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September 1959

ARDC 119A

McDONNELL MODEL 119A AIR FORCE FLIGHT EVALUATION

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1st Lieutenant, USAF
Project Engineer

FRANK E. COLE
Captain, USAF
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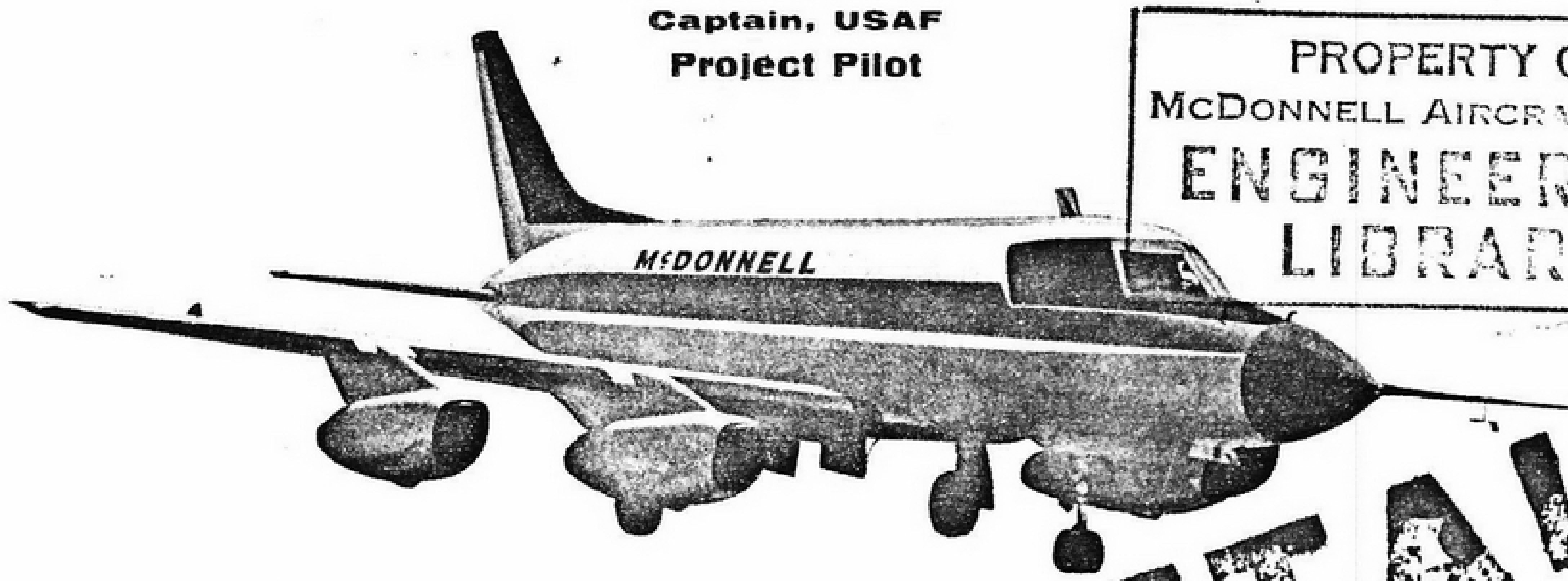

AIR FORCE FLIGHT TEST CENTER
EDWARDS AIR FORCE BASE, CALIFORNIA
AIR RESEARCH AND DEVELOPMENT COMMAND
UNITED STATES AIR FORCE

