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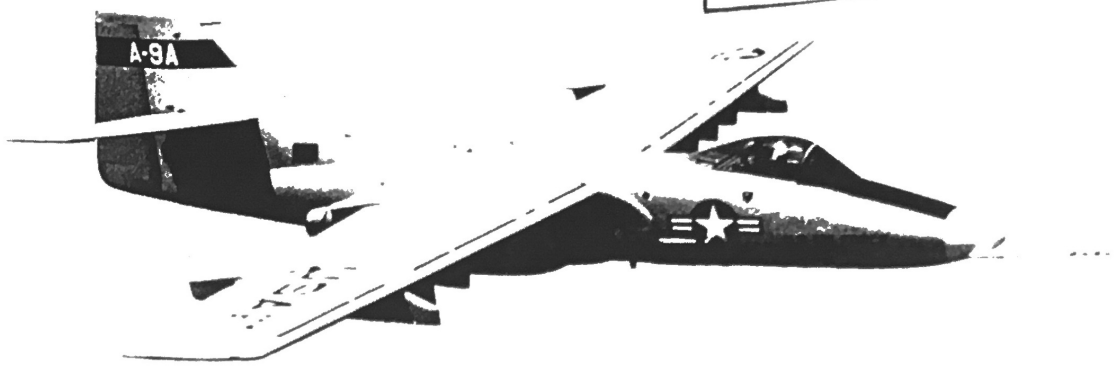

Specialized
Close Air Support
Aircraft

VOLUME II
TECHNICAL PROPOSAL

SECTION I
TEST

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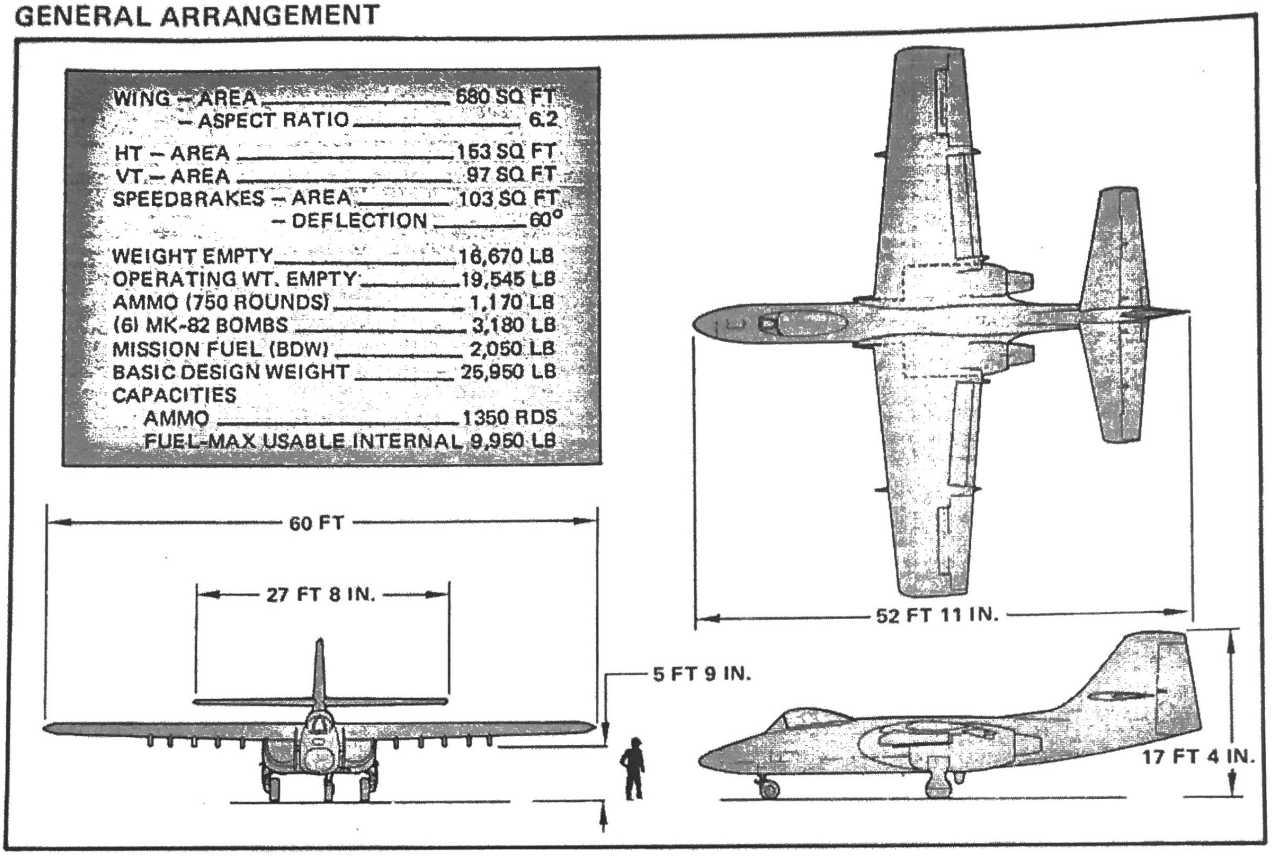
NORTHROP

