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ST. LOUIS, MO.

ENGINEERING DEPARTMENT

XF-85

PARASITE FIGHTER

DESIGN & DEVELOPMENT SUMMARY

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II. DESIGN DESCRIPTION (CONTINUED)

E. Wingfold (Cont'd)

loads in flight. Uniform folding of both wing panels in the air is insured by a single floating actuator operating an equalized mechanism. The wing fold lock pins are operated by a similar mechanism. The wing fold actuator circuit is inoperative unless the skyhook is extended for a hook-on to the trapeze. Both of the above actuators are the ball bearing screw electrical type.

F. Controls

The aileron controls are a conventional manual push pull type with balance and trim tabs. The elevator and rudder controls are connected to an "X" arrangement through a differential mechanism which operates the upper Vee surfaces as on any conventional vee tail surfaces. The lower control surfaces operate as though the torque shaft of the upper left ruddervator and torque shaft of the lower right ruddervator are common and likewise for upper right ruddervator and lower left ruddervator. The upper ruddervators have balance and trim tabs, the trim tabs on left and right hand ruddervators operate in the same direction for elevator trim and in opposite directions for rudder trim. All trim tab switches are located on the control stick grip.

The speed brake is a hoe type which extends under the aft fuselage. This type was used as the drag load acts directly through the hinge and permits the use of a small ball bearing screw electrical actuator. The speed brake is manually controlled by a momentary toggle switch located on the forward side of the throttle grip to provide accurate speed control especially during

II. DESIGN DESCRIPTION (CONTINUED)

F. Controls (Cont'd)

during retrieving operations. The speed brake is automatically opened by a Mach switch which limits the speed to the maximum controllable speed.

Nose flaps extend over the outer portion of the wing panels and are extended automatically by a pressure switch at speeds below 185 MPH to improve the lateral control. A manual over-ride switch was installed for flight tests. The flaps are actuated by a single ball bearing screw electrical floating actuator and equalizing mechanism.

G. Armament

Gun mounts, blast tubes, electrical wiring, pneumatic gun chargers and ammunition container supports have been provided for ready installation of four .50 caliber M-3 machine guns. Provisions are made for 300 rounds of ammunition per gun. The guns and ammunition containers are accessible while the parasite is stowed in the bomb bay of a B-36 or when partially stowed during tests in the B-29. Gun heater wiring has been installed. An electrical safety switch prevents inadvertent firing of the guns when the skyhook is extended during the approach or stowing of the parasite in the parent aircraft.

A flight test photo panel was installed in the ammunition compartment during the flight test program. Also fire extinguishers were installed in the gun space during flight tests.

II. DESIGN DESCRIPTION (CONTINUED)

G. Armament (Cont'd)

A mount and wiring is provided in the fuselage nose ring for a gun camera.

A Cornelius air compressor not only provides pressure for the pneumatic gun chargers, but also maintains a pressure reserve in three spherical accumulators for emergency extension of the skyhook by a pneumatic motor in the event of an electrical power failure. Check valves are provided so that all three accumulators may provide air pressure for the pneumatic motor but only one of the accumulators may be bled by the gun chargers.

H. Cockpit

During the early phase of engineering, the customer agreed to the use of a simple system of cabin pressurization by ram air which is sufficient to maintain the 2.75 PSI differential at speeds above the cruising speed. However, it was found that it was still necessary to cool the cabin air. Later the AMC insisted on the cabin pressurization system meeting the latest specification. The present system bleeds air from the engine compressor through a heat exchanger and cooling turbine which drives a fan blowing cooling air through the heat exchanger. The cabin air then passes through an automatic mixing valve which regulates the mixture of cooled pressurized air with hot pressurized air received direct from the compressor and then to the cockpit by way of canopy defrosting tubes or foot warmer which may be selected by the pilot. A pressure regulator and pressure relief valve are located under screens in the floor forward of the rudder pedals. The

II. DESIGN DESCRIPTION (CONTINUED)

H. Cockpit (Cont'd)

pressure differential 2.75 PSI for normal flight or 1.0 PSI for combat may be selected by the pilot. An emergency air control is provided which opens a ram air scoop directly to the cockpit, opens the cabin pressure relief valve and closes a shut-off valve in the pressure line from the engine.

