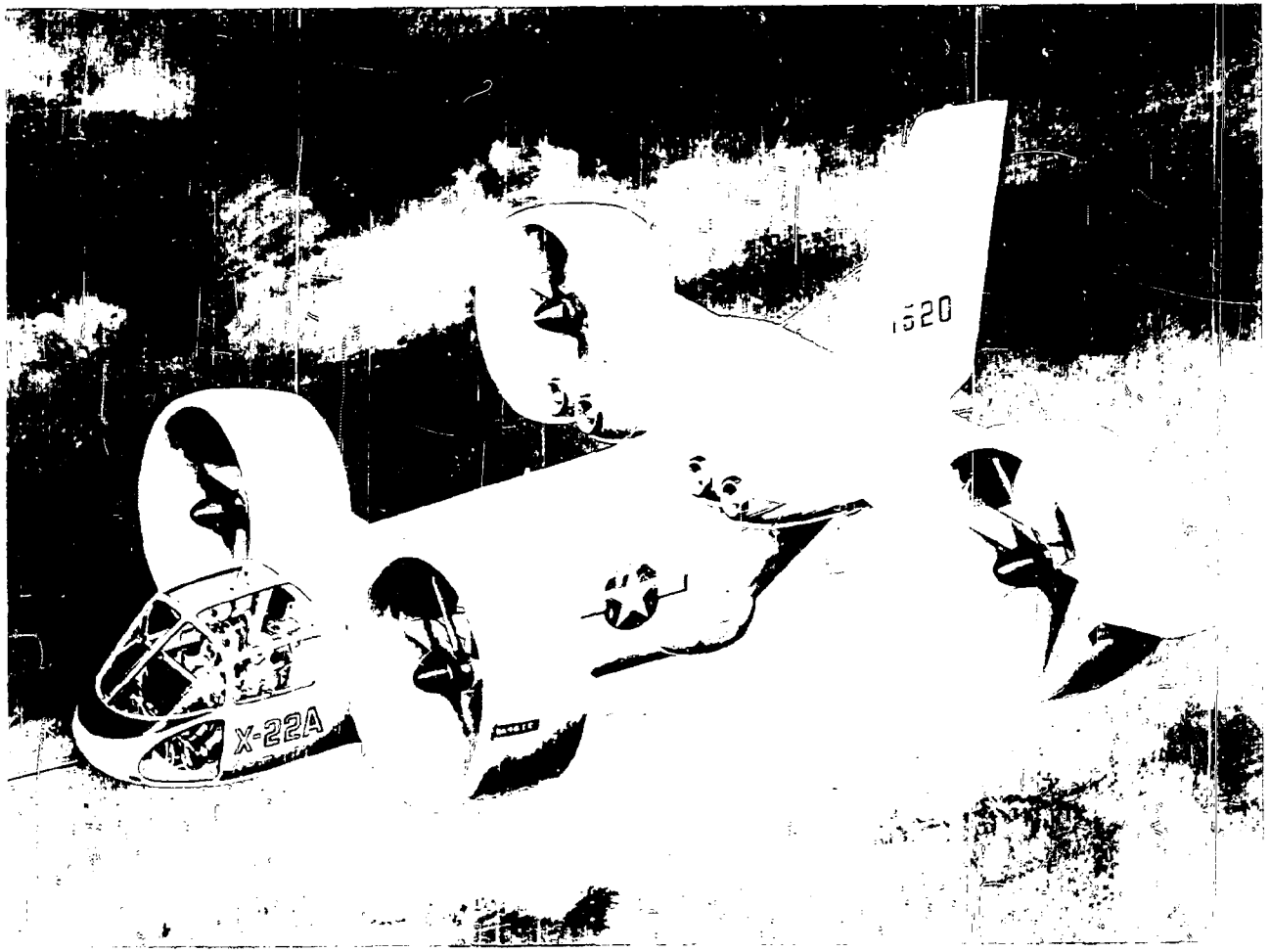
A central patch board system will be provided for parameter selection

BAC report No 2127-936001 Demonstration Instrumentation Report details the instrumentation system.



1.2.8 STANDARD AIRCRAFT CHARACTERISTICS

POWER PLANT

No. & Model: (4) T58-GE-8B
Mfr: General Electric Co.
Type: Free Power Turbine
Red. Gear Ratio: 0.133
Prop. Mfr: Hamilton Standard
Prop. Dia. 84 in.
No. of Blades: 3
Tail Pipe: Fixed Area

ENGINE RATINGS

	SLS SHP	Jet Thrust	Rpm	Min.
Mil.	1250	154	19,500	30
Nor.	1050	132	19,500	Cont.

ORDNANCE

None

CARGO

Main Compartment (Usable)	336 cu ft
Main Compartment (Floor Area)	54 sq ft
Floor Loading-Uniformly Distributed	100 lb/sq ft
Max. Capacity	5400 lb
Main Compartment	
Length	129 in.
Width	66 in.
Height	78 in.
Main Cargo Door	
Height	52 in.
Width	35 in.
Height from Ground	20 in.
Personnel	
Passengers	6

MISSION AND DESCRIPTION

The mission of this aircraft is to provide a vehicle with which to explore the mechanical and aerodynamic problems associated with the design, construction and test of the dual-tandem, ducted propeller design and to evaluate its military potential including carrier flight deck operation and compatibility with the civil airways system.

The basic missions are performed at sea level at speeds for maximum endurance with a payload of 1200 pounds. Take-off and landing are vertical.

A ferry mission is performed at the speed and altitude for long range cruise. The aircraft operates from an overload gross weight without cargo. A vertical or short running take-off and vertical landing are used.

The aircraft is a dual-tandem, ducted propeller VTOL Research Airplane in the 15,000-pound weight category. Lift and thrust are provided by four turboshaft engines mounted in a dual engine pod on each side of the aft fuselage. Four rotatable ducted propeller units, are interconnected and driven by the engines through an aircraft transmission system. The aircraft carries a flight crew of two men in the cockpit, a pilot and copilot, and is also capable of carrying 1200 pounds of payload consisting of passengers, cargo, instrumentation, or combinations thereof. Provisions are made for the installation of six passenger seats in the cabin.

Flight control of the aircraft in both conventional and VTOL modes is performed by conventional flight station controls such as stick, rudder-pedals and a collective pitch stick. Provisions are made for various types of height control. Variable stability and control is provided in the V/STOL mode and variable damping and variable control are provided about all axes.

First Flight is Estimated March 1965

DIMENSIONS

Span:
Front surface 23.16 ft
Rear Surface 39.20 ft
Length: 36.3 ft
Height: 16.3 ft
Area: 252 sq ft
Aspect Ratio
Ducts: 1.9 d/c
Aft surfaces: 6.13

WEIGHTS

Loading:	Pounds
Empty	10,635
Basic	10,733
Design	14,364
Max. take-off (Overload)	17,237
Max. take-off (Normal)	14,364
Max. landing	14,364

FUEL AND OIL

Location	No. Tanks	Gal.
Fuselage	1	500
Grade:	JP-4 or JP-5	
Specification:	MIL-F-5624E	

OIL

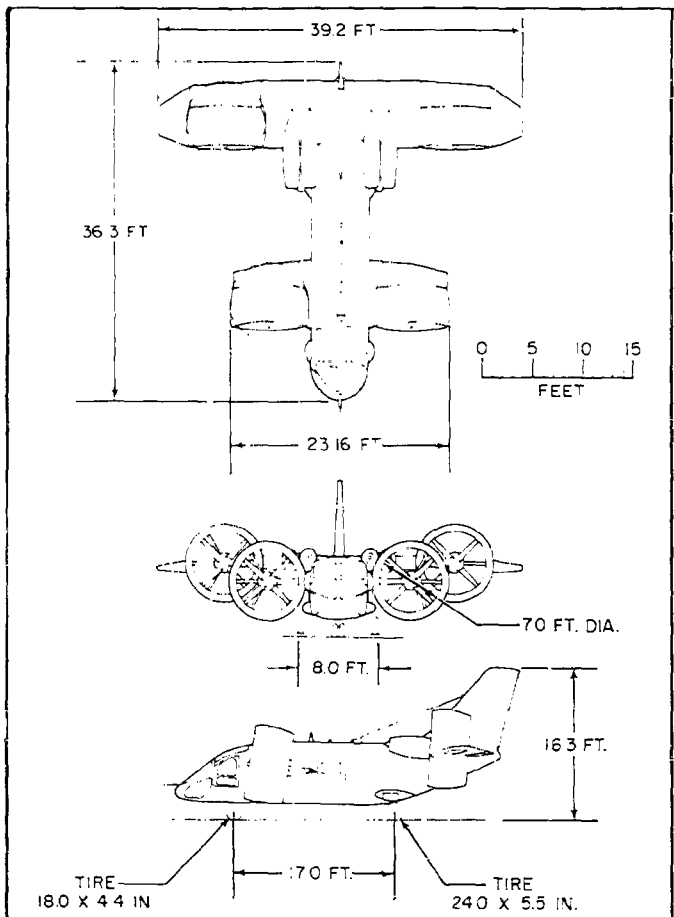
Location	No. Tanks	Gal.
Engine	4	10.0
Fwd Transmission	1	3.5
Aft Transmission	1	10.0

Specification: MIL-L-7808D

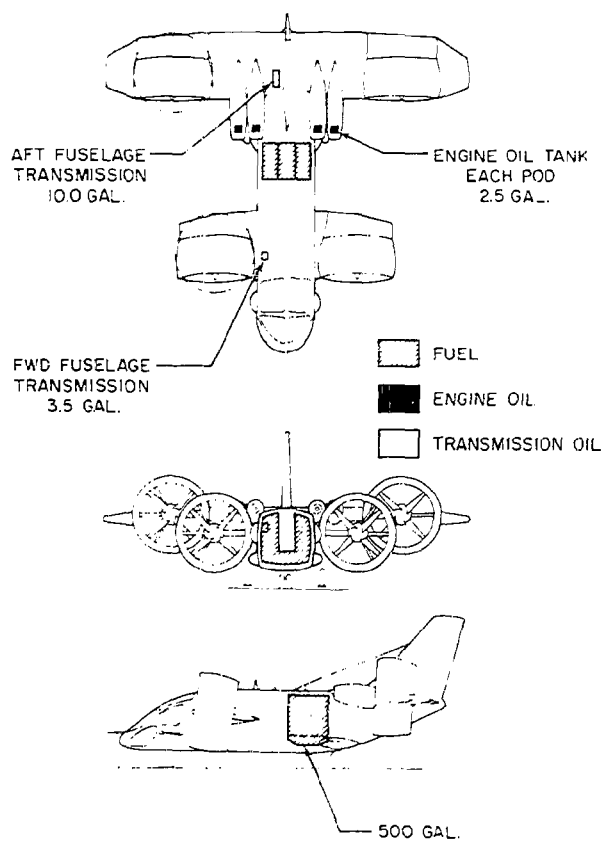
ELECTRONICS

UHF Radio Set	AN/ARC-52
Automatic D/F	AN/ARN-59
Tacan	AN/ARN-52
IFF	AN/APX-6B
Interphone System	AN/AIC-14
Coder Group	AN/APA-89
Marker Beacon RCVR	AN/ARN-32
Radar Altimeter Set	AN/APN-141

Form 0345 Rev. 1248



DESCRIPTIVE ARRANGEMENT



TANKAGE

X-22A

Model X-22A
Date 21 January 1964
BELL AEROSYSTEMS COMPANY
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Report 2127-9310

PERFORMANCE SUMMARY

TAKE-OFF LOADING CONDITION	(1) Endurance - SL	(3) Endurance - SL	(5) Radius - SL	(7) Radius - SL	(9) Ferry
TAKE OFF WEIGHT	14,364	15,733	14,364	15,733	14,533
	2,065	3,434	2,065	3,434	3,434
	1,200	1,200	1,200	1,200	0
	56.8	62.2	56.8	62.2	57.5
	91.7	96.2	91.7	96.2	92.5
	0	0	0	0	0
	0	0	0	0	0
	0	0	0	0	0
	312/9,000	307/8,000	312/9,000	307/8,000	311/8,900
	4,360	3,650	4,360	3,650	4,280
	2.6	3.1	2.6	3.1	2.62
	4.4	5.1	4.4	5.1	4.5
	27,500	24,500	27,500	24,500	27,000
	—	—	150	300	579
	—	—	208	212	215
	—	—	SL	SL	13,000/15,000
	—	—	75/1.22	150/2.14	289/2.7
	—	—	208	212	215
	1.10	2.0	—	—	—
	128/SL	135/SL	—	—	—

COMBAT LOADING CONDITION	(2)	(4)	(6)	(8)	(10)
COMBAT WEIGHT					
LANDING WEIGHT	12,536	12,677	12,536	12,677	11,477
	207	344	207	344	344
	92/ -	96/ -	92/ -	96/ -	92.6/ -
	1370/2250	1390/2265	1370/2250	1390/2265	1259/2100

Performance Basis: 1. Estimated data
2. Endurance and combat range are based on Engine Specification fuel consumption data.
3. Mission performance is based on MIL-C-5011A and MIL-P-22203 with 10% fuel reserve for landing.