NOR-72-200
10 OCTOBER 1972

GENERAL ARRANGEMENT

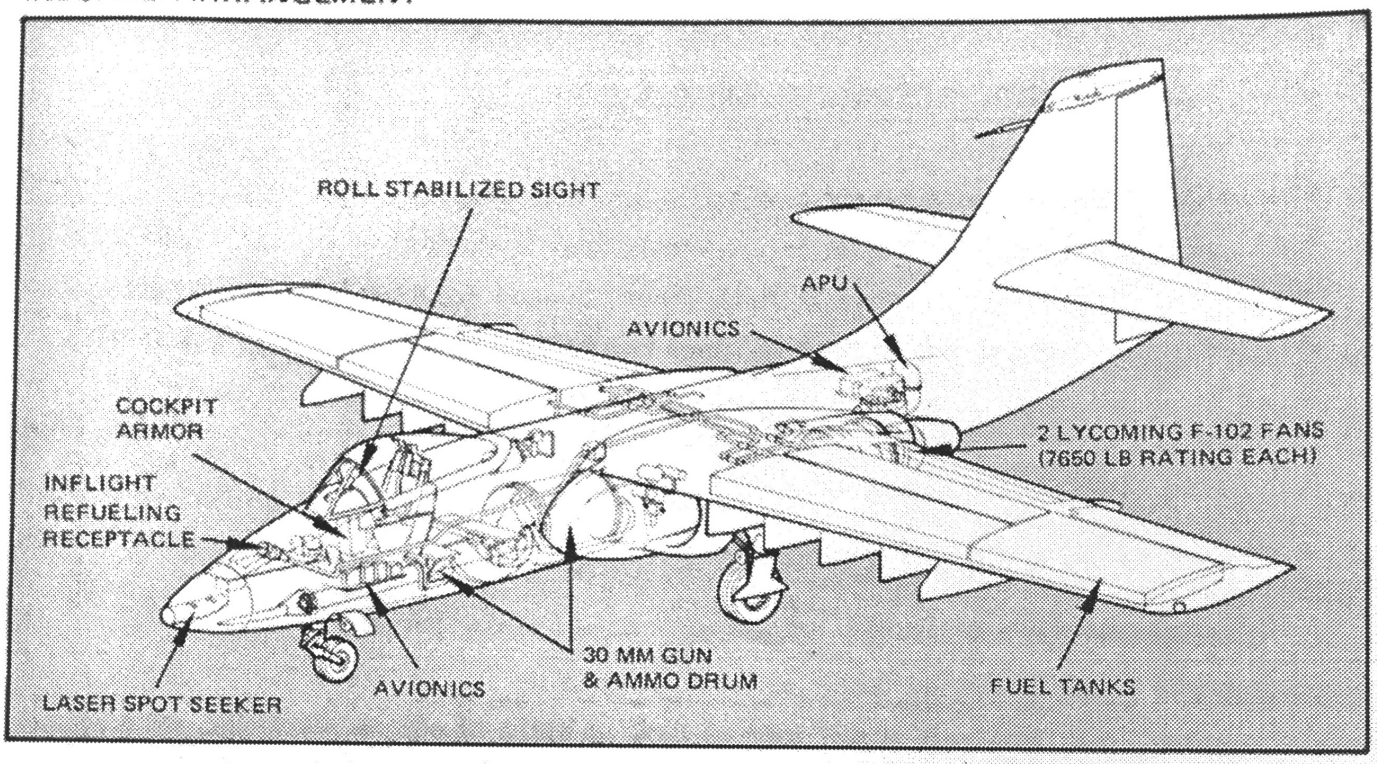
WING – AREA	680 SQ FT
– ASPECT RATIO	6.2
HT – AREA	153 SQ FT
VT – AREA	97 SQ FT
SPEEDBRAKES – AREA	103 SQ FT
– DEFLECTION	60°
WEIGHT EMPTY	16,670 LB
OPERATING WT. EMPTY	19,545 LB
AMMO (750 ROUNDS)	1,170 LB
(6) MK-82 BOMBS	3,180 LB
MISSION FUEL (BDW)	2,050 LB
BASIC DESIGN WEIGHT	25,950 LB
CAPACITIES	
AMMO	1350 RDS
FUEL-MAX USABLE INTERNAL	9,950 LB