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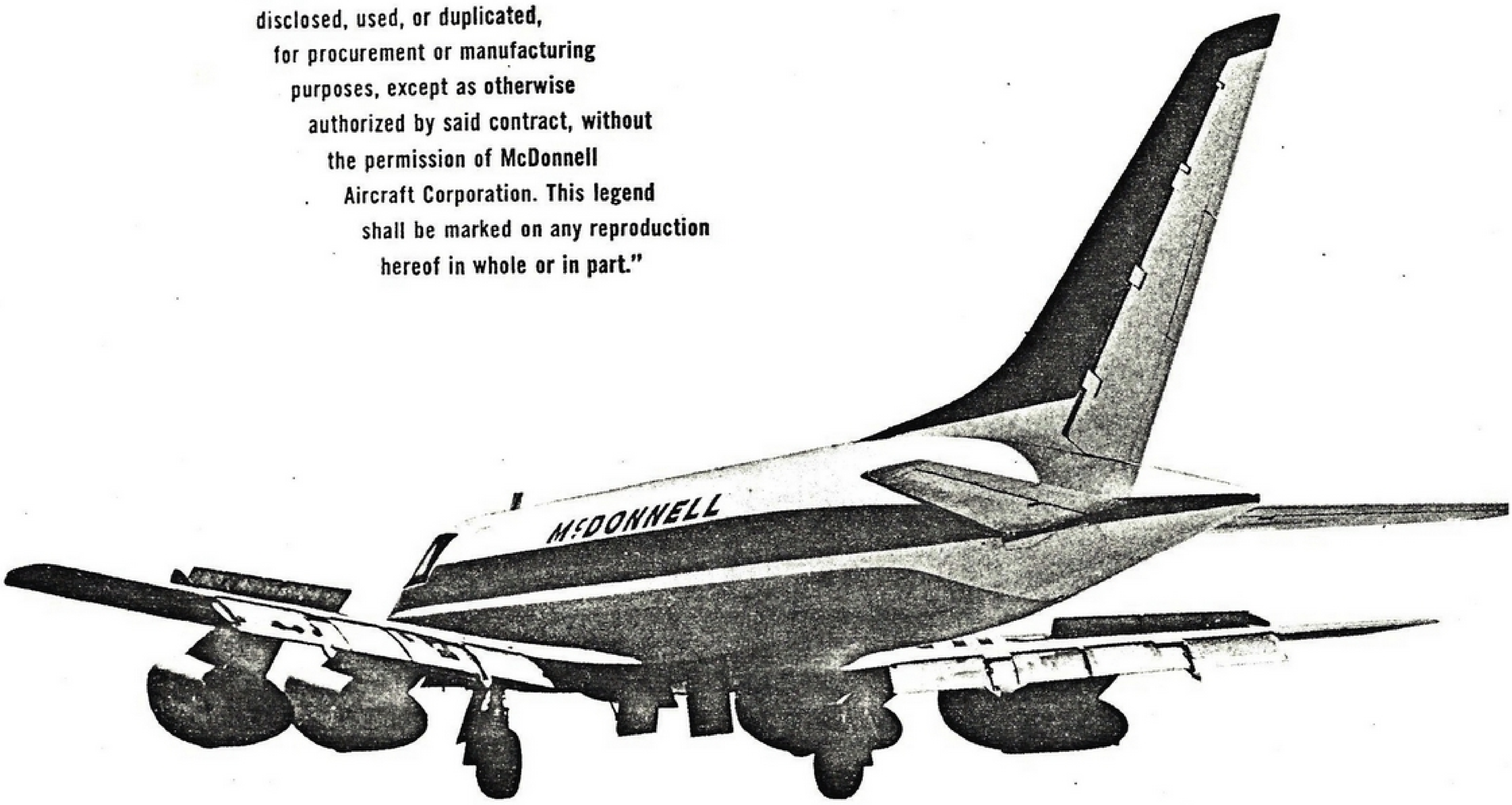

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SUMMARY

The McDonnell Model 119A is a prototype jet utility transport aircraft powered by four pod-mounted Westinghouse J34-WE-34 turbojet engines rated at 3250 pounds thrust at sea level. The aircraft carries a crew of two and accommodates 12 passengers. Production version of the aircraft will be designed to use four Pratt and Whitney J60 engines and can be used for bombardier/navigator training, cargo-personnel transport or air evacuation. The test aircraft had a basic weight of 25,726 pounds and an internal fuel capacity of 2,544 gallons (16,540 pounds of JP-3 at 6.5 pounds per gallon).

Nineteen flights, totaling 44 hours and 12 minutes, were flown at the Air Force Flight Test Center during the period from 11 May to 23 May 1959.

Although the Model 119A has speed and altitude capabilities above those of present operational USAF aircraft in its class, several deficiences exist that make the airplane operationally unsuitable.

Low elevator power and insufficient nose-up stabilizer trim limit the longitudinal controllability in the landing configuration at a forward cg. The light longitudinal maneuvering force gradients are unsatisfactory.

Stall characteristics are good.

Lateral-directional damping with the yaw damper off meets the MIL-F-8785(ASG) requirements, but is considered unsatisfactory, however, damping is excellent with the yaw damper mode of the autopilot engaged.

The prototype aircraft is equipped with a hydraulically powered, irreversible type directional control system which provides satisfactory rudder control during sideslips. The system allows for manual rudder control when the power system fails. In this configuration a rudder lock occurs. Rudder lock was exhibited at 4 to 6 degrees of sideslip and can lead to exceeding the structural limitations of the vertical tail. Directional controllability during asymmetric power conditions is good with the hydraulic power on.

Lateral control is good in terms of response and roll rates when the spoilers are operative; however, a spoilers inoperative condition reduces the roll rate by approximately 50 percent. Insufficient aileron centering is apparent in rolling maneuvers where small and accurate aileron inputs are required. Aileron inputs in excess of three-quarters deflection are force limited.