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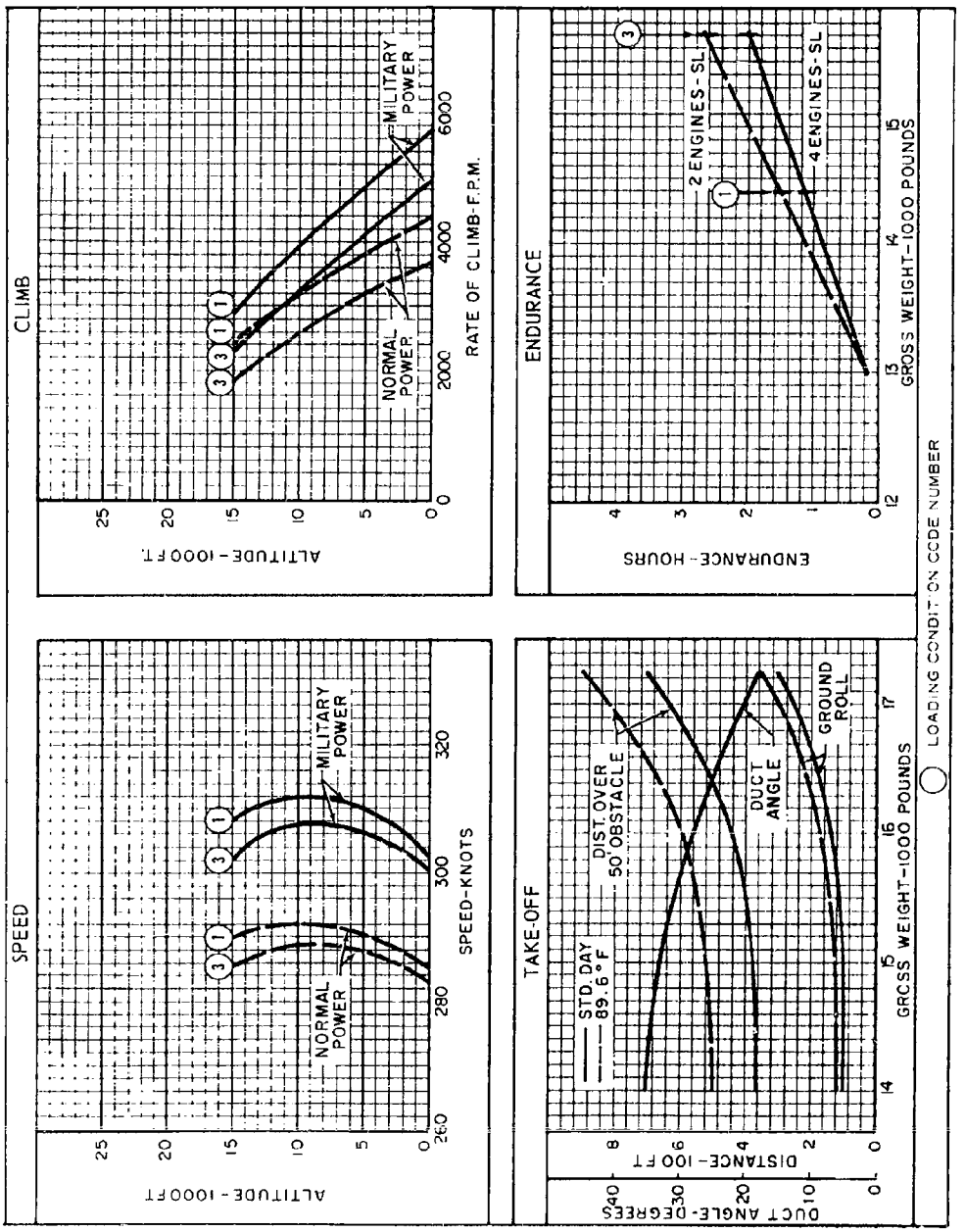
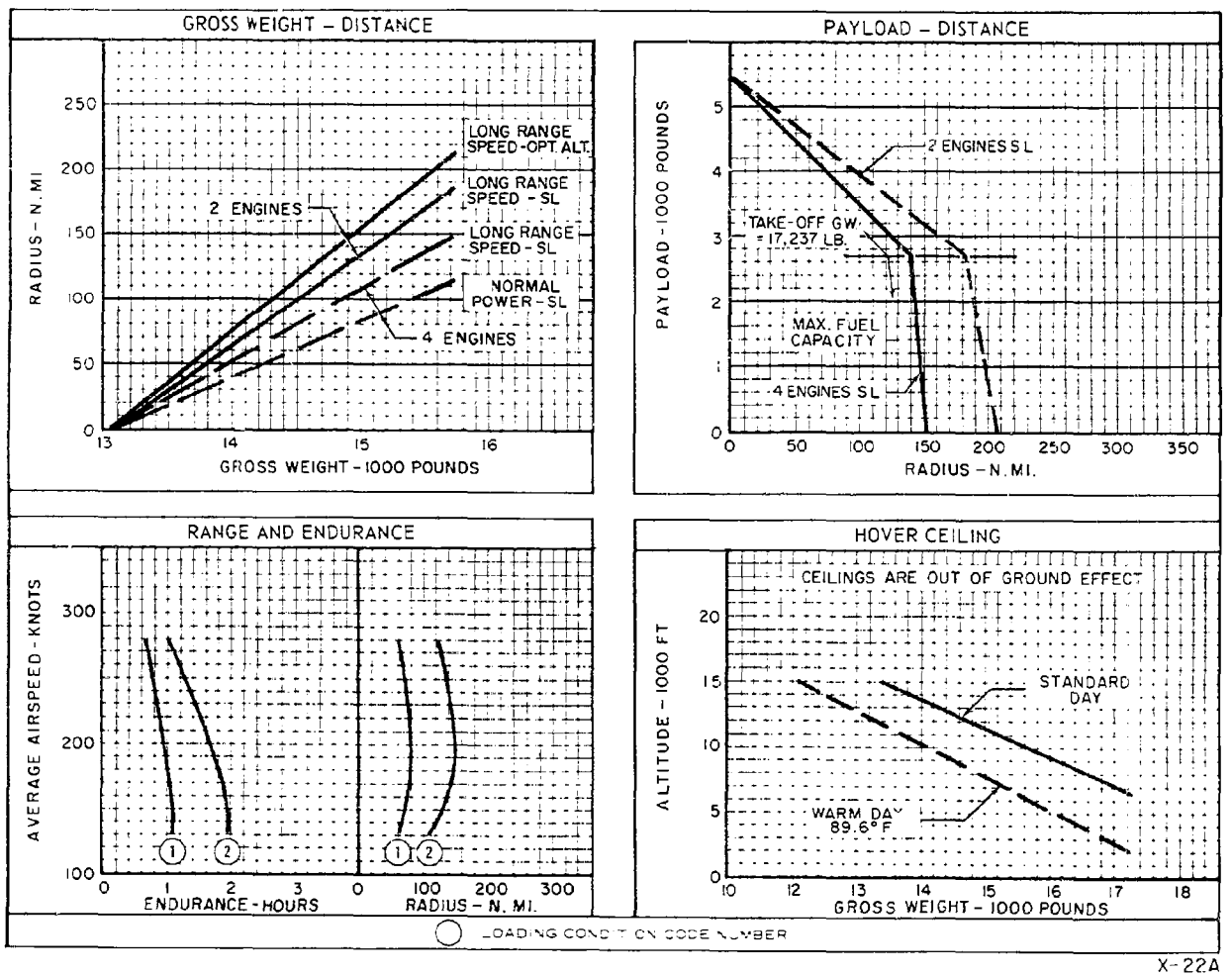

CLIMB
ALTITUDE - 1000 FT.
RATE OF CLIMB-F.P.M.
MILITARY POWER
NORMAL POWER
ENDURANCE
ENDURANCE - HOURS
2 ENGINES-SL
4 ENGINES-SL
GROSS WEIGHT-1000 POUNDS
SPEED
ALTITUDE - 1000 FT
SPEED-KNOTS
MILITARY POWER
NORMAL POWER
TAKE-OFF
STD. DAY
89.6° F
DIST. OVER
50' OBSTACLE
DUCT ANGLE
GROUND ROLL
DISTANCE - 100 FT
DUCT ANGLE-DEGREES
GROSS WEIGHT-1000 POUNDS
LOADING CONDITION CODE NUMBER

Form 0345 Rev. 1248



Model X-22A
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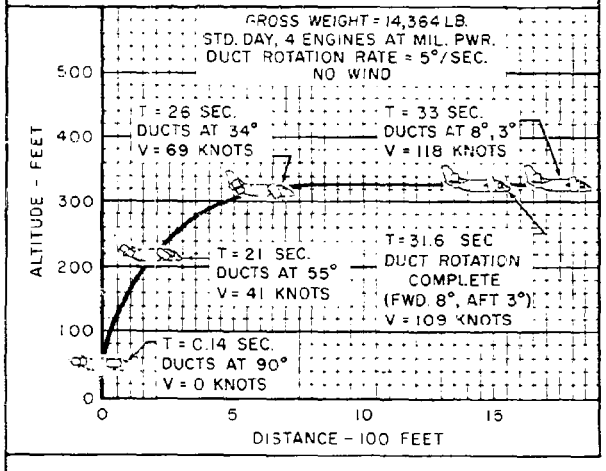
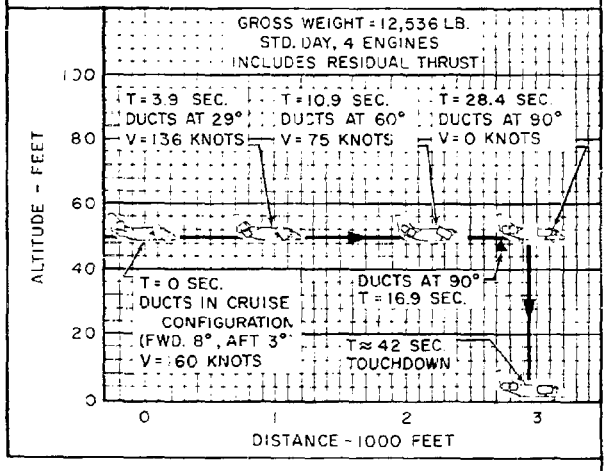
TYPICAL TRANSITION CHARACTERISTICS

TAKE-OFF



LANDING



Note: The landing transition is started at duct unlock speed with idle power. As the ducts rotate and speed decreases, power is applied to maintain level flight.

LOADING CONDITION CODE NUMBER

X-22A

NOTES

(1)

ENDURANCE MISSION

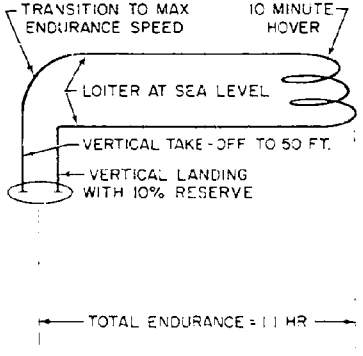
Warm-up and take-off: 5 minutes at Normal Power-SSL

Loiter: At speed for maximum endurance at sea level on 4 engines

Hover: 10 minutes at sea level

Loiter: At speed for maximum endurance at sea level on 4 engines

Reserve: 10 percent of the initial fuel



(5)

RADIUS MISSION

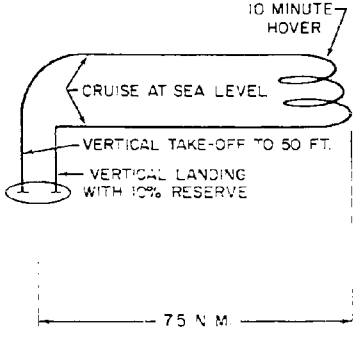
Warm-up and take-off: 5 minutes at Normal Power-SSL

Cruise out: At speed for best cruise at sea level with 4 engines

Hover: 10 minutes at sea level

Cruise back: At speed for best cruise at sea level with 4 engines

Reserve: 10 percent of the initial fuel



(9)

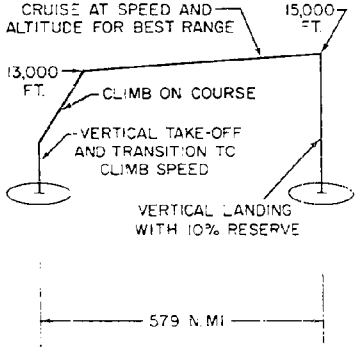
FERRY MISSION

Warm-up and take-off: 5 minutes at Normal Power-SSL

Climb: On course to best cruise altitude

Cruise: At speed and altitude for best cruise on 2 engines

Reserve: 10 percent of the initial fuel



NOTES

① ENDURANCE MISSION

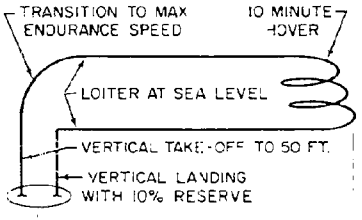
Warm-up and take-off: 5 minutes at Normal Power-SSL

Loiter: At speed for maximum endurance at sea level on 4 engines

Hover: 10 minutes at sea level

Loiter: At speed for maximum endurance at sea level on 4 engines

Reserve: 10 percent of the initial fuel



TOTAL ENDURANCE = 1.1 HR

③ RADIUS MISSION

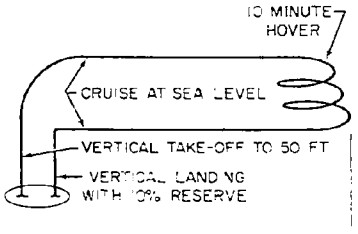
Warm-up and take-off: 5 minutes at Normal Power-SSL