PERFORMANCE SUMMARY (TROPICAL DAY MIL-STD-210A)

PERFORMANCE PARAMETERS	PI GOAL	NORTHROP A-9 CAPABILITY
BASIC DESIGN WEIGHT (BDW), LB	–	25,950
MAXIMUM TAKEOFF GROSS WEIGHT, LB	–	41,940
FORWARD AIRSTRIP WEIGHT, LB	–	26,800
MAX THRUST PER ENGINE, LB	–	7,650
FORWARD AIRSTRIP, SL (CPP GROUND RULES)		
TAKEOFF DISTANCE, FT	1,000	780
LANDING DISTANCE, FT	1,000	1,000
MAX SPEED, SL (NO STORES), KTAS	400	410
MAX RATE OF CLIMB (5,000 FT, 2 ENGINES), FPM	–	5,150
MANEUVERABILITY – FLAPS UP (5,000 FT)		
SUSTAINED G (MAX POWER) (275 KTAS)	3.5	4.0
INSTANTANEOUS G (IDLE POWER) (300 KTAS)	5.0	6.3
MANEUVERABILITY – 150 KTAS, ESCORT FLAPS (5,000 FT)		
SUSTAINED G (MAX POWER)	2.2	2.4
DESIGN LOAD FACTOR (BDW), G	7.33, -3	7.33, -3
MISSION RADIUS/LOITER WITH 18 MK-82'S	250 Mi/2 Hr	250 Mi/2 Hr

INBOARD ARRANGEMENT



NORTHROP A-9 PROTOTYPE FLIGHT TEST

A-9 AIRCRAFT DESCRIPTION

The prototype program has provided an exceptional opportunity to verify the basic design by flight test and to permit extended trade studies to improve the effectiveness and lower the cost of the production system. During the prototype program improvements were identified and incorporated in the production configuration to provide a better weapons system for the USAF.

GENERAL ARRANGEMENT

The A-9 production configuration is a single-place aircraft incorporating a straight wing with integrated wing root engine inlets and a conventional empennage as shown in Figure 1. The aircraft is powered by two Lycoming F102-LD-100 turbofan engines; each engine is rated at 7650 pounds static thrust with a "referee" nozzle. Basic design weight is 25, 950 pounds including 1170 pounds of ammunition (750 rounds), ten pylons, 3180 pounds of ordnance (6 MK-82 LDGP), and 2050 pounds of usable fuel.