The aircraft does not meet the General Design Specification (GDS) with respect to range, cruise speed and landing distance. It does meet the four and three engine service ceiling requirements. The Model 119A is capable of taking off in 4,300 feet at a gross weight of 45,500 pounds under standard sea level conditions. The four engine military rated power sea level rate of climb is 4,400 feet per minute with a service ceiling of 41,800 feet. The three engine military rated power service ceiling is 34,100 feet. The no wind range of the aircraft at a cruise speed of 0.74 Mach is 1142 nautical miles, 358 miles less than the GDS Requirement of 1500 miles. The range against a 70 knot headwind is 970 miles. Increasing the cruise speed to the GDS required .76 Mach number reduces the range by 15 miles. The maximum level flight speed at 35,000 feet altitude and 37,000 pounds gross weight is 0.82 Mach number. The minimum landing distance over a 50 foot obstacle is 4,930 feet, with a ground roll of 2,690 feet for a gross weight of 31,100 pounds. Descent performance at the gear placard speed of 285 knots IAS is satisfactory. Two and eight tenths minutes are required to descend from 38,000 to 10,000 feet.

Results of this evaluation, show that aircraft performance equals, or is better than the contractor's estimated data for take-off and climb performance, but is less than the estimated range and landing performance.

The aircraft was tested using JP-3 fuel with a 5 percent alcohol (Isopropyl) additive to prevent fuel icing.