Cruise out: At speed for best cruise at sea level with 4 engines

Hover: 10 minutes at sea level

Cruise back: At speed for best cruise at sea level with 4 engines

Reserve: 10 percent of the initial fuel



75 N MI

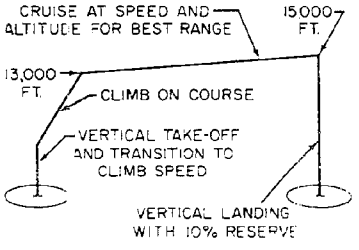
⑨ FERRY MISSION

Warm-up and take-off: 5 minutes at Normal Power-SSL

Climb: On course to best cruise altitude

Cruise: At speed and altitude for best cruise on 2 engines

Reserve: 10 percent of the initial fuel



579 N MI

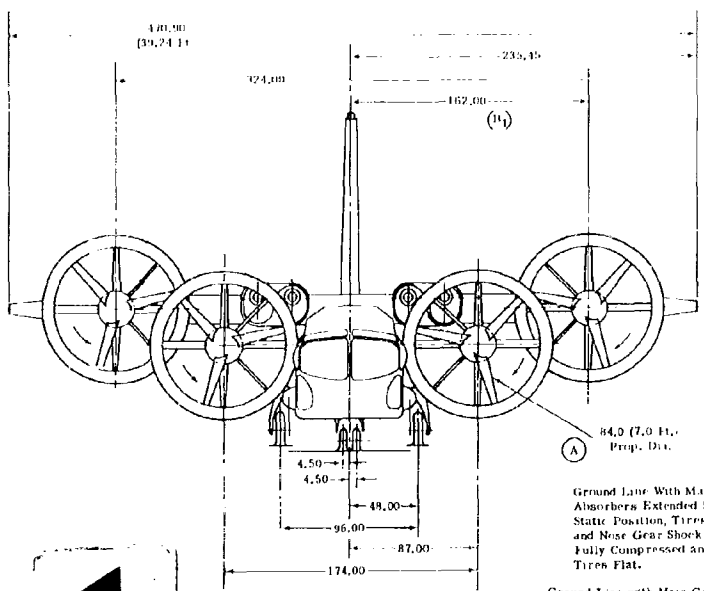
MODEL X-22A

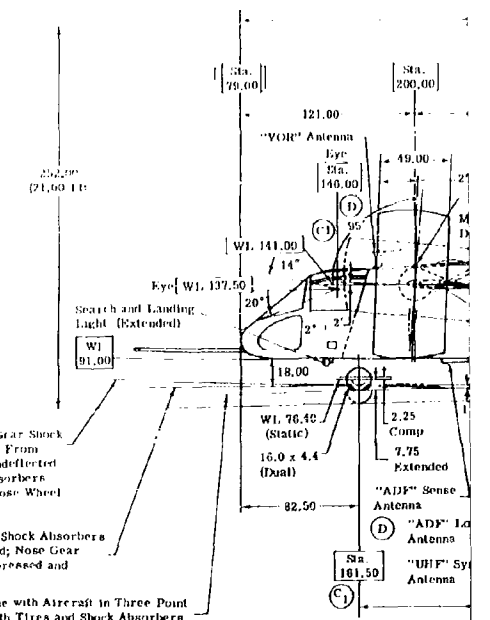
DATE 21 January 1964

BELL AEROSYSTEMS COMPAN

REVISIONS

A	Plan View: at Fwd Elevon, 10.25 was 8.0, 33.5 was 31.25 and 39.0 was 36.75 At Cockpit Added Bubble to Side Window. View Looking Aft (3) Bladed Propellers Were (4) Bladed (Typ 4 Places)	Lehnert 7 20 63
B	(1) Revised Detail A. Plan View Increased Wing Area Chgd Outer Panel. Chgd Picture of Eng Nacelles. Profile View Increased Fin Area, Added Duct Rotation Data. View Looking Aft Chgd O'bd Duct Locations Chgd Picture and Location of Eng Nacelles	Lehnert 5 27 63
C	(1) Plan View: Added, Hoist Fittings Added 275.60 (22.97 ft). Profile View 26 was 26 1/2°. Added Ground Line Conditions Added MAC Data. Added, Navigation, Search - Landing and Anti-Collision Lights Completed Data Tables. Nose Wheel Sta 161.50 was Sta 166.50 92.50 was 91.50 and 192.50 was 192.50 Added Hoisting Sling and 252.00 (21.00 ft) Norm Dsgn Grs Wt C'G Sta 303.74 was 306.52, WI 136.87 was 138.00, 38 was 36 and 176.22 Dim was 173.44 Duct Rotation Aft, 1° 2° was 3° 7/8°, Fwd 5° 42 was 5° 05°	Lehnert 7 10 63
D	See F O 83848	LAB0221 11 14 63





1

GEOMETRIC DATA

Lifting Surface	FWD	Aft
Area (sq ft)	139.00	286.00
Span (ft)	22.97	39.24
Aspect Ratio	3.86	5.38

Aft Inboard Wing
- Area (sq ft) 160.00
- Aspect Ratio 2.30
- Taper Ratio 1.00
- Airfoil Section-NASA 2419

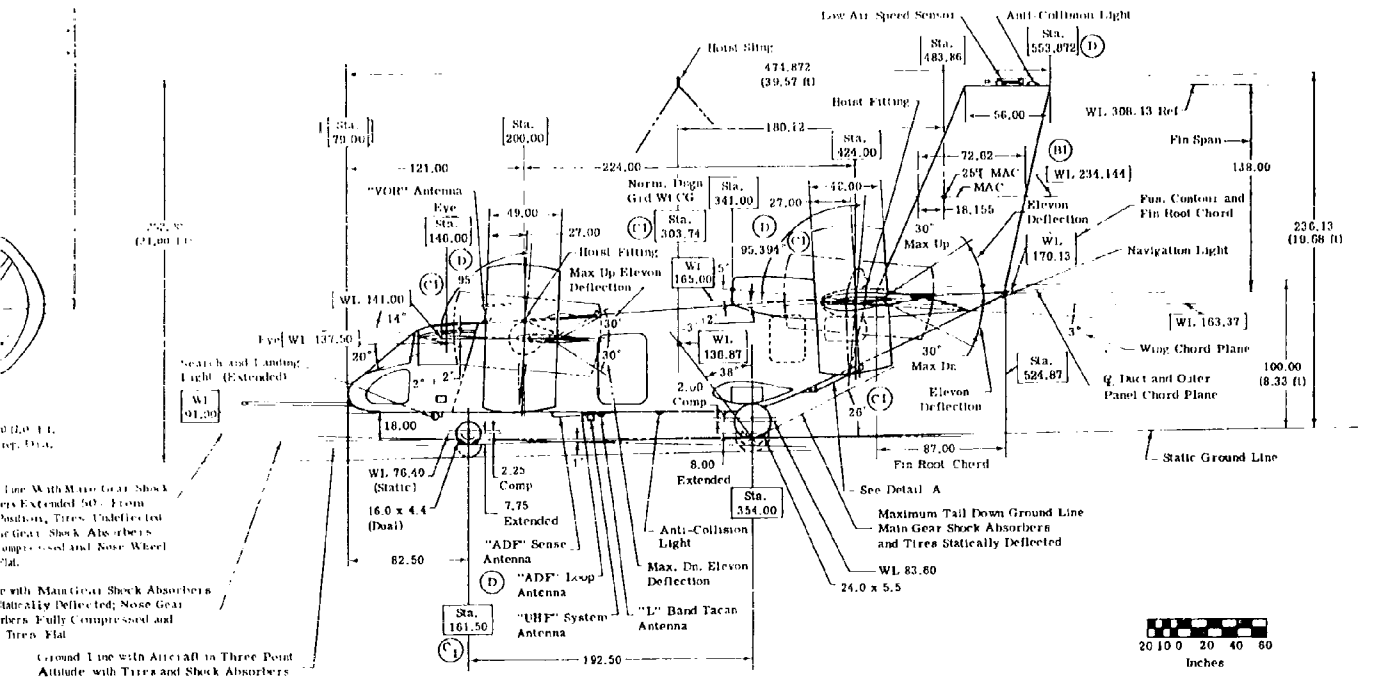
Aft Outboard Wing
- Area (sq ft) 20.00
- Aspect Ratio 0.992
- Taper Ratio 0.50
- Airfoil Section NASA 0015-61

Fin
- Area (sq ft) 68.50
- Aspect Ratio 1.93
- Thickness Ratio Root 16.72%
- Thickness Ratio Tip 11.33%
- Airfoil Section NASA 0010-64 Modified
- Taper Ratio 0.224

Elevon
- Area-Fwd (sq ft)(2) 42.70 Total
- Airfoil Section NACA 0014-64
- Area-Aft (sq ft)(2) 56.32 Total
- Airfoil Section Modified NACA 000(9.4) Section

Engines
- Four YT58-GE-8D

2

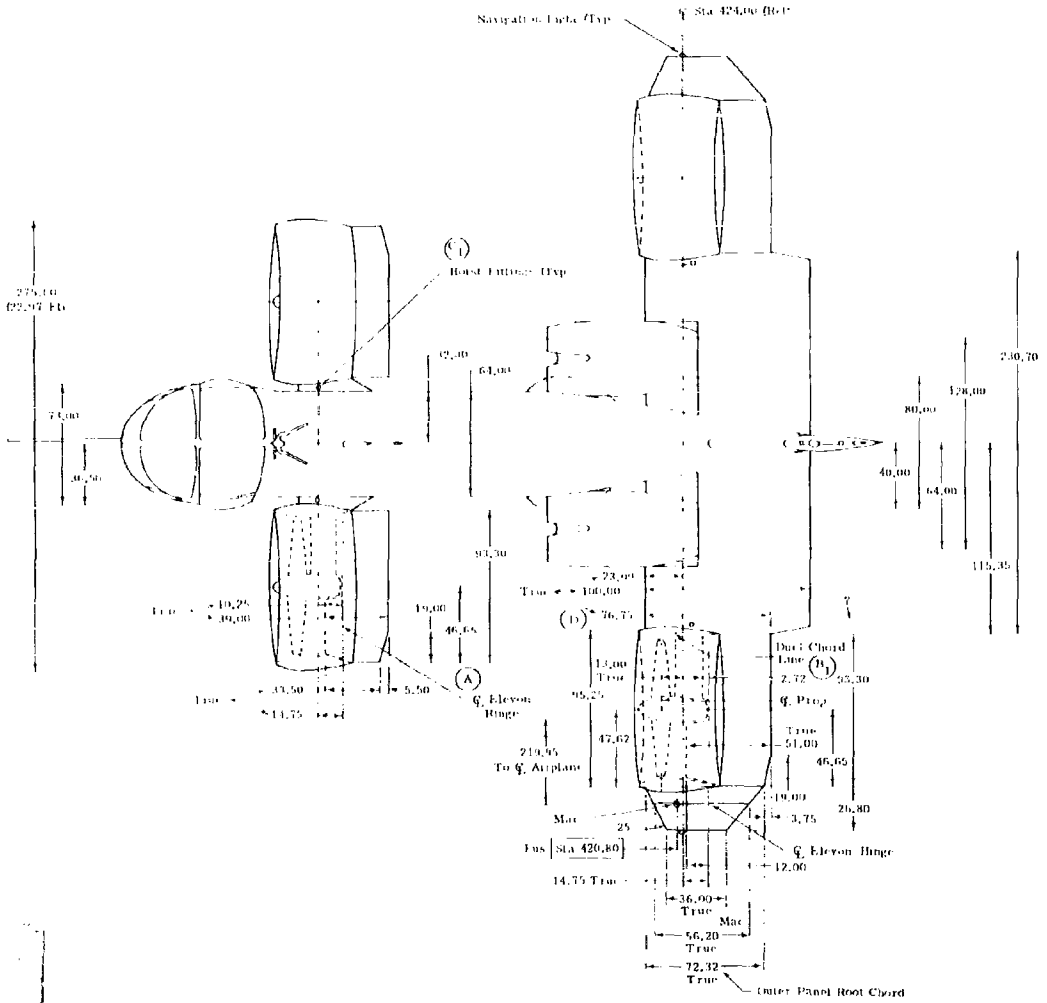


1.2.9 X-22A GENERAL ARRANGEMENT

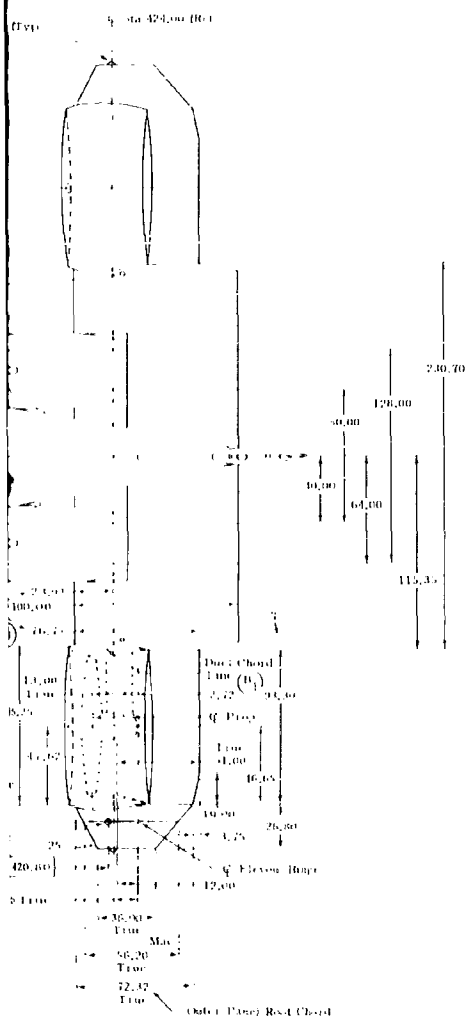
MODEL X-22A

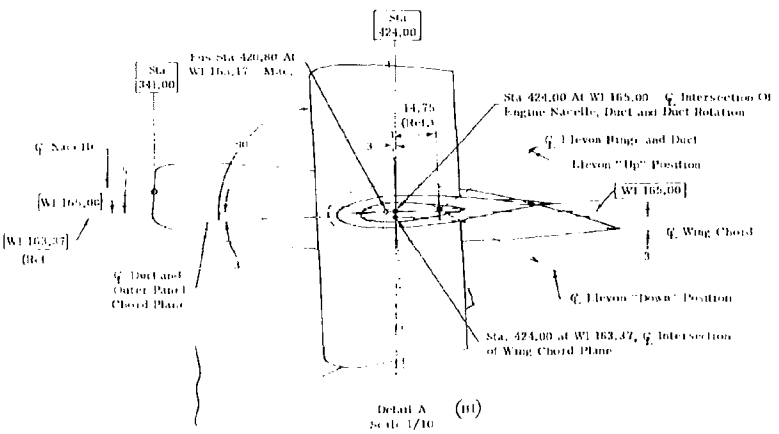
DATE 21 January 1964

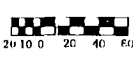
BELL AEROSYSTEMS COMPANY



1


(Typ)
℄ Sta 424.00 (B-1)
240.70
126.00
90.00
50.00
64.00
115.35
Duct Chord Line (B-1)
℄ Piers
Trim
℄ Elevon Hinge
Trim
Max
Trim
Outer Panel Root Chord


Sta 424.00
Sta 341.00
Fwd Sta 420.80 At WL 163.37 M.C.
℄ Sta 341.00
WL 165.00
WL 163.37 (B-1)
℄ Duct and Outer Panel Chord Plane
Sta 424.00 At WL 165.00 ℄ Intersection Of Engine Nacelle, Duct and Duct Rotation
14.75 (Ref.)
℄ Elevon Hinge and Duct
Elevon "Up" Position
WL 165.00
℄ Wing Chord
℄ Elevon "Down" Position
Sta. 424.00 at WL 163.37, ℄ Intersection of Wing Chord Plane
Detail A (B1)
Scale 1/10


20 10 0 20 40 60
Inches

1.2.9 (Cont)

2

2.0 APPLICABLE DOCUMENTS

Testing and demonstration of the X-22A VTOL Research Aircraft is governed by the following specifications and documents:

(a) SD-550-1 detail specification for Model X-22A VTOL Research Aircraft, control document for SD-24J general specification for design and construction of aircraft weapons systems, Volume I, Fixed Wing.