[A jettisonable seat with a type T-4E ejector gun is provided and has been fired on the ground in the No. 1 airplane with successful results. The seat jettisoning tracks are parallel to the seat back which is inclined 33 degrees back from the vertical. This large angle should cause less seat tumbling in high speed flight than for the conventional seat angle. However, the primary reason for the large angle was to reduce the cabin depth and consequently the frontal area to a minimum since the seat is necessarily located over the engine due to the overall length limitation of the airplane. The seat position is not adjustable due to space limitations however, the rudder pedals are adjustable.]

The volume of the cockpit is approximately 26 cubic feet whereas the volume of the cockpit in an average single place fighter exceeds 90 cubic feet.

Armor protection is provided for the pilot's head and back for gunfire from the rear.

I. Instruments

The standard instruments were held to a minimum due to the limited avail-

II. DESIGN DESCRIPTION (CONTINUED)

I. Instruments (Cont'd)

able space. Instruments are mounted on the aft face of the skyhook well which extends aft between the rudder pedals and on brackets projecting down from the windshield over the pilot's legs. Only electrical instruments are attached to the windshield since these instruments must be jettisoned with the canopy and windshield by breaking a gang electrical connector to provide foot clearance when jettisoning the seat. The following instruments are provided except as replaced for flight test instrumentation: radar beacon indicator, attitude gyro indicator, tachometer, turbine-out temperature gauge, single bearing temperature gauge with selector switch for checking each main bearing temperature, standby compass, airspeed indicator, airplane altimeter, cabin altimeter, accelerometer, gyro stabilized compass, fuel quantity gauge for main tank only with low level warning light, fuel pressure gauge with bands to indicate failure of the main fuel high pressure pump, emergency engine high pressure pump, engine driven booster pump, or submerged electrical booster pump and low fuel pressure warning light, oil pressure gauge and Mach number switch.

J. Radio Installation

An AN/ARC-5 receiver and transmitter was installed with the antenna located in the left vertical plastic fin.

Provisions were made for the installation of an AN/APN-61 radar beacon receiver. A homing device for locating the parent aircraft is a "must" as the XF-85

II. DESIGN DESCRIPTION (CONTINUED)

J. Radio Installation (Cont'd)

and chase F-80 has lost the parent aircraft several times even though flying under ideal conditions with constant radio contact, over familiar territory in clear weather.

K. Electrical Features

The electrical system provides power for all actuations to avoid the weight and space for an additional system such as hydraulic and also the fire hazard associated with hydraulic fluid. However, since a pneumatic system was required for the automatic gun chargers, the pneumatic system was expanded by the addition of two air accumulators for the supply of an air motor for emergency extension of the skyhook during retrieving in the event of a generator failure.

A small battery was provided for instruments, radio and small electrical equipment.

Due to limited instrument space, no voltmeter, ammeter or generator switch was provided, but a green light located on the instrument panel burns when the generator is functioning properly.

Two external power receptacles were provided per the customer's request. One receptacle is located in the skyhook well for external power supply when stowed in the parent aircraft or during launching operations. Another receptacle is located in the nose ring and may be used for ground power supply

II. DESIGN DESCRIPTION (CONTINUED)

K. Electrical Features (Cont'd)

when cycling the skyhook or ground engine starts when two standard power carts are required.

Relays, inverters or other ignition sources are sealed or enclosed in screened or explosion proof containers.

L. Fuel System

The standard fuel system consists of a 115 gallon self-sealing horseshoe shaped tank located under the compressor section of the engine from which fuel is pumped by an electric submerged centrifugal booster pump to an engine driven booster pump and then through a micronic filter to the main or emergency high pressure pumps and engine fuel governor. The engine has been started by windmilling at 165 to 200 MPH at 20,000 feet altitude without the electric booster pump in operation. The above main fuel tank will supply the engine for a combat mission of 20 minutes full thrust and 32 minutes cruising at 40,000 feet altitude or maximum endurance of 77 minutes. Air refueling equipment was designed and purchased to provide automatic refueling and shut-off while the parasite is stowed in the parent aircraft. All fuel filler necks are also equipped with spring loaded valves which shut off the neck before the refueling connection is broken so as to avoid fuel vapor in the bomb bay. The wall of the fuel cell nearest the engine compressor is covered with heat radiant material in addition to the cooling by a constant stream

II. DESIGN DESCRIPTION (CONTINUED)

L. Fuel System (Cont'd)

of air flowing between the compressor and fuel tank. Checks on ground engine runs under summer desert conditions showed temperatures on the inner wall of the fuel tank varying from ambient temperature to 10 degrees below ambient.