This report has been reviewed and approved
27 August 1959

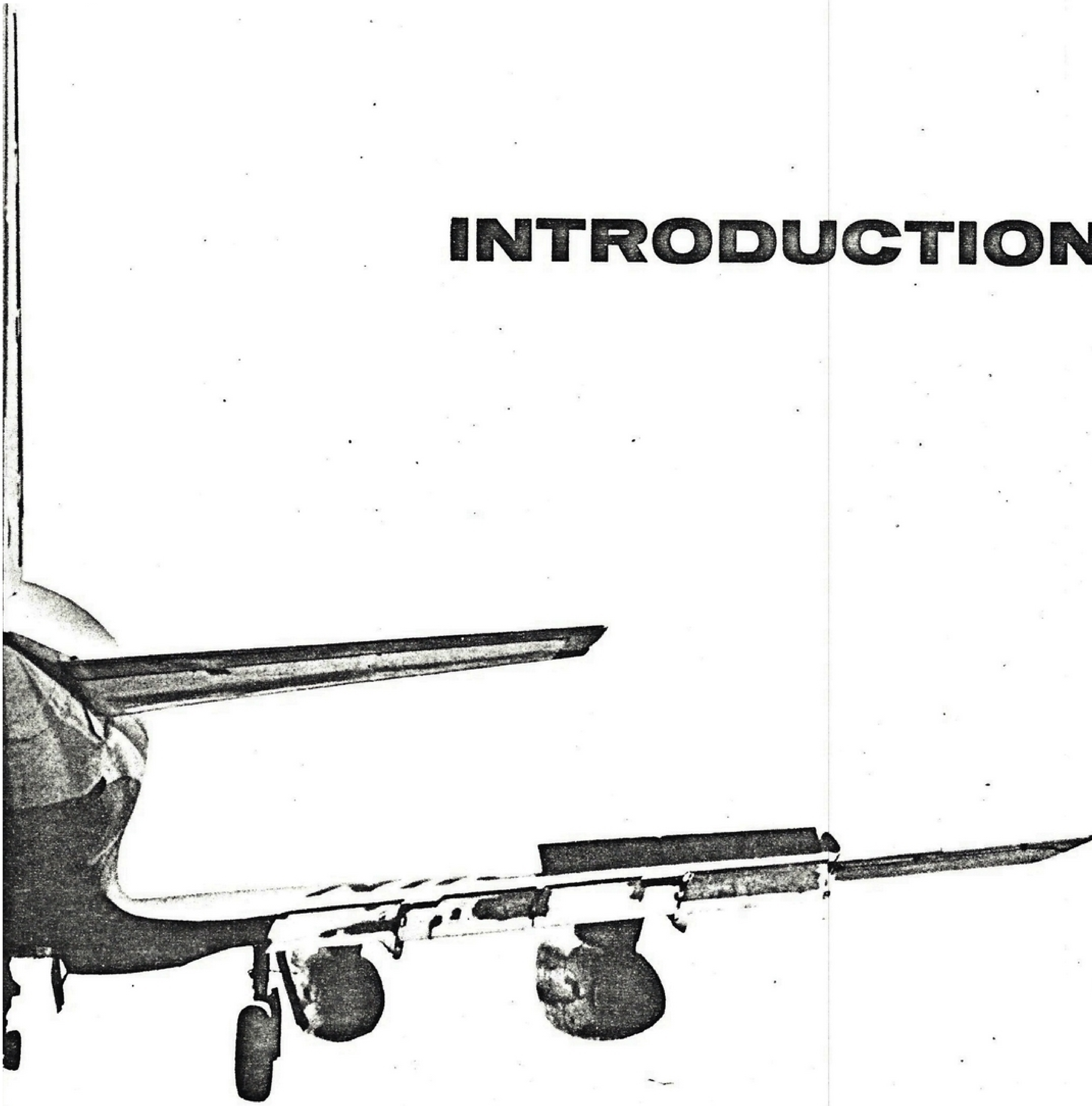
Royal N. Baker

ROYAL N. BAKER
Colonel, USAF
Director, Flight Test

John W. Carpenter III

JOHN W. CARPENTER, III
Brigadier General, USAF
Commander

INTRODUCTION



The Air Force Flight Evaluation of the prototype McDonnell Model 119A was conducted at the Air Force Flight Test Center between 11 May and 23 May 1959. Total Flight Evaluation flight time for the 19 Air Force flights was 44 hours and 12 minutes; 8 hours and 12 minutes of this time were utilized for familiarization, demonstration and night flying evaluation. The major objective of the evaluation was to determine the aircraft's capability of complying with General Operational Requirements (GOR No. 162). The manufacturer was supplied the flight test data periodically throughout the evaluation. An oral briefing on the findings of the test given at the UCX-UTX Weapons System Project Office on 1 June 1959 replaced the publication of a preliminary report.

The Model 119A, manufactured by the McDonnell Aircraft Corporation, St. Louis, Missouri, is a small four-engine utility jet transport designed to be used as a Bombardier/Navigator trainer, for the rapid transport of personnel, high priority cargo and for air evacuation. The airplane is characterized by a low 35 degree swept back wing, four pod-mounted Westinghouse J34-WE-34 engines, (uninstalled rating of 3250 pounds thrust) spoiler-speed brakes on top of the wing, a single swept vertical tail, a swept horizontal tail, tricycle landing gear and a pressurized fuselage of semi-monocoque construction. The cabin access door is located on the left side of the fuselage just forward of the wing.

The dual wheel nose gear retracts forward into the fuselage; the main gear retracts inboard into the fuselage. The elevator and ailerons are mechanically controlled while the rudder and spoilers are hydraulically operated. Longitudinal trim is achieved through a moveable horizontal stabilizer; lateral trim by positioning the left-hand aileron balance tab; and directional trim by positioning the rudder by means of a rudder trim actuator. High lift devices include trailing edge Fowler and split flaps.

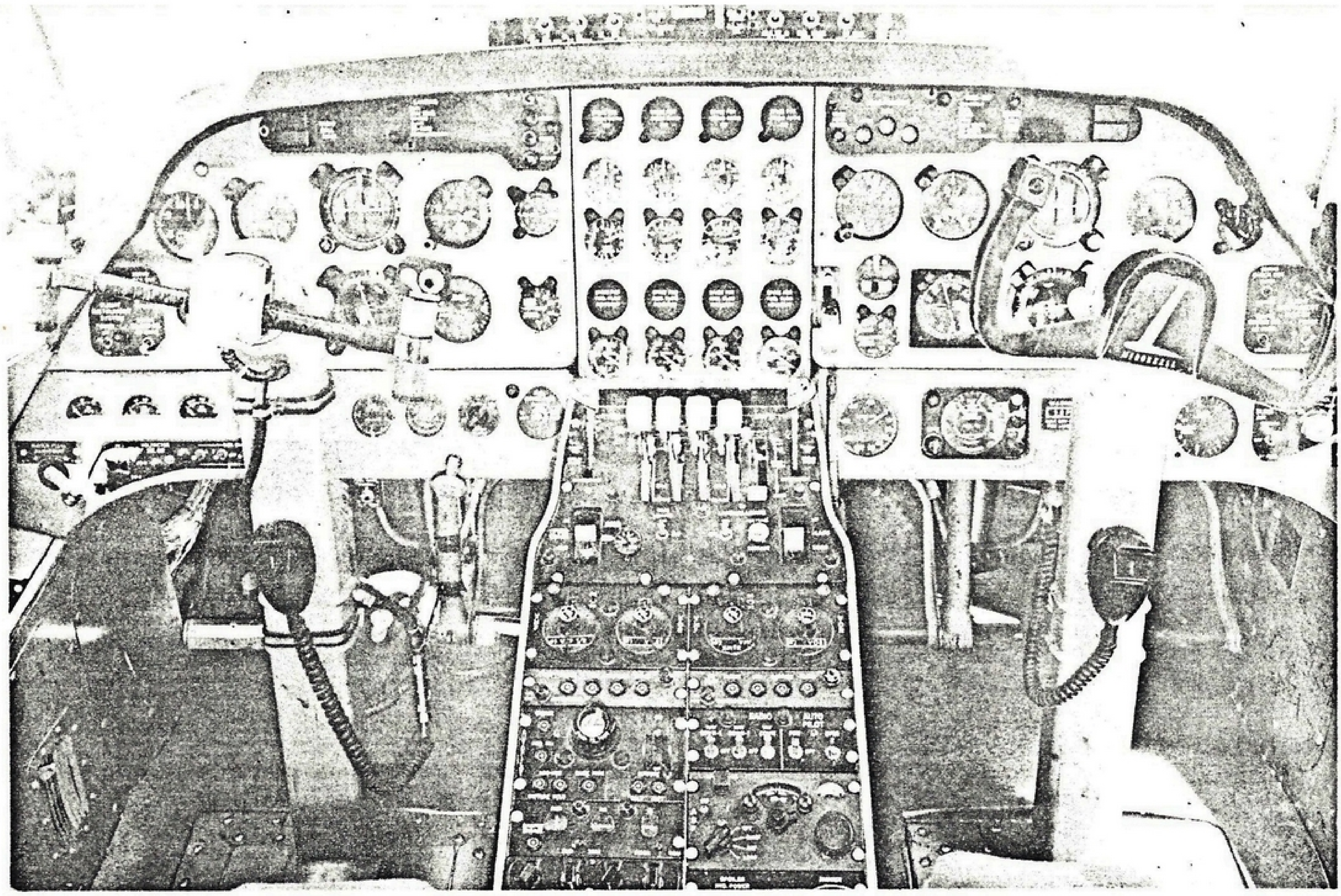
The Model 119A is designed to accommodate a crew of two and twelve passengers. Instrumentation was installed in the cabin area for the flight test program. Cabin pressurization is furnished by engine bleed air.