The prototype wing has demonstrated excellent high lift and stall characteristics. The basic production and prototype airfoils are identical. The wing is a multi-spar construction to provide multiple redundancies to withstand severe battle damage. The upper surface of the production aircraft is constructed with 26 honeycomb panels that are easily removed/replaced to provide for low-cost initial assembly and maintenance access as well as battle damage repair. The single-slotted flaps and lift dumpers are constant chord and interchangeable from left to right. The ailerons are outboard of the flaps and are split to serve as speed brakes.

The horizontal tail consists of two common parts interchangeable from left to right that bolt onto each side of the vertical surface.

The nose landing gear is a lever-suspension type and the main landing gear is a cantilever suspension type, interchangeable between right and left sides. Nose and main gears have low pressure tires for good rough field capability. The landing gear emergency extension is free-fall with airstream assist. Emergency extensions were accomplished on the second test flight of both prototype aircraft.

CHARACTERISTICS TABLE

WING

Area Total	580 Ft^2
Aspect Ratio	6.2
Taper Ratio	0.57
Sweepback at 25% Chord	3°12'
Mean Aerodynamic Chord	118.5
Airfoil Section	64A (Mod) $\frac{t}{c}$ Outbd W.S. 73" = 15%
	$\frac{t}{c}$ root = 13.7%
Flap Area Total	63.4 Ft^2
Flap Movement	45° Down
Aileron Area Aft of Hinge (70%)	23.1 Ft^2 per Aileron
Aileron Movement Trailing Edge	30° Up to 30° Down
Lift Dumper Area Total	44 Ft^2
Lift Dumper Movement	60° Up

HORIZONTAL TAIL

Area Total	153 Ft^2
Aspect Ratio	5.0
Taper Ratio	0.5
Sweepback at 25% Chord	6° 51'
Airfoil Section	NACA 63A012
Elevator Area Aft of Hinge (70%)	42 Ft^2
Elevator Movement Trailing Edge	25° Up 15° Down
Incidence	0°
Horizontal Tail Length	250 Inches (2.1 MAC)
Horizontal Tail Volume	0.56

VERTICAL TAIL

Area Exposed	97 Ft^2
Aspect Ratio	0.9
Taper Ratio	0.38
Sweepback at 25% Chord	30° 50'
Airfoil Section	NACA 65-011 (Modified)
Rudder Area Aft of Hinge	29 Ft^2
Rudder Movement Trailing Edge	30° Right 30° Left
Vertical Tail Length	255 inches (0.35 b)
Vertical Tail Volume	0.059

SPEED BRAKES (SPLIT AILERONS)

Area Total Aft of Hinge (65%)	103 Ft^2
Movement	60° Up and Down

POWER PLANT

(2) Turbofans	F102-LD-100

WEIGHTS

Empty	16,670 pounds
Useful Load (Basic Design Weight)	9,275 pounds
Basic Design Weight	25,950 pounds
Maximum Takeoff Weight	41,940 pounds