(b) Addendum No 162 contract engineering data and test requirements for Model X-22A VTOL Research Aircraft, control document for MIL-D-8706A (WEPS) data and tests, engineering; contract requirements.

(c) Addendum No 32 demonstration requirements for Model X-22A (Tri-Service Research VTOL) aircraft, control document for MIL-D-8708 (WEPS) demonstration requirements for airplanes. Applicable paragraphs from (c)

- 3.4.4 Powerplant Survey
  - 3.4.4.1 Propeller Vibration Survey
  - 3.4.4.2 Jet Engine Vibration Survey
  - 3.4.4.3 Powerplant Installation Survey
  - 3.4.4.4 Compressor inlet turbine outlet survey
- 3.12 Structural Demonstration Tables I and II
  - 3.12.6 Vibration and Flutter
- 3.13 Aerodynamic Demonstration
  - 3.13.2 Flying Qualities Table III
  - 3.13.4 Performance
  - 3.13.5 Drag
- 3.15 Powerplant Demonstration
- 3.17 Equipment Demonstration
- 3.18 Electrical Demonstration
- 3.19 Avionics Demonstration
- 3.19.2.2 Variable Stability Demonstration

3.0 TEST PLAN

Testing will be done at the Bell Aerosystems facility at Niagara Falls Airport and at the Naval Air Test Center at Patuxent River.

The enclosed flight test plan shows the basic design, fabrication and test schedule of the two aircraft.

Aircraft No. 1 will be used primarily for VTOL flying qualities and for structural demonstrations.

Aircraft No. 2 will demonstrate conventional and transition flying qualities as well as avionics, variable stability, electrical and equipment specification compliance.

The following is a complete breakdown of the flight test program by test name or specification number.

Item 3.25.2.2 (3) presents the schedule for accomplishing these tests.

3.1 AIRCRAFT NO. 1 TEST PLANS

The following is a breakdown which lists the major subheadings shown in Item 3.25.2.2.(3) plus all the tests and demonstration that are included under these subheadings by demonstration specification and paragraph number.

Ground Tests	Specification	Paragraph
Preliminary Checks		
Weight and Balance		
Electrical System		
Hydraulic System		
Vibration		
Duct Rotation		
Vibration		
Pneumatic System		

Ground Tests	Specification	Paragraph
Fire Detection System		
Intercom		
Flight Control Checks		
Vibration		
Landing Gear Checks		
Fuel System Checks		
Engine Checks		
Propeller Vibration Checks		
Dev. and Demo. Tests	MIL-D-8708A,	3.12.6
Ground Vibration Tests	MIL-A-8870,	4.6
Ground Test Demonstration		
Propulsion Demo. Tests	MIL-D-8708A,	3.4.4
Prop. Vib. Survey	MIL-D-8708A,	3.4.4.1
Jet Engine Vib. Survey	MIL-D-8708A,	3.4.4.2
Powerplant Install. Temp.	MIL-D-8708A,	3.4.4.3
Comp. Inlet & Turbine Outlet Survey	MIL-D-8708A,	3.4.4.4
Engine Ground Test	MIL-D-8708A,	3.15.5
Cockpit & Cabin Cond.	MIL-D-8708A,	3.17.2
Temp. & Vib. Elect. Comp.	MIL-D-8708A,	3.19.13
Systems Demo. Tests		
Fire Detection	MIL-D-8708A,	3.17.3
Hyd. & Pneu. System	MIL-D-8708A,	3.17.4
Ext. Mov. Equip.	MIL-D-8708A,	3.17.6
Ret. & Ext. Land. Gear	MIL-D-8708A,	3.17.7.1
Brakes	MIL-D-8708A,	3.17.7.3
Carry & Hand.	MIL-D-8708A,	3.17.8.2
Anchor & Towing	MIL-D-8708A,	3.17.8.3
Parachute	MIL-D-8708A,	3.17.13
Escape Hatches	MIL-D-8708A,	3.17.14
Personnel Equip.	MIL-D-8708A,	3.17.15
Avionics Demo. Ground	MIL-D-8708A,	3.19.1
Intercomm.	MIL-D-8708A,	3.19.1.2
Communication	MIL-D-8708A,	3.19.1.7
Antenna Checks	MIL-D-8708A,	3.19.1.4
Interference	MIL-D-8708A,	3.19.1.1
Radar Altimeter	MIL-D-8708A,	
Navigation	MIL-D-8708A,	3.19.1.5

Ground Tests	Specification	Paragraph
Electrical Demo.	MIL-D-8708A,	3.18
Performance	MIL-D-8708A,	3.18.2
Temperature	MIL-D-8708A,	3.18.2.1
Prime Mover Cap.	MIL-D-8708A,	3.18.2.2
Power	MIL-D-8708A,	3.18.2.3
Emerg. Power	MIL-D-8708A,	3.18.2.4
Protective Circuit	MIL-D-8708A,	3.18.2.5
Lighting	MIL-D-8708A,	3.18.2.6
Flight Tests		
Development and Demo. Flight Test (VTOL)		
Flight Vibration Tests	MIL-H-8501A,	3.7.1
Performance Tests	MIL-D-8708A,	3.13.4
Flying Qualities (Table III)	MIL-D-8708A,	3.13.2
Powerplant Survey	MIL-D-8708A,	3.4.4
Propeller Vib. Survey	MIL-D-8708A,	3.4.4.1
Jet Engine Vib. Survey	MIL-D-8708A,	3.4.4.2
Powerplant Install. Survey	MIL-D-8708A,	3.4.4.3
Comp. Inlet & Turbine Outlet Survey	MIL-D-8708A,	3.4.4.4
Load Survey		
Flight Vibration Tests	MIL-D-8708A,	4.9.1
Flight Flutter Tests	MIL-D-8708A,	4.9.2
Landings - Table I	MIL-D-8708A,	3.12.2
Dives and Pullouts - Table II	MIL-D-8708A,	3.12.4
80 Percent Structural Demo.		
Landings - Table I	MIL-D-8708A,	3.12.2
Dives and Pullouts - Table II	MIL-D-8708A,	3.12.4
100 Percent Structural Demo.		
Landings - Table I	MIL-D 8708A,	3.12.2
Dives and Pullouts - Table II	MIL-D-8708A,	3.12.4
Structural Demo at NATC		
Landings - Table I	MIL-D-8708A,	3.12.2
Dives and Pullouts - Table II	MIL-D-8708A,	3.12.4
Operating Flight Envelope	MIL-D-8708A,	3.13.2.1
Max. Per Speed Envelope	MIL-D-8708A,	3.13.2.2
Performance Tests	MIL-D-8708A,	3.13.4
Drag Measurements	MIL-D-8708A,	3.13.5

3.2 AIRCRAFT NO. 2 TEST PLANS

Ground Test	Specification	Paragraph
Preliminary Checks		
Weight and Balance		
Electrical System		
Hydraulic System		
Pneumatic System		
Fire Detection System		
Fire Extinguishing System		
Intercomm.		
Duct Rotation Check		
Flight Control Check		
Fuel System Funct. Check		
Engine Checks		
125 Hour Tie-Down Tests	MIL-T-8679,	3.6.4
Prep. A/C No. 2 for Flight		
Inspection		
Hydraulic Checks		
Pneumatic Checks		
Electrical Checks		
Avionics Checks		
Fuel System		
Engine Checks		
Taxi & Ground Hand. Checks		
Flight Tests		
Dev. & Demo. Flight Tests (Conv.)		
Flying Qualities - Table III	MIL-D-8708A,	3.13.2
Powerplant Survey	MIL D 8708A,	3.4.4
Avionics Flight Test	MIL-D-8708A,	3.19
Interference	MIL-D-8708A,	3.19.1.1
Intercomm.	MIL-D-8708A,	3.19.1.2
Temp. & Vibration	MIL-D-8708A,	3.19.1.3
Antenna Pattern	MIL-D-8708A,	3.19.1.4
Navigation Equipment	MIL-D.8708A,	3.19.1.5
Identification Equip.	MIL-D-8708A,	3.19.1.6
Communication Equip.	MIL-D-8708A,	3.19.1.7
Radar Altimeter	MIL-D-8708A,	3.19.1.8
Indicating Equip.	MIL-D-8708A,	3.19.1.12

Flight Tests	Specification	Paragraph
Dev. & Demo. Flight Tests - (Transition)		
Flying Qualities, Table III	MIL-D-8708A,	3.13.2
Electrical Demo.	MIL-D-8708A,	3.18
Performance	MIL-D-8708A,	3.18.2
Temperature	MIL-D-8708A,	3.18.2.1
Prime Mover Cap.	MIL-D-8708A,	3.18.2.2
Power	MIL-D-8708A,	3.18.2.3
Emergency Power	MIL-D-8708A,	3.18.2.4
Protection	MIL-D-8708A,	3.18.2.5
Lighting	MIL-D-8708A,	3.18.2.6
Equipment Demo Flight Tests	MIL-D-8708A,	3.17
Contamination	MIL-D-8708A,	3.17.2.1
Non-Press. Aircraft	MIL-D-8708A,	3.17.2.3
Acoustical Noise Level	MIL-D-8708A,	3.17.2.6
Fire Detecting System	MIL-D-8708A,	3.17.3
Hyd. & Pneu. System	MIL-D-8708A,	3.17.4
Hyd. & Pneu. Ext. Pwr.Conn	MIL-D-8708A,	3.17.4.1
Ext. Movable Equip.	MIL-D-8708A,	3.17.6
Land. Gear Ext. & Ret.	MIL-D-8708A,	3.17.7.1
Brakes	MIL-D-8708A,	3.17.7.3
Carry & Hand.	MIL-D-8708A,	3.17.8.2
Anchoring & Towing	MIL-D-8708A,	3.17.8.3
Parachute Sur.Equip.Assem	MIL-D-8708A,	3.17.13
Escape Hatches	MIL-D-8708A,	3.17.14
Anti-Fogging & Rain Rem.	MIL-D-8708A,	3.17.16
Powerplant Demo.	MIL-D-8708A,	3.15
Engine Power Output Tests	MIL-D-8708A,	3.15.2
Military Power Runs	MIL-D-8708A,	3.15.3
Propeller Operation	MIL-D-8708A,	3.15.4
Starting Characteristics	MIL-D-8708A,	3.15.5.1
Steady State Char.	MIL-D-8708A,	3.15.5.2
Noise Level Meas.	MIL-D-8708A,	3.15.5.4
Constant Mach. No Climbs	MIL-D-8708A,	3.15.6.1
Altitude Idle Schedule	MIL-D-8708A,	3.15.6.2
Accel & Decel.	MIL-D-8708A,	3.15.7.1
Emergency Protection	MIL-D-8708A,	3.15.7.2
Anti-Icing	MIL-D-8708A,	3.15.7.6
Air Starts	MIL-D-8708A,	3.15.10
Fuel Dumping	MIL-D-8708A,	3.15.11
Fuel Venting	MIL-D-8708A,	3.15.12(1-5)

Flight Tests	Specification	Paragraph
Dev. & Demo. Var. Stab Calibration Open Loop Closed Loop Demonstration	MIL-D-8708A,	3.19.2.2
STATIC TEST ARTICLE		
Ejection Seat Tests	MIL-D-8798A,	3.4.3

Addendum No. 32
to MIL-D-8708A(WEPS)

DEPARTMENT OF THE NAVY
BUREAU OF NAVAL WEAPONS
WASHINGTON 25, D. C.