The aircraft is equipped with a test nose boom containing test airspeed and altitude measuring sources and vanes to measure angle of attack and sideslip.

The following configurations as listed in Military Specifications MIL-F-8785(ASG) are presented on the plots and referred to in the discussion:

Configuration	Gear	Flaps	Power	Spoilers
Take-off (TO)	Down	50 percent	Military	Down
Cruise (CR)	Up	Up	PLF	Down
Power Approach (PA)	Down	50 percent	PLF	Down
Landing (L)	Down	100 percent	Idle	Extended 15°

The airplane was evaluated at the maximum allowable take-off gross weight of 45,500 pounds. The maximum capacity of the internal fuel tanks is 2,544 gallons (16,540 pounds of JP-3 at 6.5 lbs/gal). Weight and balance information and flight limitations adhered to during the flight evaluation are presented in Appendix II.



TEST RESULTS

cockpit and cabin evaluation

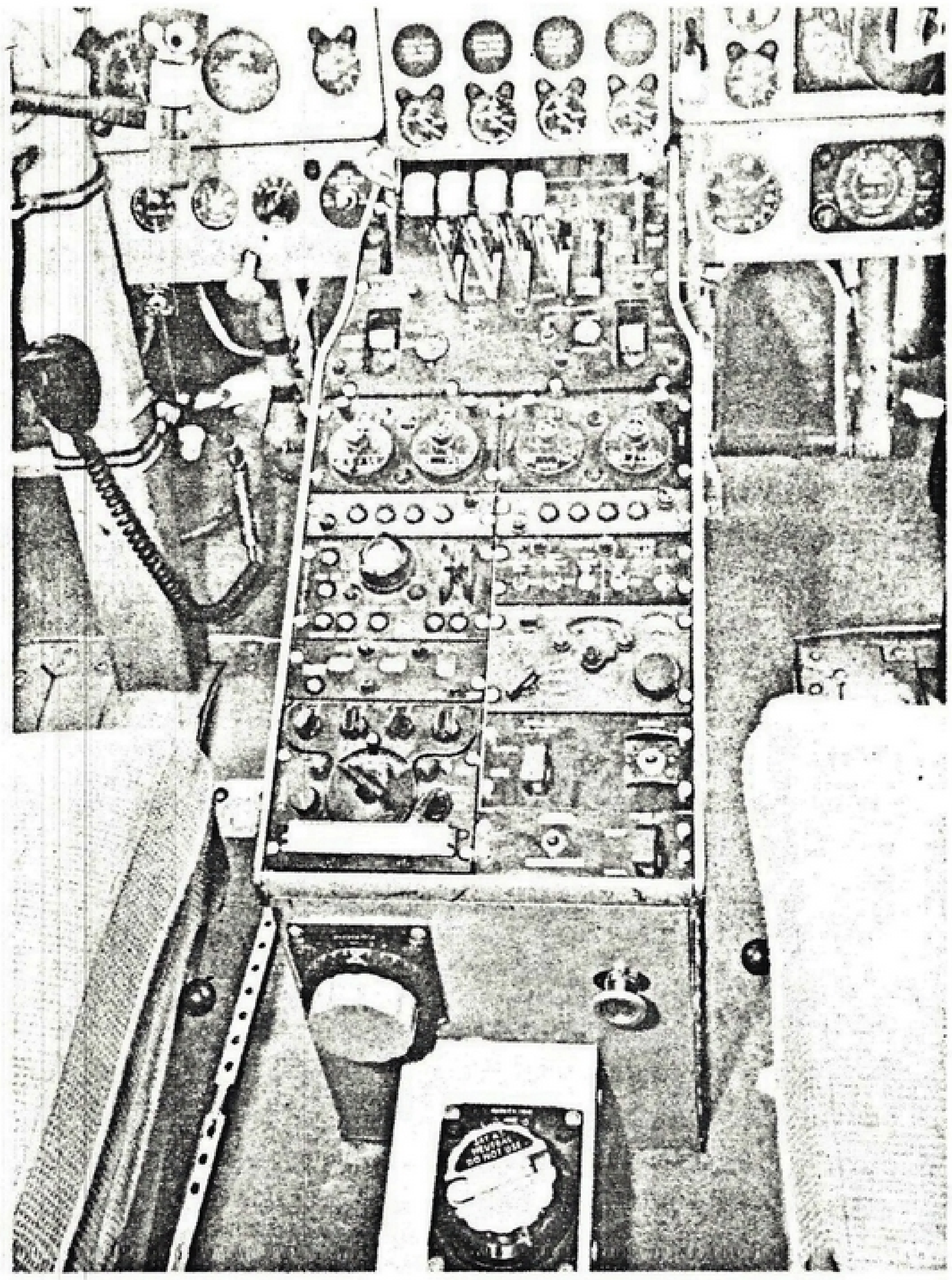
Entrance to the aircraft is gained through the cabin access door located on the left side of the fuselage just forward of the wing. The inward opening plug type door is air operated. The door is moved inward about six inches by pneumatic pressure from the door accumulator, then is manually slid aft on a small track. Enough air is stored in the accumulator for five complete operating cycles of the door. The system can be recharged on the ground by a high pressure compressor.