An auxiliary fuel system consists of an integral 30 gallon fuel cell in each outer wing panel and a 25 gallon bladder tank in the empty case and link compartment from which fuel is transferred to the main fuel cell by nitrogen pressure. The bladder tank has not been used due to the fire hazard of fuel under pressure below the engine tail pipe. As soon as the engine is started and advanced to the generator cut-in RPM, the generator circuit opens a solenoid operated valve releasing nitrogen through a pressure regulator into the auxiliary tanks at 3.5 PSI pressure which transfers the fuel to the top of the main tank except if it is stopped by a float check valve in the main tank when it is full. A pressure relief valve is provided in each auxiliary fuel cell for protection. By the above system the main fuel cell is automatically kept filled until all auxiliary cells are emptied and purged with nitrogen. Also the main tank is purged until the nitrogen is exhausted. Idling of the engine at any time closes the nitrogen shut-off valve. Removable vents are provided for refueling the wing cells which are fueled with wings folded to vertical position which is normal for the stowed condition in a B-36. Switches are provided in the experimental airplanes to regulate the fuel transfer for center of gravity control during flight tests.

II. DESIGN DESCRIPTION (CONTINUED)

M. Fire Extinguishing System

An overheat and fire detection system is installed. Also a fire extinguishing system is installed in the stripped experimental airplanes with rings for spraying CO_2 in the accessory section and also around the engine burner section.

III Proof Test Program

Functional tests were made on the major mechanisms of the No. 2 airplane while the mechanisms were subjected to proof loads. Major mechanisms tested without any difficulty or failure were: skyhook head mechanism, skyhook extension, wingfold, canopy jettisoning mechanism, seat ejection with actual catapult gun, leading edge flaps, speed brakes and primary control system. Also all components of the airplane including engine operation, fuel transfer system, radio and electrical systems were checked during captive flight at 200 MPH at 20,000 feet altitude before any free flight was attempted on either experimental airplane

IV. TRAPEZE DESIGN

A working full scale mock-up was first made of a proposed B-36 trapeze for handling the full scale XF-85 mock-up. This trapeze was based on the principal used successfully by biplane trainers launched and retrieved by the airship, Akron. The parasite was supported by a skyhook located above and two inches forward of it's center of gravity. Stabilizing clamps with motion like ice tongs closed about the nose of the fuselage to steady the parasite during stowing. In the absence of better information, the trapeze was designed to lower the parasite to a position of about 6-1/2 feet between the parasite canopy and B-36 fuselage lower contour line at bomb bay No. 1. A cylindrical decompression chamber for four crew members was also mocked-up just forward of bomb bay No. 1.

The decision was made to install a trapeze in a B-29 instead of a B-36 for flight testing of the XF-85 due to the unavailability of a B-36 and to reduce the cost of the flight test program. Meanwhile, after the design of a B-29 trapeze was in progress, a customer pilot and a contractor pilot alternately flew a P-80 under bomb bay No. 2 of a B-29 and found that the turbulence prevented flying nearer than nine feet to the bomber. Therefore, the trapeze design was altered by moving the arresting bar to position 10-1/2 feet below the B-29. However the P-80 flights indicated reasonable ease of synchronizing speeds of the parent and parasite aircraft so only about 14 inches travel was left in the shock absorbing mechanism. [However the long rigid extension of the trapeze required a double hydraulic extension mechanism of very heavy structure

IV. TRAPEZE DESIGN (CONTINUED)

bearing loading far exceeded that normally used on bronze journal inserts. Also most joints rotated about 180 to 270 degrees and reversed rotation repeatedly. This pressure between bearing surfaces and rotation reversal wiped the lubricate from the loaded surfaces in a few cycles and caused galling even though hard chrome plated pins were used. The final solution of this problem has given good service without any galling throughout approximately 500 trapeze cycles on the ground and in the air during the flight test program. The final solution simply consists of hard chrome plated steel pins operating in honed steel journals treated with Aquadag at 250 degrees Fahrenheit temperature and lubricated at reasonable intervals with Oildag which is colloidal graphite suspended in oil. The arresting bar deflected slightly under the parasite's weight and therefore it was necessary to grind a slightly spherical surface on the Graphmo steel bearing split caps at each end supporting journal to avoid binding. Some Graphmo steel caps were replaced due to cracking prior to obtaining a flat seat but no bearing galling was experienced.