3.25.2.2.(1)

DEMONSTRATION REQUIREMENTS

FOR

MODEL X-22A (TRI-SERVICE RESEARCH VTOL) AIRCRAFT

APPROVED L.S. Chambers
Captain, USN
By direction

DATE 31 August 1962

Addendum No 32
to MIL-D-8708A(Wep)

1.	SCOPE
1.1	SCOPE. - Applicable.
1.1.1	CORRELATIVE PROVISIONS. - Applicable.
1.2	PURPOSE OF DEMONSTRATION. - Applicable.
1.3	DURATION OF DEMONSTRATION. - Applicable.
2.	APPLICABLE DOCUMENTS
2.1	EFFECTIVITY DATE OF DOCUMENTS. - Applicable.
2.1.1	SPECIFICATIONS AND STANDARDS. - Applicable and add MIL-H-8501A, dated 5 November, 1962, "General Requirements for Helicopter Flying and Ground Handling Qualities" as modified for the VTOL Research Aircraft.
2.1.2	PUBLICATIONS. - Applicable.
2.2	OTHER DOCUMENTS. - Applicable.
3	REQUIREMENTS
3.1	GENERAL
3.1.1	LOCATION FOR TESTS. - Applicable except delete Items (1), (2), (3) and substitute; (1) "Dives and pull-outs and performance guarantees shall be performed at the Naval Air Test Center (NATESTCEN)"
3.1.2	TEST AUTHORITY. - Applicable.
3.1.3	AIRPLANE CONFIGURATION FOR DEMONSTRATION TESTS. - Applicable, except in last sentence delete "build-up" and substitute "developmental flight".
3.1.4	APPROVAL, QUALIFICATIONS, AND INSTRUCTIONS FOR CONTRACTOR'S PILOTS. - Applicable.
3.1.4.1	FLIGHT EQUIPMENT FOR CONTRACTOR'S TEST PILOTS. - Applicable.
3.1.5	RELEASE FOR FLIGHT AND OPERATING LIMITS. - Applicable except delete (1) and substitute "STOL, VTOL, and hovering are authorized (but not carrier or simulated carrier landing; and,". Add to (2) (b): "in the STOL configuration and an angle of bank of 30° shall not be exceeded in the VTOL configuration."
	Add to 3.1.5 as follows:

3.1.5	(Cont) "The cognizant BUWEPSREP may release the aircraft for formal structural demonstration tests at NATC following the conference required by 3.2.1.2 provided that all pertinent factors have been resolved, all contractual prerequisites have been complied with, and that the development flight tests of 3.12.1.6 have been satisfactorily completed and the data therefrom have been submitted to BUWEPS and NATC."
3.1.5.1	OPERATING LIMITS FOR CONTRACTOR'S PILOTS. - Applicable.
3.1.5.2	OPERATING LIMITS FOR NAVY PILOTS. - Applicable.
3.1.6	ANTI-SPIN DEVICE. - Not Required.
3.1.7	FLIGHT MONITORING
3.1.7.1	MOVING PICTURE COVERAGE. - Required.
3.1.7.2	TELEMETERING COVERAGE. - Required.
3.1.7.3	CHASE AIRCRAFT. - Required.
3.1.8	AIRCRAFT CHANGES AND ADJUSTMENTS. - Required.
3.1.9	FLIGHT PLAN RELEASE. - Required.
3.2	REQUIREMENTS PRIOR TO FIRST FLIGHT. - Required.
3.2.1	INSTRUMENTATION AND TEST PLANNING CONFERENCES. - Required.
3.2.1.1	CRUISE CONTROL TESTS PLANNING CONFERENCES. - Required.
3.2.1.2	STRUCTURAL DEMONSTRATION PLANNING CONFERENCE. - At least four weeks prior to arrival at NATC of the airplane for the structural demonstration tests of 3.12, representatives of the contractor shall confer with NATC personnel for the purpose of reaching agreement relative to the details of the aircraft configuration and the test procedures to be used in the structural demonstration. The results of this conference shall be configured by submittal by NATC to BUWEPS of a summary approved by responsible representatives of NATC and the contractor. A summary of those factors affecting the structural demonstration which require resolution by BUWEPS shall be forwarded to BUWEPS and the cognizant BUWEPSREP with the conference summary.
3.3	NAVY PRELIMINARY EVALUATION

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3.3.1	GENERAL. - Applicable.
3.3.2	PURPOSE. - Applicable.
3.3.3	CONTRACTOR'S RESPONSIBILITY. - Required.
3.4	REQUIREMENTS PRIOR TO EVALUATION. - Required.
3.4.1	PRE-EVALUATION ENGINEERING DATA. - Required.
3.4.2	EQUIPMENT TESTS. - Required.
3.4.3	EMERGENCY ESCAPE SYSTEM. - Required.
3.4.4	POWER PLANT SURVEY. - Applicable.
3.4.4.1	PROPELLER VIBRATION SURVEY. - Required.
3.4.4.2	JET ENGINE VIBRATION SURVEY. - Required.
3.4.4.3	POWER PLANT INSTALLATION TEMPERATURE SURVEY. - Required and 3.1.10.3 of MIL-T-8679 is applicable.
3.4.4.4	COMPRESSOR INLET AND TURBINE OUTLET SURVEY. - Required except delete third sentence and substitute, "These surveys shall be made for the takeoff, power approach, maximum yaw to right and to left, near stall, hover in ground effect, hover out of ground effect, transition, to forward flight, and level flight conditions for aircraft from hover to $V_{max.}$"
3.4.5	ARMAMENT. - Not applicable.
3.4.6	PHOTOGRAPHIC. - Not applicable.
3.4.7	INSPECTION. - Required.
3.4.8	PRE-EVALUATION CONFERENCE. - Required.
3.5	PHASE I, Navy Preliminary Evaluation
3.5.1	SCOPE OF EVALUATION, PHASE I. - Required except add "VTOL and Transition" to applicable sections of items (2) and (3), and delete items (2e), (2i), (3b), (4) and (5). In addition delete (2) (b) and substitute: "Takeoff and landing characteriscs including hovering, sideward and rearward flight, transition and climb out characteristics."
3.5.2	FLYING QUALITIES TESTS

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3.5.2.1		Phase I. - Required except modify as follows:
	(1)	Delete and substitute: "Take-offs, hover, transitions, and landings in accordance with the procedures of tests (a), (c), and (d) of Table 3.
		(4), (6) and (10) not applicable.
		Add new subparagraphs (12) and (13) as follows:
	(12)	Power off landings in accordance with the procedures of test (r) of Table 3.
	(13)	Power control system tests in accordance with the procedures of test (p) of Table 3.
3.5.3		REQUIRED FLIGHT ENVELOPES. - Required.
3.6		PHASE II AND SUBSEQUENT PHASES; NAVY PRELIMINARY EVALUATION
3.6.1		SCOPE OF EVALUATION. - Applicable.
3.6.2		FLYING QUALITIES TESTS
3.6.2.1		PHASE II AND SUBSEQUENT PHASES. - Required.
3.6.3		REQUIRED FLIGHT ENVELOPE
3.6.3.1		PHASE II. - Required.
3.7		FINAL PHASE, NAVY PRELIMINARY EVALUATION
3.7.1		SCOPE OF EVALUATION FINAL PHASE. - Required except delete Item (3).
3.7.2		FLYING QUALITIES TESTS, FINAL PHASE. - Requied, except delete last sentence.
3.7.3		REQUIRED FLIGHT ENVELOPE, FINAL PHASE. - Required.
3.7.4		OTHER TESTS, FINAL PHASE. - Required, except delete and substitute: "In addition, prior to the final phase of the evaluation the applicable equipment demonstrations of 3.17 shall have been performed by the contractor.
3.8		REQUIREMENTS PRIOR TO GOVERNMENT TESTS AND EVALUATION
3.8.1		GENERAL

3.8.1.1	CONFIGURATION OF AIRPLANE. - Required.
3.8.1.2	STRUCTURAL LABORATORY TESTS. - Required.
3.8.1.3	FIELD LANDING TESTS. - Required.
3.8.1.4	CARRIER SUITABILITY TESTS. - Not required.
3.8.2	REQUIREMENTS PRIOR TO BIS TRIALS INITIAL TRIALS PHASE. - BIS Trials, Initial Trials Phase - not applicable, however structual flight tests of 3.8.2.1 are required as indicated.
3.8.2.1	STRUCTURAL FLIGHT TESTS. - Required except in the first sentence delete 3.12.5 and 3.12.5.1. Also, delete "build-up tests" in the last sentence and substitute "developmental flight tests".
3.8.2.2	PRELIMINARY SPIN TESTS. - Not required.
3.8.2.3	FLYING QUALITIES. - Required.
3.8.2.4	EQUIPMENT. - Required.
3.8.2.5	PERFORMANCE. - Required.
3.8.2.6	HYDRODYNAMIC TESTS. - Not required.
3.8.2.7	WEAPONS SYSTEM. - Required.
3.9	REQUIREMENTS PRIOR TO BIS NUCLEAR WEAPON TRIALS. - Not applicable.
3.10	REQUIREMENTS PRIOR TO FIRST DELIVERIES TO OPERATIONAL TEST AND EVALUATION FORCE (OPTEVFOR). - Not applicable.
3.10.1	FLIGHT MANUALS. - Required.
3.10.2	SPINS. - Not applicable.
3.11	REQUIREMENTS PRIOR TO CONTINUED FLEET DELIVERIES. - Not required.
3.12	STRUCTURAL DEMONSTRATION TESTS. - The tests shall be performed in the cruise configuration, unless otherwise specified.
3.12.1	GENERAL.
3.12.1.1	ALTERNATIVE GROSS WEIGHT. - Required.
3.12.1.2	ENGINE OPERATION DURING DIVES AND PULL-OUTS. - Delete and add "Dives and pull-outs shall be performed with at least normal rated power (or thrust) and RPM of the power plants except as specified otherwise in 3.12.4.

3.12.1.3 OPERATION OF APPURTENANCES. - During developmental flights at the contractor's plant, appurtenances which can be put into continuous motion, which can be extended or rotated to different positions (such as rotation of ducted propellers), or which can be suddenly extended and suddenly retracted (such as landing gears), shall be operated sufficiently to determine, by a combination of test data and calculations, the effects on airplane loads and motions up to the V-n limits required for structural design of the particular item. This determination shall be discussed fully in the Demonstration-Planning and Progress Report information required by 3.25.2.2(11) after which BUWEPS will select the positions and/or motions of appurtenances required for the dives and pull-outs if such positions and/or motions are not specified in Table 2.

3.12.1.4 TRIM FOR DIVES AND PULL-OUTS. - Required.

3.12.1.5 MAXIMUM CONTROL DISPLACEMENTS. - Required.

3.12.1.6 GRADUAL APPROACH TO CRITICAL LIMITS. - Development Flight Testing.- Delete present text and substitute: All of the combinations of airplane gross weight, configuration, center-of-gravity position, altitude, speed, Mach number, load factor, and cockpit control movement required to be demonstrated during the land-plane landings and dives and pull-outs specified to be performed at NATC, shall be attained during the contractor's development flights at the contractor's flight test facility prior to release of the airplane for structural demonstration tests at NATC. During these flights, in preparation for the formal demonstration tests of 3.12.2 and 3.12.4, structural loads or stresses in probably critical areas of the airframe shall be monitored to insure that the specified limit strength is adequate for the tests; critical limits shall be approached gradually in safe increments as approved by the cognizant test authority; the vibration tests of 4.9.1(h) of MIL-A-8870(ASG) shall be performed; and, if determined necessary by the pertinent provisions of MIL-A-8870(ASG), the flutter tests of 4.9.2 of MIL-A-8870(ASG) shall be performed. These data shall be presented and discussed fully in the Demonstration Data Report information required by 3.25.2.5.

3.12.1.7 OPERATION OF PILOT - OVERRIDING FLIGHT CONTROL SYSTEMS. - Required.

3.12.2 LANDPLANE LANDINGS. - Required except revise text to read: "The landings specified in Table I shall be performed conventionally and vertically. These landings shall be performed once to the sinking speeds specified in column 5 of Table I or, alternatively, 12 times to 80 percent of the sinking speeds specified."

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3.12.2 (Cont)

In Table I for test e, change columns 3 and 5 to read: "Landplane design gross weight" and "Maximum sinking speed for which design strength exists."

3.12.3 SEAPLANE TAKEOFF AND LANDINGS. - Not applicable.

3.12.4 DIVES AND PULL-OUTS WITH STORES FOR PRIMARY MISSION. - Required except for the following text changes: In Item (c), delete "for which the specified speed corresponds to the Mach number of 0.75 or greater." Delete tests e, n, o, p, and t in Table II. Add: Test r shall be performed in the landing configuration at maximum design speed for that configuration, in the transition configuration at a speed midway between the maximum landing configuration speed and the minimum cruise configuration speed, and in the cruise configuration at a speed not lower than the maximum EAS for V_{LF} as specified in MIL-A-8860. The required load factor for test r shall be n_z for each specified configuration".

"Tests f, and h shall be repeated in the landing configuration at maximum design speed for this configuration and in the transition configuration at a speed midway between the maximum landing configuration speed and the minimum cruise configuration speed."

Add the following tests to Table II

(1)	(2)	(3)	(4)	(5)	(6)
u	Vertical Jump Takeoff	Max Obtainable	Optional	Optional	Apply military power and propeller collective pitch corresponding to max thrust in not more than 0.2 sec. Other controls to be used as necessary.
v	Rolling	Not Specified	Zero forward Speed Max Lateral Speed	"	Perform to the left and right with the aircraft at maximum lateral speed, the lateral control shall be displaced to full displacement in the direction opposite to the flight direction in not more than 0.2 sec.

3.12.5	DIVES AND PULL-OUTS WITH STORES FOR ALTERNATE MISSIONS. - Not required.
3.12.6	FLIGHT FLUTTER AND VIBRATION TESTS. - Required.
3.13	AERODYNAMIC DEMONSTRATION TESTS
3.13.1	GENERAL
3.13.1.1	GROSS WEIGHT AND CENTER-OF-GRAVITY POSITIONS. - Required.
3.13.2	FLYING QUALITIES. - Delete basic Table 3 and substitute revised table. (Page 16 - 19)
3.13.2.1	OPERATING FLIGHT ENVELOPE. - Flying qualities tests shall consist of tests to demonstrate functional adequacy of all related equipment and safety of flight throughout the design envelope, to determine emergency flight procedures for various critical failures and to demonstrate compliance with selected requirements of Spec MIL-F-8785(ASG) and MIL-H-8501A. Tests are to be performed to the limits of the boundaries of the operating flight envelope defined in 3.1.3 of MIL-F-8785(ASG) and are outlined in Table 3. The terminology used in the table is that employed in Spec MIL-F-8785(ASG), MIL-H-8501A or defined in 6.4.3 - Functional checks shall include ground and in-flight calibration of the variable stability system in the V/STOL and conventional flight modes. In-flight calibration shall demonstrate the effectiveness of the Variable Stability System throughout the flight envelope.
3.13.2.2	MAXIMUM PERMISSIBLE SPEED ENVELOPE. - Required.
3.13.2.3	ALTITUDES. - Required.
3.13.4	PERFORMANCE TESTS. - Required.
3.13.5	DRAG MEASUREMENTS. - Required.
3.14	HYDRODYNAMIC DEMONSTRATION TESTS. - Not applicable.
3.15	POWER PLANT DEMONSTRATION
3.15.1	GENERAL. - Applicable.
3.15.1.1	DEFINITION OF POWER. - Applicable.
3.15.1.2	FLIGHT RESTRICTIONS. - Applicable.
3.15.2	ENGINE POWER OUTPUT TESTS. - Required.