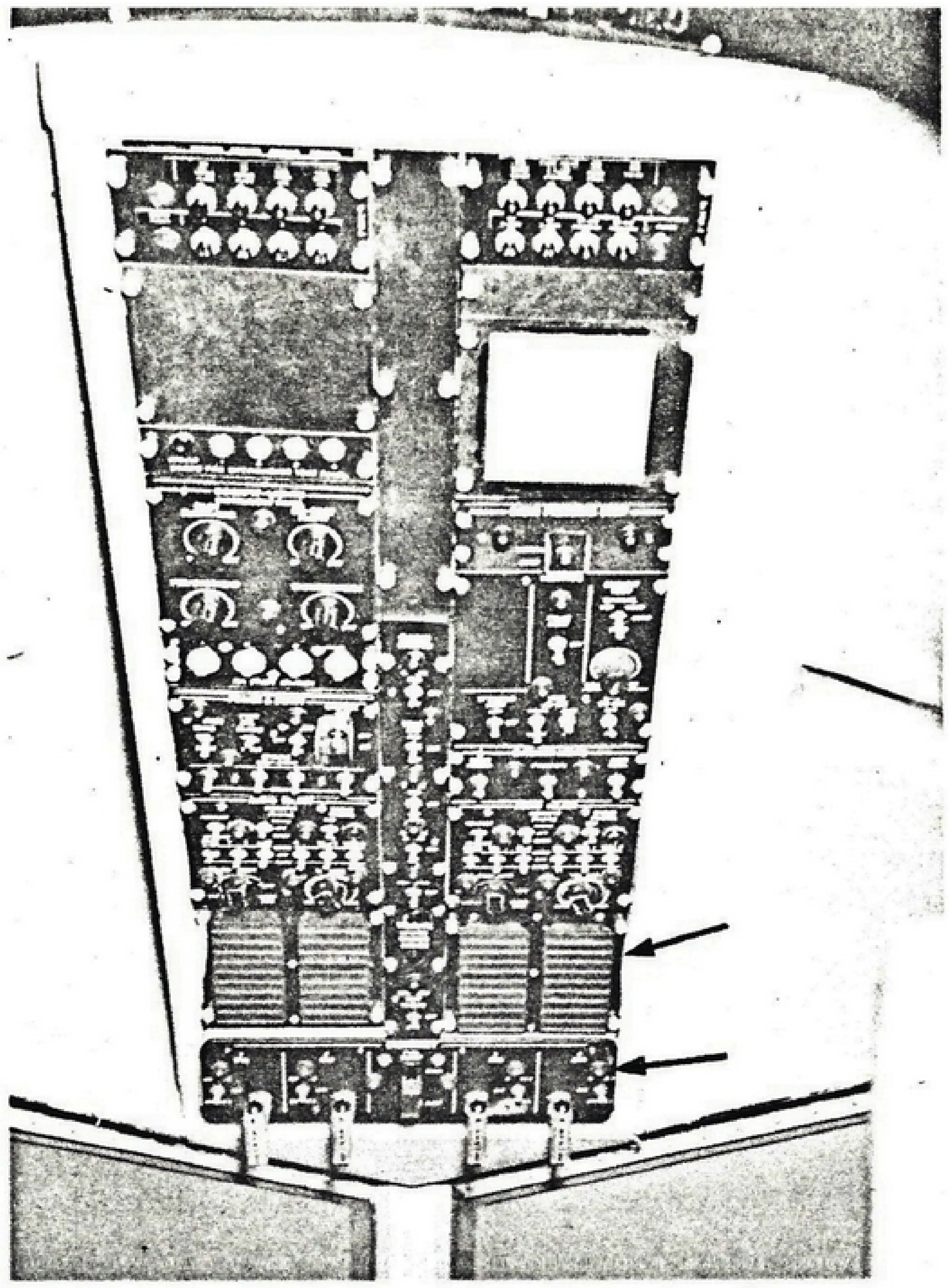
If an integral stair folding door were provided, the necessity of having a ladder or stand brought to the aircraft would be eliminated. Some saving in space would be realized since there is presently an area aft of the door required for stowage in the open position.