USABLE FUEL

Internal	9,750 pounds

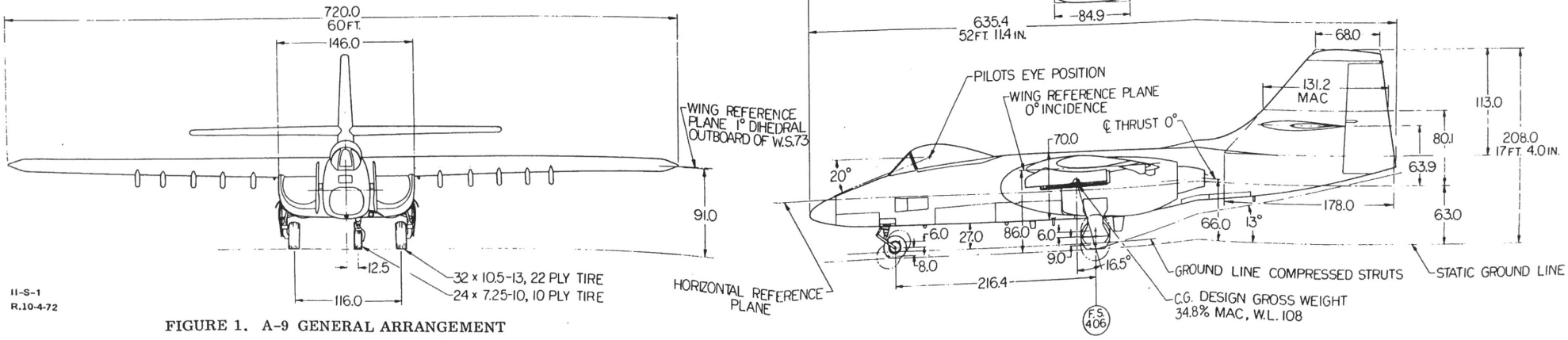


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FIGURE 1. A-9 GENERAL ARRANGEMENT

INTERNAL ARRANGEMENT

Major internal components are shown in the inboard profile, Figure 2. The aircraft nose contains the laser spot seeker, the nose gear, and the aerial refueling receptacle.

The cockpit is located well forward to provide 20 degrees over-the-nose visibility and 40 degrees over-the-side visibility with no shoulder movement, and 60 degrees with shoulder movement. The bubble canopy is aft hinged. The windshield also hinges aft to permit good maintenance access to the forward cockpit and instrument panel area. Immediately aft of the pilot's cockpit is an area that has been reserved for a second cockpit. This compartment is a feature included in the basic aircraft configuration inherent in the arrangement of the pilot's cockpit, the gun, and the ammunition drum. For the two-place aircraft, no change to the basic aircraft aerodynamic configuration is required, other than a two-place canopy.

High survivability is achieved by protection measures which include protected fuel tanks located in the wings outboard of the engine nacelles. The Air Force Flight Dynamics Laboratory has conducted gunfiring tests of the A-9 fuel system that have verified the basic design. These tests revealed that if a fuel fire occurred, it could slowly progress within the foam to adjacent bays. Further protection was achieved by introducing titanium firewalls between tanks to keep critical structural zones isolated from fuel fires.

The ground refueling adapter is on the right engine nacelle in a position to safely conduct "hot refueling" with both engines running.

ARMAMENT

The GAU-8 30mm gun is installed in the lower fuselage below the cockpit floor. Mounting to main structural elements minimizes deflections during firing. The gun is readily accessible and removable through large, hinged, quick-opening doors in the bottom of the fuselage.

The gun muzzle is located five feet aft of the nose of the aircraft and on the centerline to provide a minimum disturbance to the aircraft and pilot during gun firing. Yaw is eliminated by locating the firing barrel on the aircraft centerline. Gun gases are directed downward by a blast deflector to balance the pitching moment from the gun recoil. In addition, the gun gas is deflected well below the fuselage to eliminate gun gas ingestion by the engines. Flash from gun firing is also below the aircraft to minimize the impact of gun flash on the pilot's night vision.

The same blast deflector concept was used with the 20mm M-61 gun installation in the A-9 prototype. Flight test results confirm that there is no noticeable aircraft reaction nor gun gas ingestion during gun firing.

The 1350-round capacity ammunition drum is located aft of both the gun and the area reserved for the second cockpit. The drum attaches directly to the airframe by four bolts and is readily removed or serviced after removal of a large one-piece, easily-removed door in the lower fuselage Ammunition loading is accomplished through a smaller access door in the large access door.

Ten wing-mounted pylons are provided. The pylons are at eye level height and spaced for easy stores loading. Eight pylons have tandem store capacity, six pylons have triple ejection rack (TER) capability, and four pylons have capability for multiple ejection rack (MER), or triple ejection rack (TER), or missiles. One pylon per side can carry a gun pod and is plumbed for fuel. Pylons incorporate either the MAU-40 or MAU-50 racks, and are suitable for store-ejection, gravity release of iron bombs, aft dispensed bomblets or flares, and forward firing rockets.