3.15.2.1	RECIPROCATING ENGINES. - Not applicable.
3.15.2.2	TURBO-PROP/SHAFT. - Required.
3.15.2.3	TURBO-JET ENGINES. - Not applicable.
3.15.2.4	ROCKET ENGINES. - Not applicable.
3.15.2.5	RAM-JET AND PULSE-JET ENGINES. - Not applicable.
3.15.2.6	COMBINATION POWER PLANTS. - Not applicable.
3.15.3	MILITARY POWER RUNS. - Required.
3.15.3.1	RECIPROCATING ENGINES. - Not applicable.
3.15.3.2	TURBO-PROP/SHAFT ENGINES. - Required except delete (1) and (2) and substitute: (1) Hovering and level flight below 2000 feet (2) Level flight above 15,000 feet.
3.15.3.3	TURBO-JET ENGINES. - Not applicable.
3.15.3.4	RAM-JET, PULSE-JET, AND ROCKET ENGINES. - Not applicable.
3.15.3.5	COMBINATION OF POWER PLANTS. - Not applicable.
3.15.4	PROPELLER OPERATION
3.15.4.1	PROPELLER PITCH SETTINGS. - Required, except (3) and (4) not applicable.
3.15.4.2	PROPELLER OPERATION TESTS
3.15.4.2.1	LOW PITCH (RECIPROCATING ENGINES). - Not applicable.
3.15.4.2.2	LOW PITCH (TURBO PROP ENGINES). - Required.
3.15.4.2.3	HIGH PITCH. - Required.
3.15.4.2.4	FEATHERING PITCH. - Not applicable.
3.15.4.2.5	REVERSE PITCH. - Not applicable.
3.15.4.2.6	CONTROL LEVERS. - Applicable.
3.15.4.3	SYNCHRONIZATION AND SYNCHROPHASING. - Required.
3.15.4.4	HUNTING AND SURGING. - Required.

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3.15.4.5 TRANSMISSION SYSTEM TESTING. - Transmission system testing shall be in accordance with MIL-T-8679 except for the following modifications of the bench tests and tie down tests to be conducted prior to flight. Both tests shall be conducted on the same set of components.

a. The bench tests of 3.7 to be conducted prior to the tie down tests shall consist of 125 hours pro-rated as follows:

30% at maximum engine power
50% at normal rated power
20% at less than NPR using various combinations of torque and RPM selected from the estimated flight envelope of the vehicle and the engine operating envelope.

b. The 50 hour tie down test of 3.6.2.1 shall be increased to 125 hours at various combinations of powers, numbers of engines operating, and left-right/fore-aft unbalance of propeller loadings. The proposed test schedule shall be submitted to the Bureau of Naval Weapons for approval.

3.15.5 GROUND TESTS. - Required.

3.15.5.1 STARTING CHARACTERISTICS. - Required.

3.15.5.2 STEADY STATE CHARACTERISTICS. - Required except delete (1) Reciprocating Engines.

3.15.5.3 ACCELERATION CHARACTERISTICS. - Required except delete (1) Reciprocating Engines and (d), (e), (f), (g) and (h) of para. (2).

3.15.5.4 NOISE LEVEL MEASUREMENTS. - (TURBO-PROPS/TURBO SHAFT). - Required.

3.15.5.5 NOISE LEVEL MEASUREMENTS - TURBOJETS). - Not applicable.

3.15.6 ENGINE CHARACTERISTICS AT VARYING POWERLEVEL SETTINGS. - Required.

3.15.6.1 CONSTANT MACH NUMBER CLIMBS. - Required.

3.15.6.2 ALTITUDE IDLE SCHEDULE AT LOW AIR SPEEDS. - Required except delete "idle" and substitute "descent power recommended for duct position."

3.15.7 ALTITUDE POWER CONTROL PERFORMANCE

3.15.7.1 ACCELERATIONS AND DECELERATIONS. - Required.

3.15.7.2 EMERGENCY PROTECTION. - Required

3.15.7.3 AFTERBURNER OPERATION. - Not applicable.

3.15.7.4	OPERATION WITH MISSLE FIRING. - Not applicable.
3.15.7.5	INFRARED RADIATION. - Not required.
3.15.7.6	ANTI-ICING. - Required.
3.15.8	FLAME DAMPING. - Not applicable.
3.15.9	EMERGENCY POWER TESTS. - Not applicable.
3.15.10	AIR STARTS. - Required.
3.15.11	FUEL DUMPING. - Required.
3.15.12	FUEL VENTING. - Required and add "In addition, tests shall be demonstrated under the following conditions: (1) Sideward flight, left and right (2) Climb (3) Hover (4) Rearward flight (5) Level flight at V_{max}."
3.16	ARMAMENT DEMONSTRATION. - Not applicable.
3.17	EQUIPMENT DEMONSTRATION REQUIREMENTS
3.17.1	GENERAL. - Required.
3.17.2	COCKPIT AND CABIN CONDITIONING. - Required.
3.17.2.1	CONTAMINATION. - Required.
3.17.2.2	PRESSURIZED AIRCRAFT. - Not applicable.
3.17.2.3	NON-PRESSURIZED AIRCRAFT. - Required.
3.17.2.4	OXYGEN EQUIPMENT. Not applicable however portable oxygen equipment shall be utilized on flights which exceed 10,000 feet above sea level or on night flights exceeding 5,000 feet altitude.
3.17.2.5	PRESSURE SUIT SYSTEM. - Not applicable.
3.17.2.6	ACOUSTICAL NOISE LEVEL. - Required.
3.17.3	FIRE DETECTING SYSTEM. - Required.

3.17.4	HYDRAULIC AND PNEUMATIC SYSTEMS. - Required.
3.17.4.1	HYDRAULIC AND PNEUMATIC EXTERNAL POWER CONNECTIONS. - Required.
3.17.5	ANTI-ICING SYSTEMS. - Not required.
3.17.6	EXTERNAL MOVABLE EQUIPMENT. - Required.
3.17.7	LANDING GEAR SYSTEM
3.17.7.1	RETRACTION AND EXTENSION. - Required.
3.17.7.2	NOSE GEAR STEERING. - Not applicable.
3.17.7.3	BRAKES. - Required except insert after "power" in first sentence "of one engine and idle power on the remaining three."
3.17.8	ACCESSORY EQUIPMENT
3.17.8.1	WINCHES AND HOISTS. - Not applicable.
3.17.8.2	CARRYING AND HANDLING. - Required.
3.17.8.3	ANCHORING AND TOWING. - Required.
3.17.8.4	HOISTING SLING. - Not applicable.
3.17.9	EXTERNAL AUXILIARY FUEL TANKS. - Not applicable.
3.17.10	AIR REFUELING. - Not applicable.
3.17.11	AUTOMATIC LIFE RAFT RELEASE SYSTEM. - Not applicable.
3.17.12	AIR REFUELING TANKER EQUIPMENT. - Not applicable.
3.17.13	PARACHUTE SURVIVAL EQUIPMENT ASSEMBLY. - Applicable.
3.17.14	ESCAPE HATCHES. - Required.
3.17.15	PERSONNEL EQUIPMENT. - Required.
3.17.16	ANTI-FOGGING AND RAIN REMOVAL SYSTEMS. - Required.
3.18	ELECTRICAL DEMONSTRATION
3.18.1	GENERAL. - Required.
3.18.2	PERFORMANCE. - Required.
3.18.2.1	TEMPERATURE. - Required.

Addendum No. 32
to MIL-D-8708A(Weps)

3.18.2.2	PRIME MOVER CAPACITY. - Required.
3.18.2.3	POWER. - Required.
3.18.2.4	EMERGENCY POWER. - Required.
3.18.2.5	PROTECTION. - Required.
3.18.2.6	LIGHTING. - Required.
3.19	AVIONICS DEMONSTRATION TESTS
3.19.1	PERFORMANCE. - Required.
3.19.1.1	INTERFERENCE. - Required.
3.19.1.2	INTERCOMMUNICATION SYSTEM. - Required.
3.19.1.3	TEMPERATURE AND VIBRATION. - Required.
3.19.1.4	ANTENNAS. - Required, except change Item (1) to read "The azimuth and elevation coverage of the antennas of the various configurations of the airplanes at the required frequencies is adequate to the extent of the requirements of the applicable antenna specifications." Change Item (2) to read, "The gain of the antennas is adequate for accomplishment of the mission."
3.19.1.5	NAVIGATION EQUIPMENT. - Required.
3.19.1.6	IDENTIFICATION EQUIPMENT. - Required, except add, "The procuring agency shall make available an instrumented ground interrogating station which will report the signal strength of the transponded signal from the test airplane during performance of a 12 heading clover-leaf pattern 50 miles distance from the ground station."
3.19.1.7	COMMUNICATIONS EQUIPMENT. - Required.
3.19.1.8	RADAR AND INFRARED EQUIPMENTS.-Infrared equipment not applicable. The contractor shall demonstrate that the operation of the radar altimeter is in accordance with applicable equipment specifications within the designed mission of the airplane.
3.19.1.9	COUNTERMEASURES. - Not applicable.
3.19.1.10	ASW EQUIPMENT. - Not applicable.
3.19.1.11	RADIO RELAY EQUIPMENT. - Not applicable.
3.19.1.12	INDICATING EQUIPMENT. - Required.

3.19.2	INSTRUMENTS
3.19.2.1	PITOT AND PITOT STATIC SYSTEMS. - Required.
3.19.2.2	VARIABLE STABILITY SYSTEM. - Required.
3.19.2.3	FUEL QUANTITY GAGE SYSTEMS. - Required.
3.19.2.4	COMPASS SYSTEMS. - Required.
3.19.2.5	ATTITUDE INDICATING SYSTEMS. - Required.
3.19.2.6	ENGINE POWER PARAMETER SYSTEM. - Required.
3.19.2.7	ANGLE OF ATTACK SYSTEMS. - Not applicable.
3.19.2.8	PERFORMANCE. - Required.
3.20	CARRIER SUITABILITY DEMONSTRATION TESTS. - Not required.
3.21	PHOTOGRAPHIC DEMONSTRATION REQUIREMENTS. - Not applicable.
3.22 3.23 3.24	RESERVED
3.25	REPORTS
3.25.1	GENERAL
3.25.1.1	FORMAT AND GENERAL REQUIREMENTS. - Required.
3.25.1.2	ACTION ON REPORTS. - Required.
3.25.1.3	RESPONSIBILITY FOR REPORTS AND DATA
3.25.1.3.1	BUWEPS REP. AND BUWEPS RES. REP. - Applicable.
3.25.1.3.2	NATESTCEN. - Applicable.
3.25.2	REQUIRED REPORTS
3.25.2.1	DEMONSTRATION INSTRUMENTATION REPORT. - Required.
3.25.2.2	DEMONSTRATION PLANNING AND PROGRESS REPORT. - Required.
3.25.2.3	DAILY FLIGHT REPORTS. - Required.
3.25.2.4	BI-WEEKLY SUMMARY REPORTS. - Required.

3.25.2.5	DEMONSTRATION DATA REPORT. - Required.
3.25.2.6	PERFORMANCE DATA REDUCTION REPORT AND CONFERENCE. - Required.
3.25.2.7	GUARANTEED PERFORMANCE DATA REPORT. - Required.
3.25.2.8	AVIONICS SYSTEMS DEMONSTRATION DATA REPORTS. - Required.
3.25.2.9	MOVING PICTURE COVERAGE REPORT. - Required.
3.25.2.10	PROPELLER VIBRATION SURVEY REPORT. - Required.
3.25.2.11	COMPRESSOR INLET AND TURBINE OUTLET SURVEY REPORT. - Required.
3.25.2.13	AIRPLANE WEAPONS SYSTEM ACCURACY REPORT. - Not applicable.
3.25.2.14	MILITARY SPECIFICATION AIRCRAFT DEMONSTRATION REPORTS - DISTRIBUTION OF - Required.
4.	QUALITY ASSURANCE PROVISIONS. - Applicable.
5.	DELIVERY. - Applicable.
6.	NOTES. - Applicable.