The main cabin is equipped with twelve forward facing passenger seats and drop out oxygen masks. A variety of cabin interiors have been proposed for the production aircraft.

A survey of cockpit and cabin noise levels was conducted on one flight though the cabin was not in its production configuration. Only four seats were installed and the carpet was removed to allow the fastening of ballast to the seat tracks. The noise levels were low and did not exceed the maximum permitted by MIL-A-8806.

Easy access to the pilot's or co-pilot's seat is hampered by the large center control pedestal which has an additional projection upon which the manual rudder trim is mounted. A generous fore and aft adjustment range of the seats has been provided to facilitate entry; however, it still requires an awkward step over the pedestal for the pilot to be seated. Use of back pack parachutes adds to the inconvenience of getting into the seat.





The cockpit itself is generally well designed. Control positions, control knob shapes and control movements are in keeping with Air Force standards and comply, in most cases, with the recommended layout in the Handbook of Instructions for Aircraft Designers. Flight and engine instruments are arranged in accordance with the Air Force interim instrument panel specifications and present accepted practice for priority of jet engine instruments.

Master fire warning and master caution lights are provided for both the pilot and co-pilot. Four translucent plastic emergency engine shut-off "T" handles are located on the emergency panel. These are individually illuminated with red lights in conjunction with the master fire warning lights in case of engine fire or overheat. Immediately aft of the emergency panel is the telelight or word warning panel which contains 40 warning positions including several spares. These are illuminated in conjunction with the master caution lights in case of failure or deactivation of various components or accessories, low fuel quantity, when approaching flap placard speed with the flap still down, etc. The location of these lights is satisfactory except that the master caution light is partially obscured by the glare shield. A location beside, rather than above, the master fire warning light is recommended. The telelight panel could be seen more easily if it were located on the instrument panel itself instead of overhead.

A normal operation light panel similar to the telelight panel, but lighted with green instead of amber, is located in front of the throttle quadrant. This panel contains space for 16 operating conditions, most of which were spare spaces on the prototype aircraft. The concept of normal operation lights is not endorsed and the panel is considered superfluous. If the space occupied by this panel were used

APPENDIX II

general aircraft information

Design information and general aircraft description are presented below. This data was obtained from McDonnell Report No. 6630 and the Familiarization Manual.

■ airplane:

Overall length	66.49 ft.
Height	23.64 ft
Span	57.3 ft
Design gross weight	45,500 lb

■ wing:

Area	550 sq ft
Span	57.3 ft
Root chord	164.3 in
Tip chord	65.45 in
Mean aerodynamic chord	122.1 in
Aspect ratio	6.0
Taper ratio	.40
Dihedral	6 deg
Incidence	2 deg
Sweepback (¼ chord)	35 deg
Airfoil section:	
root	NACA 64A314 modified
tip	NACA 2409 modified

■ horizontal tail:

Area	119.0 sq ft
Span	23.2 ft
Root chord	278 in
Tip chord	88.3 in
Mean aerodynamic chord	65.6 in
Aspect ratio	4.5
Taper ratio	.40
Sweepback (¼ chord)	35 deg
Airfoil section:	
root	64A009
tip	64A009
Tail length	366.3 in

■ vertical tail:

Area	90.05 sq ft
Span	12.36 ft
Root chord	135.2 in
Tip chord	39.67 in
Mean aerodynamic chord	96.133 in
Aspect ratio	1.70
Taper ratio	.294
Sweepback (¼ chord)	45 deg
Tail length	345.58 in

■ control surfaces:

Surface	Area — ft²	Design Movement deg	Actual Movement deg
Aileron*	16.36 (total)	±30	+29, −31
Elevator*	24.6 (total)	±15	+20, −15
Stabilizer	94.4	12 degrees leading edge down with respect to W.L. 0	
Rudder*	24.05	±30	±30
Spoiler	12.6	60	56.5
Fowler flap	58 (total)	35	35
Split flap**	27.4 (total)	60	31

* Area aft of hinge line.
** The split flap movement was blocked to 31 degrees for the evaluation.

aircraft flight limitations

The following flight limitations as obtained from McDonnell flight test personnel were imposed upon all test flights:

Maximum gross weight — 45,500 lb
Center of gravity limitation — 18%MAC to 33%MAC
Positive load factor — 2g for gross weights up to 37,000 pounds; 1.7g at 45,500 pounds
Negative load factor — 0g
Sideslip angle or rudder force:
- hydraulic power off — 300 pounds below 165 knots IAS, 100 pounds above 165 knots IAS, 120 pounds maximum for yaw damper on condition
- hydraulic power on — 300 pounds, 120 pounds for yaw damper on condition

These limits are imposed along with a βq limit of 2400 degrees- pound per square foot, whichever is less.