AVIONICS

The majority of the normal communication, navigation, and maintenance condition reporting equipment is located in the aft fuselage near the electrical power supply and the antennas. The aft equipment is serviced through two large hinged doors in the bottom of the fuselage. The laser search/track set and air data computer equipment are installed in the forward fuselage with access through large quick-opening doors in the side of the fuselage at a convenient height for servicing. Equipment was selected for operational suitability and cost as well as reliability and maintainability. Complete provisions (Group A) for the radar homing and warning system and an ECM pod are included in the A-9. Space, weight, power and cooling are provided for the Infrared countermeasure.

The weapon delivery sight system provides a head-up display which presents a fixed reticle, a laser spot reticle, or a roll-stabilized reticle with a compensating release point cue to increase weapon delivery accuracy. Roll attitude bars are concentric with the reticle. The flight parameters of true airspeed, altitude and flight path dive angle are a digital display in the HUD.

CREW STATION

The cockpit is pressurized to permit high altitude cruise for best specific range and cruise above adverse weather, and to minimize pilot fatigue. The cockpit has armor protection from all aspects except the top. The windshield consists of three pieces with the front panel of armor glass. All three windshield panels have spall-suppression construction. An anti-icing system is incorporated in the front windshield panel and a windshield wiper is installed for rain removal.

Pilot and aircraft have high survivability achieved by protection measures which include titanium cockpit armor. The Air Force Flight Dynamics Laboratory has conducted gunfiring tests on the titanium cockpit armor that verified the basic design.

A zero-zero escape system, the Stanley Yankee seat, is installed. This is a cost effectiveness deviation from the ACES-II seat specified by the Proposal Instructions. Rationale for selection of the Yankee seat is described in Volume X, Trade/Cost Impact Study, "Alternative Escape Seat." Adequate space exists for installation of any of four alternative escape systems including ACES-II.

FLIGHT CONTROLS

Primary flight control is accomplished through conventional dual-powered elevators, dual-powered ailerons, and a single-powered rudder, all of which are equipped with artificial "feel" for normal control. A manual backup system is provided for primary flight controls and all control surfaces are both aerodynamically and mass balanced. Secondary flight controls include flaps, lift dumpers, and split-aileron speed brakes.

Flight controls are widely separated for survivability. The separation originates at the control stick and continues throughout the aircraft. All control system components in the cockpit area, except the rudder cable quadrant, are located above the armor floor for protection.

Each aileron surface is powered by two hydraulic actuators. An aileron-to-speed brake interconnect increases aileron effectiveness by causing both speed brakes to modulate to approximately one-third open when the control stick is moved to full travel in either direction. The horizontal stabilizer is fixed and has a dual-actuator, hydraulic-powered elevator with manual backup. The A-9 is provided with a single-actuator, hydraulic-powered rudder with manual backup. The A-9 prototype aircraft has been flown and landed in the manual backup mode.

Side force control permits the pilot to correct the aircraft flight path in azimuth without steering cross-coupling being introduced into the tracking tasks. For side force control the rudder is deflected to produce side force in the direction of the turn, while simultaneous asymmetric (left/right) speed brake deflections negate the yawing moment introduced by the rudder. Control of the asymmetric speed brake and rudder is accomplished automatically with normal manual rudder (rudder pedal) application by the pilot.

Split aileron speed brakes provide speed stabilization during the dive with small effect on stability or trim change. The speed brakes are variable-position, affording precise speed control with easily controllable changes.

The single-piece trailing edge flaps are electrically actuated. Hydraulically-actuated lift dumpers automatically extend during landing when the speed brake control is actuated, the weight of the aircraft on the gear, and throttles retarded.

PROPULSION

Lycoming F102 turbofan engines are located on each side of the fuselage under the wing in integral wing root nacelles. Engine air inlets are behind the leading edge of the wing with the ducts carried straight through to the engine. The engines are located aft of the rear spar below the trailing edge of the wing. Flight and wind tunnel tests have shown excellent recovery at severe aircraft attitudes and flight conditions. No engine operating difficulties including compressor surge, flameout, overtemp, or stall have been encountered under any flight conditions or engine transients. Weapon delivery dive recovery can be accomplished with confidence due to positive stability and good aircraft characteristics, accompanied by excellent thrust response with throttle.