TABLE 3 FLYING QUALITIES (REVISED)

		DESCRIPTION	
		VTOL Flight Mode - Ducts in Fixed Vertical Position, Vertical Flight Including Hover (0 - 30 Knots).	Transition Flight Mode - Du Between Vertical and Horiz
a.	Elevator Control Force Gradient Straight Flight	It will be demonstrated that push forces are required to maintain speeds higher than trim speed and pull forces are required to maintain speeds lower than trim speed as specified by MIL-H-8501A Para. 3.6.3 as modified by the Detail Specification. These tests will be demonstrated at 0 to 1000 Ft.	The airplane will be flown selected airspeeds with duc for optimum performance at selected. The airplane wil for level flight (wings le T.O, P, and V_{SPA} configurat will be demonstrated that p are required to maintain sp than trim speed and that pu are required to maintain sp than trim speed. Tests wil conducted at 1000 Ft.
b.	Elevator Control Force Gradient Turning Flight	Turning flight capability of the aircraft will not be limited by stick force and Table II of MIL-H-8501A will apply. Tests will be conducted at the mid center-of-gravity condition.	At 75kn with duct angle set 40 degrees and power requir flight, it will be demonstr stick force per "G" is with requirements of MIL-F-8785-
c.	Elevator Control Power - Take-off.	It will be demonstrated that the take-off performance guaranteed in the Detail Specification, Vol. I, is not limited by blade pitch control effectiveness.	1) Applicable for STOL excep longitudinal control forces exceed 20 pounds pull or 10 push. 2) Not applicable
d.	Elevator Control Power - Landing.	In accordance with MIL-H-8501A, Paragraph 3.2.5 and sub-paragraphs as modified by the Detail Specification (Vol.1), it will be demonstrated that the ability to make rapid decelerations to hover and descents to landing is not limited by longitudinal control power. These tests will be accomplished in ground effect and at 4000 Ft.	With the airplane trimmed a duct settings it will be de that the elevator control i of developing the required speeds with a control force 20 pounds and in addition, operation, the requirement graph 3.3.1.2 of the Detail cation (Vol.1) will be demo
e.	High Mach Number Characteristics	Not applicable	Not applicable
f.	Trim Change Due to Power	From trimmed flight conditions in hover, application of power will be demonstrated to require no more than three inches control displacement from the initial trim position to maintain longitudinal trim as described in Para. 3.2.10.2 of MIL-H-8501A.	See test (a) above. It wil demonstrated at the selecte speeds that application of require no more than three control displacement from t trim position to maintain l trim as described in Para. MIL-H-8501A.

1

TABLE 3 FLYING QU[illegible] (REVISED)

D E S C R I P T I O N		
ucts in Fixed Verti- al Flight Including .	Transition Flight Mode - Duct Position Between Vertical and Horizontal.	Conventional Flight Mode - Ducts in Fixed Horizontal Position.
ted that push forces tain speeds higher pull forces are speeds lower than ied by MIL-H-8501A ied by the Detail e tests will be 1000 Ft.	The airplane will be flown at six selected airspeeds with ducts positioned for optimum performance at the speeds selected. The airplane will be trimmed for level flight (wings level) in the T.O, P, and V_{SPA} configurations. It will be demonstrated that pull forces are required to maintain speeds lower than trim speed and that push forces are required to maintain speeds higher than trim speed. Tests will be conducted at 1000 Ft.	1) Applicable 2) Applicable except delete "20,000" and add "10,000" 3) Applicable 4) Applicable
ility of the air- mited by stick f MIL-H-8501A will e conducted at the y condition.	At 75kn with duct angle set at 40 degrees and power required for level flight, it will be demonstrated that stick force per "G" is within the requirements of MIL-F-8785-4(ASG).	1) Applicable 2) Applicable NOTE: Class II applies.
ted that the take- anteed in the , Vol. I, is not ch control	1) Applicable for STOL except that longitudinal control forces shall not exceed 20 pounds pull or 10 pounds push. 2) Not applicable	1) Not applicable 2) Applicable
IL-H-8501A, Para- paragraphs as il Specification demonstrated that rapid decelerations s to landing is not nal control power. accomplished in 4000 Ft.	With the airplane trimmed at selected duct settings it will be demonstrated that the elevator control is capable of developing the required landing speeds with a control force less than 20 pounds and in addition, for STOL operation, the requirement of Paragraph 3.3.1.2 of the Detail specification (Vol.1) will be demonstrated.	Applicable except that the longitudinal pull force shall not exceed 20 pounds.
	Not applicable	1) Applicable for Class II 2) Applicable for Class II 3) Applicable for Class II
conditions in hover, will be demonstrated han three inches from the initial ntain longitudinal Para. 3.2.10.2 of	See test (a) above. It will be demonstrated at the selected test speeds that application of power will require no more than three inches control displacement from the initial trim position to maintain longitudinal trim as described in Para. 3.2.10.2 of MIL-H-8501A.	Applicable

TABLE 3 (Continued

TEST	NAME	D E S C R I P T	
		VTOL Flight Mode - Ducts in Fixed Vertical Position, Vertical Flight Including Hover (0 - 30 Knots).	Transition Flight M Between Vertical an
g	Trim Change Due to Deceleration Device	Not Applicable	Not Applicable
h	Dynamic Longitudinal Stability	In accordance with MIL-H-8501A paragraphs 3.2.11, 3.2.12, and 3.6.1.2, demonstration will be made at sea level to show that aircraft response characteristics are within the limits specified. The longitudinal control motions and control power will be demonstrated in accordance with paragraph 3.3.2 of the Detail Specification.	In accordance with M graphs 3.2.11, 3.2.1 stration will be mad and at selected spee aircraft response ch within specified lim will also be made in paragraph 3.2.5 and stated in 3.3.1.1 of fication to show tha decelerate rapidly o verse the direction either direction is longitudinal control characteristics. The performed in ground ft.
i	Dynamic Lateral Stability	It shall be demonstrated that the dynamic lateral-directional oscillation shall be within the limits specified in MIL-H-8501A, paragraph 3.6.1.2.	At selected speeds ir shall be demonstrated directional response are within the limits MIL-H-8501A, paragrap
j	Maximum Yaw	For hovering conditions demonstration will be made in accordance with Spec. MIL-H-8501A, paragraph 3.3.5 as modified by paragraph 3.3.2 of the Detailed Specification.	Demonstration in acc MIL-F-8785, paragraph and 3.4.13 as describ 3.3.1.2 of the Detail
k	Control-Free Directional Stability	It shall be demonstrated that a right pedal force accompanies nose-right yaw and a left pedal force accompanies nose-left yaw as required in MIL-H-8501A as modified by paragraph 3.3.1.1 of the Detail Specification (Vol. I).	Same as VTOL mode at and duct angles.
l	Control for Sidewise flight and turns.	a. In accordance with MIL-H-8501A, paragraph 3.3.2, it shall be demonstrated that a sidewise velocity of 35 knots can be attained. b. In accordance with MIL-H-8501A, paragraph 3.3.6 it shall be demonstrated that complete turns in a wind of at least 35 knots can be accomplished.	Not Applicable (see 1

TABLE 3 (Continued

D E S C R I P T I O N		
le - Ducts in Fixed Verti- 'ertical Flight Including hots).	Transition Flight Mode - Duct Position Between Vertical and Horizontal.	Conventional Flight Mode - Ducts in Fixed Horizontal Position.
	Not Applicable	Not Applicable
'ith MIL-H-8501A para- 3.2.12, and 3.6.1.2, 'ill be made at sea level rcraft response charac- ithin the limits speci- itudinal control motions er will be demonstrated ith paragraph 3.3.2 of ification.	In accordance with MIL-H-8501A paragraphs 3.2.11, 3.2.12, 3.6.1.2, demonstration will be made at 0 to 4000 ft and at selected speeds to show that aircraft response characteristics are within specified limits. Demonstrations will also be made in accordance with paragraph 3.2.5 and subparagraphs as stated in 3.3.1.1 of the Detail Specification to show that the ability to decelerate rapidly or to rapidly reverse the direction of conversion in either direction is not limited by longitudinal control or response characteristics. These tests will be performed in ground effect and at 4000 ft.	Demonstration will be performed at 10,000 ft in accordance with paragraph 3.3.5 of MIL-F-8785 as modified in paragraph 3.3.1.2 of the Detail Specification.
onstrated that the -directional oscilla- ithin the limits speci- 501A, paragraph 3.6.1.2.	At selected speeds in transition, it shall be demonstrated that the Lateral directional response characteristics are within the limits specified in MIL-H-8501A, paragraph 3.6.1.2	1) Required, except substitute Figure 3 of the Detail Specification (Vol. I) for Figure 2 of Spec. MIL-F-8785. 2) Required, except substitute "directional control pulses" for "rudder pulses.
nditions demonstration accordance with Spec. ragraph 3.3.5 as modified 3.2 of the Detailed	Demonstration in accordance with Spec. MIL-F-8785, paragraphs 3.4.11, 3.4.12, and 3.4.13 as described in paragraph 3.3.1.2 of the Detail Specification.	1) Not Applicable 2) Required
onstrated that a right ompanies nose-right yaw l force accompanies nose- ired in MIL-H-8501A paragraph 3.3.1.1 of the ation (Vol. I).	Same as VTOL mode at selected speed and duct angles.	Applicable
ith MIL-H-8501A, paragraph demonstrated that a sidewise s can be attained. ith MIL-H-8501A, paragraph demonstrated that complete at least 35 knots can be	Not Applicable (see last column)	Not Applicable. Because all propellers are interconnected and rpm is governor controlled, loss of one engine will not produce assymetric forces on the aircraft.

TABLE 3 (Continued)

ITEM	NAME	DESCRI	
		VTOL Flight Mode - Ducts in Fixed Vertical Position, Vertical Flight Including Hover (0 - 30 Knots).	Transition Flig Between Vertica
m	Lateral Control (Power Approach Configuration)	For trimmed hover condition demonstrate the range of lateral control power as described in paragraph 3.3.2 of the Detail Specification and paragraphs 3.3.15, 3.3.16, and 3.3.17 of MIL-H-8501A.	At selected spee power settings t described in par and 3.3.17 of MI lateral control in paragraph 3.4 modified by 3.3.
n	Lateral Control (P Configuration)	Demonstrated in Item m.	Demonstrated in
o	Lateral Control - High Speed	Not Applicable	Not Applicable
p	Power Control System	Demonstrate in accordance with Specification MIL-H-8501A, paragraph 3.5.8(g)	1) Not Applicabl 2) Applicable ex replaced by " the test duct power." 3) For dual powe in accordance MIL-H-8501A, 4) Demonstrate a altitude and function of c primary syste lateral contr produce a rat 15°/sec with exceeding 30% 5) Applicable ex shall be repl V_{PA} as a func 6) Applicable ex shall be repl V_{PA} as a func
q	Stalls	Not Applicable	Applicable excep at selected airs duct angle shall PA configuratio

TABLE 3 (Continued)

D E S C R I P T I O N		
ode - Ducts in Fixed Verti- Vertical Flight Including Knots).	Transition Flight Mode - Duct Position Between Vertical and Horizontal.	Conventional Flight Mode - Ducts in Fixed Horizontal Position.
over condition demonstrate lateral control power as paragraph 3.3.2 of the ication and paragraphs 6, and 3.3.17 of MIL-H-	At selected speeds, duct angles and power settings the compatibility described in paragraphs 3.3.15, 3.3.16, and 3.3.17 of MIL-H-8501A and the lateral control for STOL as specified in paragraph 3.4.16.2 of MIL-F-8785 modified by 3.3.1.2 of the Detail Spec.	Applicable except that the lateral control as specified in paragraph 3.4.16.2 of the Detail Specification shall be demonstrated.
in Item m.	Demonstrated in Item m.	Applicable [illegible] as above in Item m.
e	Not Applicable	Applicable except as above in Item m.
n accordance with Specifi- 8501A, paragraph 3.5.8(g)	1) Not Applicable	1) Not Applicable
	2) Applicable except "0.6 n_z" shall be replaced by "max g obtainable for the test duct angle at constant power."	2) Applicable
	3) For dual power controls demonstrate in accordance with Specification MIL-H-8501A, paragraph 3.5.8(g).	3) Applicable except 10,000' instead of 20,000'.
	4) Demonstrate at 7500 feet altitude and at selected V_{PA} as a function of duct angle, with the primary system inoperative that the lateral control is sufficient to produce a rate of roll of at least 15°/sec with lateral forces not exceeding 30# stick force.	4) Applicable
	5) Applicable except that 1.1 V_{SPA} shall be replaced with "selected V_{PA} as a function of duct angle."	5) Applicable
	6) Applicable except that 1.15 V_{SPA} shall be replaced by "selected V_{PA} as a function of duct angle."	6) Applicable
e	Applicable except that demonstration at selected airspeeds as a function of duct angle shall only be in the P and PA configurations.	Applicable

TABLE 3 (Continued)

ITEM	NAME	DESCRIPTION: VTOL Flight Mode - Ducts in Fixed Vertical Position, Vertical Flight Including Hover (0 - 30 Knots).	DESCRIPTION: Transition Flight M Between Vertical ar
r	Power Off Landings	One engine out landings will be demonstrated at selected weight conditions exceeding the Design Gross Weight (to determine limits of piloted operation).	Applicable, except th shall be at landing ing to various duct
s	Inertia Coupling	Under the most critical conditions of rolling and yawing rate it shall be demonstrated that no uncontrollable conditions exist.	Applicable, except t be limited to those be accomplished at as a function of du
t	Artificial Stability Devices	Demonstrate in accordance with paragraph 3.5.9 (b), (c), (d) and (e) of Specification MIL-H-8501A.	Demonstrate in acco graph 3.5.9 (b), (c Specification MIL-H
u	Longitudinal Control System Sensitivity	The flight conditions for this test will be determined from considerations of flight test and engineering analysis. It will be demonstrated that there is no tendency for divergent or uncontrollable oscillations resulting from efforts of the pilot to maintain steady flight.	
v	Height Control	Demonstration will be made in accordance with MIL-H-8501A paragraphs 3.4.1 and 3.4.2 as modified by paragraph 3.3.1.1 of the Detail Specification using the methods of height control stated in paragraph 3.3.2 of the Detail Specification.	Not Applicable
w	Control Cross Coupling	In accordance with MIL-H-8501A paragraph 3.3.14 demonstration shall be made to show that control coupling effects are within specified limits.	Same as VTOL Mode e speeds and duct ang

NOTES: 1. Demonstration of the aircraft will be performed in accordance with the applica
2. For VTOL and transitional flight modes the terms "longitudinal control" shall control" shall be submitted for "rudder control".
3. This table covers "Flying Qualities" for aerodynamic demonstration of the basi items such as the variable stability system.