Maximum Speed:

Cruise configuration — 300 knots IAS or .815 indicated Mach number whichever is less
Flap extension and retraction — 185 knots IAS
Landing gear extension — 280 knots IAS
Landing gear retraction — 185 knots IAS
Speed brake extension and retraction — 300 knots IAS
Roll rate — 80 degrees per second

Weight and Balance

The fuel tank quantity indicating system was calibrated prior to the test program. The fuel quantity system is designed for maximum accuracy at a 3 degree airplane nose up attitude. The airplane was placed in this attitude, throughout the calibration, and the average gage errors were as follow: right hand - 100 pounds, center wing - 200 pounds, left hand - 150 pounds.

Fuel tank capacities were determined by servicing each tank through its external filler ports. The quantities obtained are believed to be very close to the single point refuel capacity. Tank capacities in gallons as determined in this manner are: right hand — 952, center wing — 634, left hand — 958.

The pre-and post-flight gross weights were calculated on the basis of the empty weighing and the results of the fuel tank calibration.

The following is a list of pertinent gross weight and cg data.

Design gross weight	45,500 pounds
Empty weight including 660 pounds ballast	25,726 pounds
Empty cg including 660 pounds ballast at F. S. 597	29.4 percent MAC
Fuel Weight (2,544 gallons at 6.26 lbs/gal)	15,910 pounds
Full fuel condition	41,636 pounds
	26.4 percent MAC

The above figures do not include crew. Additional ballast was installed in the cabin area to increase the gross weight to 45,500 pounds.

Fuel System

The Model 119A is equipped with a wet wing fuel system composed of three integral wing tanks, one in each wing and one in the wing center section. The center wing tank holds 634 gallons, the right outer 952 and the left outer 958. In-flight, approximately 1.0 psi is maintained in all tanks by two independent dive and climb vent systems.

Center wing fuel is transferred through two shutoff valves to the outer wing tanks by two AC electric motor driven pumps. Fuel transfer is controlled automatically by the fuel level in the outer wing tanks which are the engine feed tanks. Two boost pumps located in the aft compartment of each outer tank supply the engines through individual feed lines. Cross feed between the outer wing tanks is accomplished by two DC electric motor driven pumps. The cross feed feature is not automatic. These pumps are also used for fuel dumping. In an emergency two additional pumps will dump fuel from the center wing tank.

Fueling and defueling are accomplished by using the aircraft pressure refuel manifold. The aircraft may also be refueled through individual tank filler ports.

Power Plant

The Model 119A is powered by four Westinghouse J34-WE-34 engines rated at 3250 pounds of sea level static thrust. The J34 incorporates an eleven stage spool compressor with a compression ratio of 4.1 to 1 and a two stage turbine mounted on the compressor shaft. The engine burns JP-3 or 90/110 octane aviation fuel at an approximate rate of 1.04 pounds of fuel per pound of thrust at military rated power. The test program was conducted using JP-3 plus 5 percent Isopropyl additive to prevent fuel ice from clogging the fuel strainers.

Each engine turns a DC generator and furnishes compressor air for blow away jets. The blow away jets, installed on each engine, are designed to eliminate the source of most foreign object engine damage. The vortex, formed whenever the engine is running on the ground, is eliminated by directing compressor bleed air at the base of the vortex.

test instrumentation

The flight test instrumentation was installed and maintained by McDonnell Aircraft Corporation. Calibrations were checked prior to beginning the flight evaluation. The test instrumentation included in this aircraft is outlined below:

Photo Recorder Panel:

- Altitude—standard system
- Altitude—nose boom system
- Airspeed—standard system
- Airspeed—nose boom system
- Time of day
- Coordination counter
- Engine rpm—4 engines
- EGT—4 engines
- Accelerometer
- Elevator position
- Stabilizer position
- Right-hand aileron position
- Left-hand aileron position
- Right-hand spoiler position
- Left-hand spoiler position
- Rudder position
- Fuel quantity
- Fowler flap position

Oscillograph:

- Fuel flow—4 engines
- P_{t5}—4 engines
- Fuel temperature at flowmeter—2 engines
- Elevator position
- Stabilizer position
- Right-hand aileron position
- Left-hand aileron position
- Right-hand spoiler position
- Left-hand spoiler position
- Rudder position
- Angle of attack
- Angle of sideslip
- Bank angle
- Pitch angle
- Roll rate
- Pitch rate
- Yaw rate
- Normal acceleration
- Elevator wheel force
- Aileron wheel force
- Rudder pedal force