Engine thrust line is aligned with the aircraft center of gravity to minimize power/trim changes. The right and left engine installations are interchangeable. Large quick-opening doors provide ready access to the engine and allow the engine to be lowered vertically downward for ease of removal. The entire engine installation is readily available for servicing at a convenient height without the use of maintenance stands.

Airframe-mounted gearboxes connect to each of the engines by a short driveshaft. An air turbine-starter/motor, hydraulic pump, and integrated drive generator are mounted on each gearbox. The gearbox and accessories are mounted on the airframe

to permit engine removal or installation without disconnecting the hydraulic and electric systems. The accessory drive may be powered by the Auxiliary Power Unit for ground checkout of systems. Access to the accessories has been significantly improved on the production aircraft by increasing the length of the bay, modifying the support structure, and rerouting the lines.

The non-augmented turbofan A-9 engines, with over 5 to 1 bypass ratio, inherently generate a low signature level at critical infrared frequencies. If further signature reductions becomes necessary, the basic engine design permits suppression with minimal weight and performance penalty. Analyses of baseline and suppressed engine signatures will be submitted in accordance with Amendment No. 8 to the Proposal Instructions. The Infrared Signature Data will be in Northrop Report NOR-72-331.

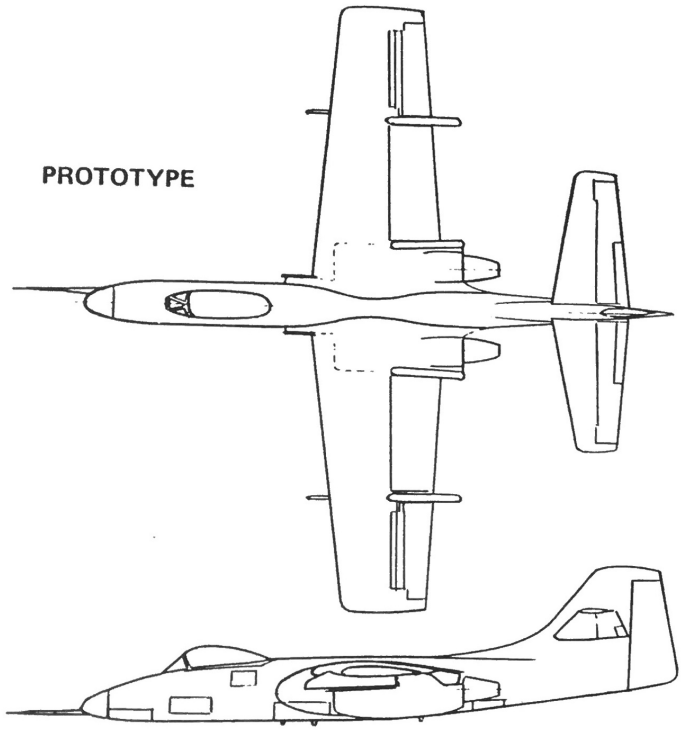
PRODUCTION/PROTOTYPE AIRCRAFT COMPARISON

The A-9 production aircraft has essentially the same basic external configuration as the prototype aircraft, as shown in Figure 3. Minor differences consist of a slight change in the wing aspect ratio, elimination of dihedral in the horizontal tail, shortening of the inlet and fuselage, increased ground clearance at the aft fuselage, and simplified high lift system. Wind tunnel tests and analysis have indicated that the flight characteristics are not changed with the exception of the expected reduction in maximum lift with flaps down, which is permissible because takeoff and landing requirements were exceeded with the prototype high lift systems.