V. XF-85 HANDLING DOLLY

A handling dolly was designed with the following features:

(a) Open end construction to facilitate installation and removal of the engine mounted on a M-22 bomb hoist.

(b) All non-magnetic materials used to allow compass calibration while airplane is mounted on dolly.

(c) Provision for securely fastening airplane to dolly during ground engine operation.

(d) Easy access to all doors, inspection plates, hand holes and areas requiring servicing while airplane is supported on dolly at its jack points.

(e) Provide means of lowering parasite into loading pit for trapeze.

VI. XF-85 LOADING PIT

A loading pit was designed and constructed at Muroc Air Force Base to permit complete cycling of the trapeze with the XF-85 attached as well as a means of loading and unloading the parasite from the B-29. The dimensions of the pit are approximately 24-1/2 feet wide, 17-1/2 feet deep for a distance of 26-1/2 feet with a slope at one end for lowering the XF-85 giving an overall length at the surface of 92 feet.

VII. PREPARATION FOR FREE FLIGHT

In view of frequent delays in XF-85 Flight Test Program, the following is a summary of factors each of which have at some time caused delays and all of which must be satisfied simultaneously in order to schedule a free flight:

(a) Lake bed must be dry to support heavy emergency field equipment without leaving ruts in lake surface.

(b) Atmosphere must be almost totally clear up to operational altitude of 20,000 feet.

(c) Air must be free of turbulence at altitudes near 20,000 feet.

(d) Surface winds must not exceed 25 MPH and be free of gusts to permit reasonably safe emergency landings.

(e) All seven members of parent and parasite aircraft crews must be free of head colds to avoid severe discomfort at operational altitude without pressurization.

(f) XF-85 must be operable.

(g) EB-29B must be operable and capable of developing maximum power on all engines to maintain satisfactory speed for hook-on with trapeze extended.

(h) Trapeze components and power supply must function properly.

VII. PREPARATION FOR FREE FLIGHT (CONTINUED)

(i) Chase aircraft must be available not clashing with other test program requirements or aircraft service lay-ups.

(j) Air Force pilot must be available for chase aircraft and usually are very cooperative.

(k) Area must be cleared of other test flights or bombing missions on lake.

(l) Above items (b), (c), (e), (g), (h) and (k) must be satisfied for all practice F-80 hook-on flights which are required not more than a couple of days prior to any scheduled free flight to restore pilot proficiency.

VIII. DESIGN CHARACTERISTICS

A. Captive Flight Characteristics

The parasite was held rigidly in captive flight when hooked on the arresting bar and with the nose stabilizer closed. The parasite was also controllable when hanging as a pendulum but with the nose stabilizer raised, except for high power settings of the XF-85 when it was necessary to apply forward stick and maintain the airplane within small angles of roll, yaw, and pitch. These characteristics were also true for the free flight model when thrust was simulated. Therefore a new concept for attachment will be recommended later in this report.

B. Air Starts

The jet engine was started with or without the electric fuel booster pump at 165 to 200 MPH at 20,000 feet altitude. The jet engine windmilled at 1800 RPM at the above air speeds and required no starter current to boost the air starts. The small battery, Willard Type BB-206/?, was sufficient to supply the ignition, radio and instruments for air starts. Air starts seemed to be somewhat quicker and cooler at the lower speeds.

C. Launching Features

The parasite was released from the up latches and extended into the airstream beneath the B-29 by a hydraulic sequence. The engine starts were then made prior to opening and raising the nose stabilizer. The parasite was launched by the XF-85 pilot by pulling a control which unlatched and tumbled the skyhook head to release the airplane from the arresting bar.