TABLE 3 (Continued)

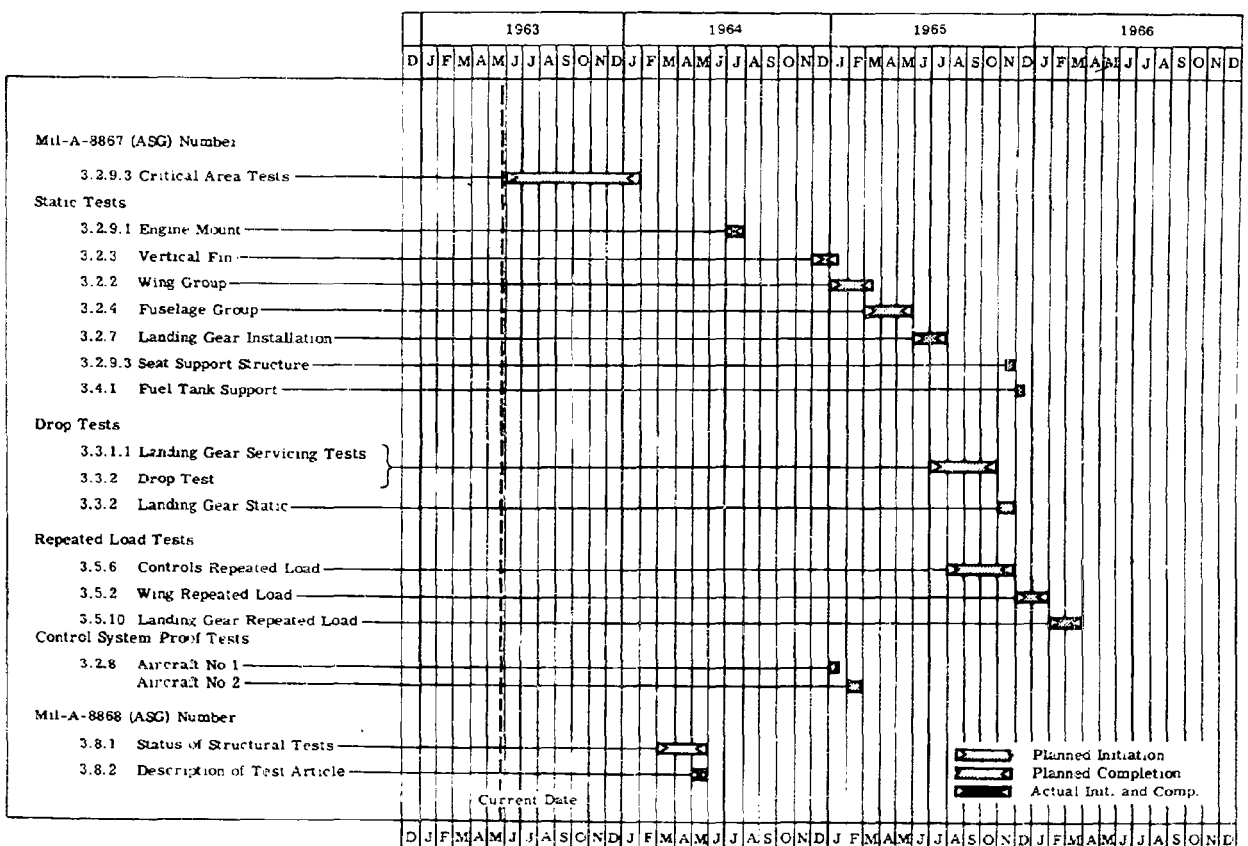
	D E S C R I P T I O N	
cts in Fixed Verti- l Flight Including	Transition Flight Mode - Duct Position Between Vertical and Horizontal.	Conventional Flight Mode - Ducts in Fixed Horizontal Position.
gs will be demon- eight conditions Gross Weight (to iloted operation).	Applicable, except that demonstration shall be at landing speeds corresponding to various duct angle settings.	Applicable, except that the configuration makes it impossible to simulate engine seizure. Engine seizure will result in the engine disconnecting from transmission without asymmetric power effects.
al conditions of te it shall be uncontrollable	Applicable, except that rolls shall be limited to those angles which can be accomplished at selected airspeeds as a function of duct angle.	Applicable, except that rolls shall be limited to 120° (from -60° to +60°)
ance with para- (d) and (e) of 501A.	Demonstrate in accordance with paragraph 3.5.9 (b), (c), (d) and (e) of Specification MIL-H-8501A.	Required.
for this test will nsiderations of eering analysis. ed that there is gent or uncontroll- ulting from efforts ain steady flight.		Required.
made in accord- paragraphs 3.4.1 by paragraph Specification height control .3.2 of the Detail	Not Applicable	Not Applicable
L-H-8501A para- ation shall be trol coupling ecified limits.	Same as VTOL Mode except for selected speeds and duct angles.	Not Applicable

erformed in accordance with the applicable requirements at altitudes from 0 to 10,000 feet.
the terms "longitudinal control" shall be substituted for "elevator-control", and "directional
control".
r aerodynamic demonstration of the basic aircraft and does not cover testing of special
stem.

Form 0345 Rev. 1248

Model X-22A

Date 21 February 1964



3.25.2.2.(2) a. Structural Work Plan (Test Program – Static & Repeated Load)

Report 2127-931001

Form 0845 Rev. 1245

3.2.2.2 (cb) PLANNED DATES FOR SUBMITTAL OF CONTRACT DESIGN DATA

Report	Report Number	Specification Requirement		Submittal Date
		Specification	Paragraph	
Basic Data Report	2127-941033	MIL-D-8706A, Add. 162 MIL-A-8870 (ASG)	3.6.1 3.3.4	11-20-63
Compliance Data Report	2127-941037	MIL-D-8706A, Add. 162 MIL-A-8870 (ASG)	3.3.5	3-5-65
Ground Vibration Test Reports	2127-941036	MIL-D-8706A, Add. 162 MIL-A-8870 (ASG)	3.3.5	3-5-65
Final Flutter and Divergence Analysis Report	2127-941034	MIL-D-8706A, Add. 162 MIL-A-8870 (ASG)	3.3.6.1	6-15-65
Final Environmental Vibration Report	2127-	MIL-D-8706A, Add. 162 MIL-A-8870 (ASG)	3.3.6.2	2-15-65
Wing Structural Analysis Report	2127-941013	MIL-D-8706A, Add. 162 MIL-A-8868 (ASG)	3.7	7-9-65
Ducts and Stabilizer Structural Analysis Report	2127-941014	MIL-D-8706A, Add. 162 MIL-A-8868 (ASG)	3.7	7-9-65
Fuselage Structural Analysis Report	2127-941015	MIL-D-8706A, Add. 162 MIL-A-8868 (ASG)	3.7	7-9-65
Fin Structural Analysis Report	2127-941016	MIL-D-8706A, Add. 162 MIL-A-8868 (ASG)	3.7	7-9-65
Landing Gear Structural Analysis Report	2127-941017	MIL-D-8706A, Add. 162 MIL-A-8868 (ASG)	3.7	7-9-65
Control System Structural Analysis Report	2127-941018	MIL-D-8706A, Add. 162 MIL-A-8868 (ASG)	3.7	7-9-65
Engine Installation Structural Analysis Report	2127-941019	MIL-D-8706A, Add. 162 MIL-A-8868 (ASG)	3.7	7-9-65

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Report	Report Number	Specification Requirement		Submittal Date
		Specification	Paragraph	
Transmission Structural Analysis Report	2127-941020	MIL-D-8706A, Add. 162 MIL-A-8868 (ASG)	3.7	7-9-65
Miscellaneous Structure Analysis Report	2127-941021	MIL-D-8706A, Add. 162 MIL-A-8868 (ASG)	3.7	7-9-65
Fatigue Analysis Report	2127-941022	MIL-D-8706A, Add. 162 MIL-A-8868 (ASG)	3.7	7-9-65
Preliminary Strength Summary and Operating Restrictions Report	2127-941006	MIL-D-8706A, Add. 162 MIL-A-8868 (ASG)	3.9	10-29-64
Inertia Loads Report	2127-941007	MIL-D-8706A, Add. 162 MIL-A-8868 (ASG)	3.5.2	10-29-64
Magnitudes and Distributions of Aerodynamic Loads	2127-941008	MIL-D-8706A, Add. 162 MIL-A-8868 (ASG)	3.5	10-29-64
Detail Ground Load Report	2127-941010	MIL-D-8706A, Add. 162 MIL-A-8868 (ASG)	3.5.7.1	10-29-64
Control System Loads Report	2127-941011	MIL-D-8706A, Add. 162 MIL-A-8868 (ASG)	3.5.8	10-29-64
Development of New or Unconventional Methods of Determining Loads	2127-941012	MIL-D-8706A, Add. 162 MIL-A-8868 (ASG)	3.5.9	10-29-64
Final Strength Summary and Operating Restriction Report	2127-941006	MIL-D-8706A, Add. 162 MIL-A-8868 (ASG)	3.9	7-9-65
Weight and Balance Status Reports Phase I		MIL-D-8706A, Add. 162	3.5.9	
Calculated Weight Report Phase I		MIL-D-8706A, Add. 162	3.5.9	
Seat Test Report		MIL-D-8706A, Add. 162	3.6.18	

Form 9345 Rev. 1244

3.25.2.2.5(c) (CONT

Report	Report Number	Specification Requirement		Submittal Date
		Specification	Paragraph	
Constant Speed Drive System Program		MIL-D-5706A, Add. 162		
Summary of Engineering Data		MIL-D-5706A, Add. 162		
Weight and Balance Status-Reports Phase II		MIL-D-5706A, Add. 162	3.6.12	
Calculated Weight Report Phase II		MIL-D-5706A, Add. 162	3.6.12	
Actual Weight Reports and Appendices		MIL-D-5706A, Add. 162	3.6.12	

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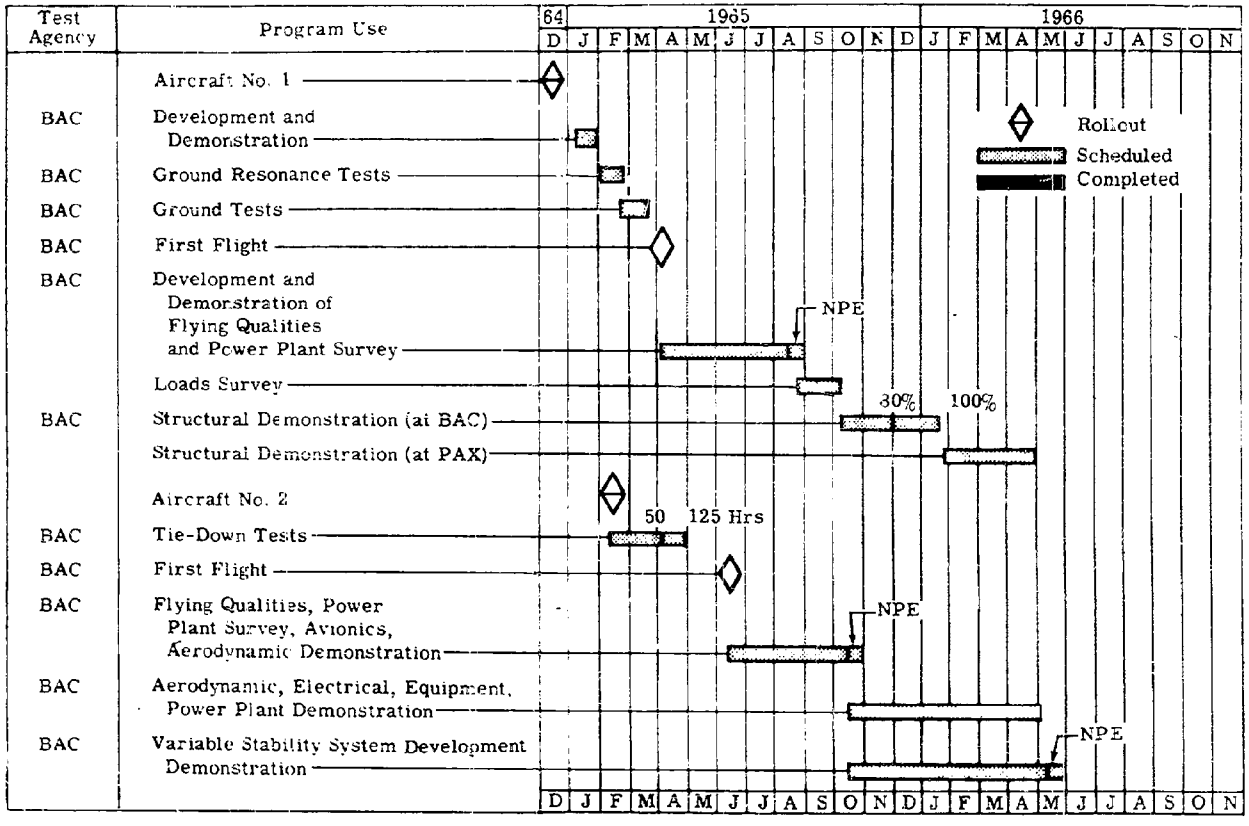
FLIGHT TEST PLAN



3.25.2.2.(3) DEMONSTRATION SCHEDULE

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3.25.2.2 (4) NAVY PRELIMINARY EVALUATION SCHEDULE DATES

Navy Preliminary Evaluations

Phase I	Start	8/17/65
	Comp.	8/31/65
Phase II	Start	9/23/65
	Comp.	10/7/65
Phase III	Start	4/28/66
	Comp.	5/12/66

3.25.2.2 (5) SCHEDULE OF DELIVERY OF AIRPLANES

Aircraft No. 1 - 4/7/66 at NATC Patuxent River

Aircraft No. 2 - 5/6/66 at BAC Wheatfield