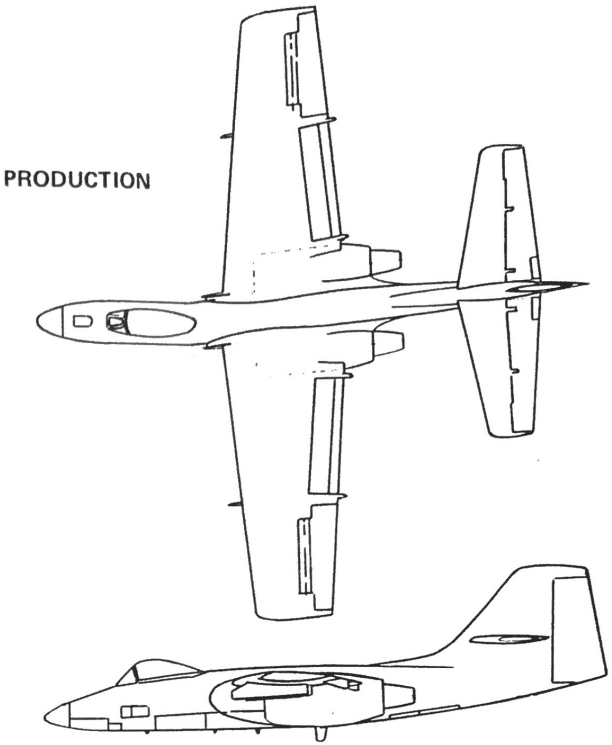
Internal changes were incorporated to accommodate production systems such as the gun, landing gear, and avionics. The structure was studied in detail to incorporate field breaks and to minimize production cost by using automated equipment. All airplane systems were reviewed with the object of simplification for better maintainability and lower cost.

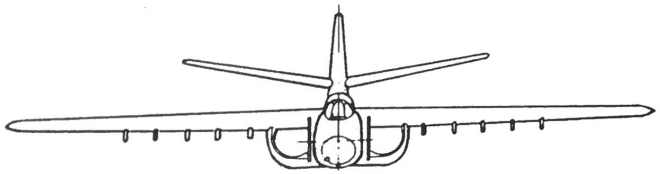
NORTHROP Aircraft Division

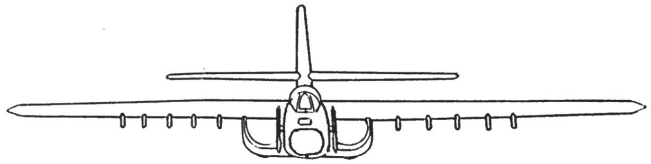
PROTOTYPE



PRODUCTION







		PROTOTYPE	PRODUCTION	CHANGE RATIONALE
WING AREA	SQ FT	580	580	NO CHANGE
WING SPAN	FT	58	60	IMPROVE SINGLE-ENGINE RATE OF CLIMB
WING DIHEDRAL		0°	1°	IMPROVE FUEL DRAINAGE TO THE PUMP
HIGH LIFT SYSTEM		(SEE NOTE)		PROTOTYPE EXCEEDED REQUIREMENTS – COST AND WEIGHT SAVING
SPEED BRAKE AREA	SQ FT	103	103	NO CHANGE
HORIZONTAL TAIL AREA	SQ FT	153	153	NO CHANGE
HORIZONTAL TAIL DIHEDRAL		10°	0°	DIHEDRAL NOT REQUIRED – WEIGHT SAVING
VERTICAL TAIL AREA	SQ FT	98	97	NEGLIGIBLE CHANGE
LENGTH		53.5	52.9	WEIGHT SAVING
FUSELAGE HEIGHT ABOVE GROUND		30	33	INCREASE MAINTENANCE ACCESS AND TAKEOFF CLEARANCE
LANDING GEAR LOCATION		FS 399	FS 406	CG MOVED AFT
ENGINE INLET LIP LOCATION		FS 351	FS 369	DRAG AND WEIGHT SAVING – IMPROVE AMMUNITION DRUM REMOVAL

NOTE: FLAPS SIMPLIFIED AND CHORD REDUCED
LIFT DUMPERS SIMPLIFIED, AREA REDUCED AND ACTUATORS REDUCED FROM 8 TO 4.