F-20 flightgear simulation

Utility manual

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Aircraft

The simulation of the F-20 on flightgear depicts three variants, the prototypes as built and two would be versions A and C.

Commercial documents (cockpit mockups, information leaflets) indicate that the F-20 was to feature as standard features from the onset a ALR-56 radar warning receiver, conformal counter-measure dispensers and an emergency tail hook and a slightly enlarged nose section to integrate a larger antenna for the radar. All those items have not been seen on the prototypes as built.

The A version depicted in the simulator introduces those items while retaining the shape of the basic F-20 for aesthetic reasons

Also in the plans of Northrop due to demand of certain customers was the introduction of a self contained starting method different from the hazardous and maintenance intensive (if light and reliable) hydrazine cartridge starter. This was to take the form of a Jet Fuel Starter.

An advanced gun was to take the place of the ageing Pontiac M-39 cannons, dating back to the F-86 era, and by F-20 entry into service, becoming hard to procure.

Liberally a “what if” variant has been added, the C variant, introducing an electrically started jet fuel starter (standard air force starters use hydraulic accumulators to start), an autopilot, and support for ECM and electro-optical pods. The cannon has not been introduced as its actual shape is an unknown (event though it was described in some detail in the now defunct f20.com website).

This C variant also replaces the original F404-GE-100A engine by a derivative of the F404-GE-400 or even better the RM-12 as installed on the Saab Gripen, the KAI-T-50 or the HAL Tejas.

Engine

Engine controls

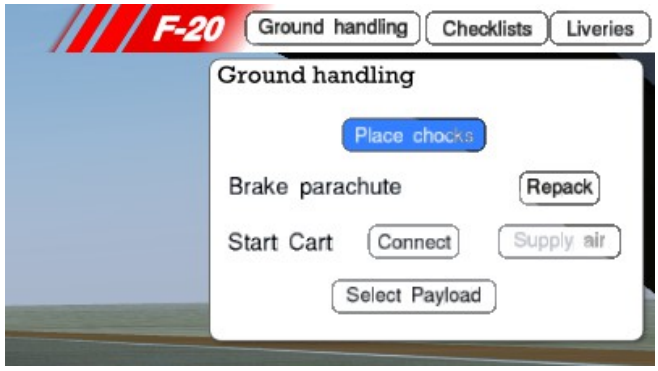
To be completed

Engine start system

Start cart

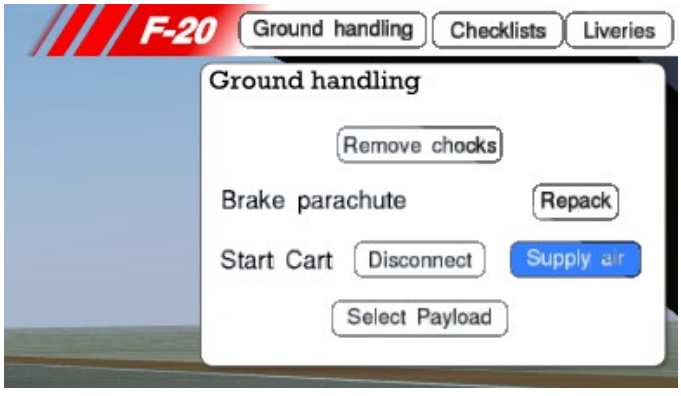
The standard method for starting the F-404 on pre-C variants is the use of an external start cart.

The aircraft needs to be on chocks to prevent it from moving on its own due to idle residual thrust.



The start cart is then connected to the aircraft automatically powering the electrical system.

To initiate the start procedure air is sent from the cart into the Air Turbine Starter, via a start control valve. For this to be possible the engine needs to be shutdown



Positive indication of connection is available on the indicator panel

The engine will then accelerate to 25 percent N2 (high pressure compressor rpm) and the throttle can be moved in the idle detent (**Shift-q** with the throttle at idle) to start admitting fuel. The start sequence will continue until positive engine start by which time the start control valve will automatically shut off and the start cart will stop supplying compressed air.

Cartridge system

The F-20 was basically equipped with a hydrazine cartridge system for in-flight engine start in case altitude did not allow for a windmill airstart. Hydrazine, a mono-propellant fuel, was decomposed over a catalyst and hot gases were sent to the air turbine starter.

This system needs DC power to be activated so at least the main battery should be on for this purpose.

Northrop advertised the cartridge system as a way to achieve quick scramble times without ground support. This may be dubious since hydrazine is a serious health hazard and regular use of the system would have implied manipulating the product a lot.

In order to start the engine just energize the DC bus and depress the cartridge starter button

As for the start cart procedure wait for 20% N2 before pushing the throttle past the stop detent (**Shift-q** with the throttle at idle).

Bear in mind that hydrazine supply is limited to the contents of the cartridge and so is cranking time and the number of starts possible through this method,

Not that connecting the start cart air supply will automatically shut the cartridge starter down

Windmill start

In flight, in case of engine shutdown, it can be restarted by keeping N2 above 25% and moving the throttle past the stop detent into idle detent (**Shift-q**). For this to happen you will need forward airspeed.

If airspeed is insufficient to maintain 25%, you will need to initiate a dive in order to regain speed or initiate a cartridge start if altitude is insufficient to do so,

Jet Fuel Starter

The C variant introduces another self contained start method in the form of a Jet Fuel Starter. This is a small, electrically started, jet fuel fed, gas turbine providing compressed air to the Air Turbine Starter for engine start.

It as a fairly unlimited operation time (even though at the expense of fuel consumption), but is restricted to lower airspeeds and altitudes for operation, as it is intended for ground starts mainly.

The introduction of the JFS also introduces a manual control to the start control valve (SCV) to crank the engine. This alters the start procedure because the valve needs also to be manually selected for start cart.

The start procedure becomes :

- Provide DC power to the aircraft (e.g. main battery)
- Start the JFS with the JFS start switch or connect the start cart air supply as described previously
- Wait for the JFS ready light to illuminate if JFS is needed
- Use the crank switch to start the SCV
- Wait for 20% N2 before pushing the throttle past the stop detent (**Shift-q** with the throttle at idle).

The SCV will automatically shut when engine is started and the JFS will be stopped after 10 minutes operation, even though it is recommended to stop it after engine start to avoid unnecessary fuel consumption and possible damage to the intake flap if flying too fast.

Shutdown procedure

The engine can be shutdown following :

- By placing the throttle in the stop detent (Shift-q with the throttle at idle)
- By using the guarded fuel cutoff switch
- A failure

Fuel system

To be completed

Jettison system

To be completed

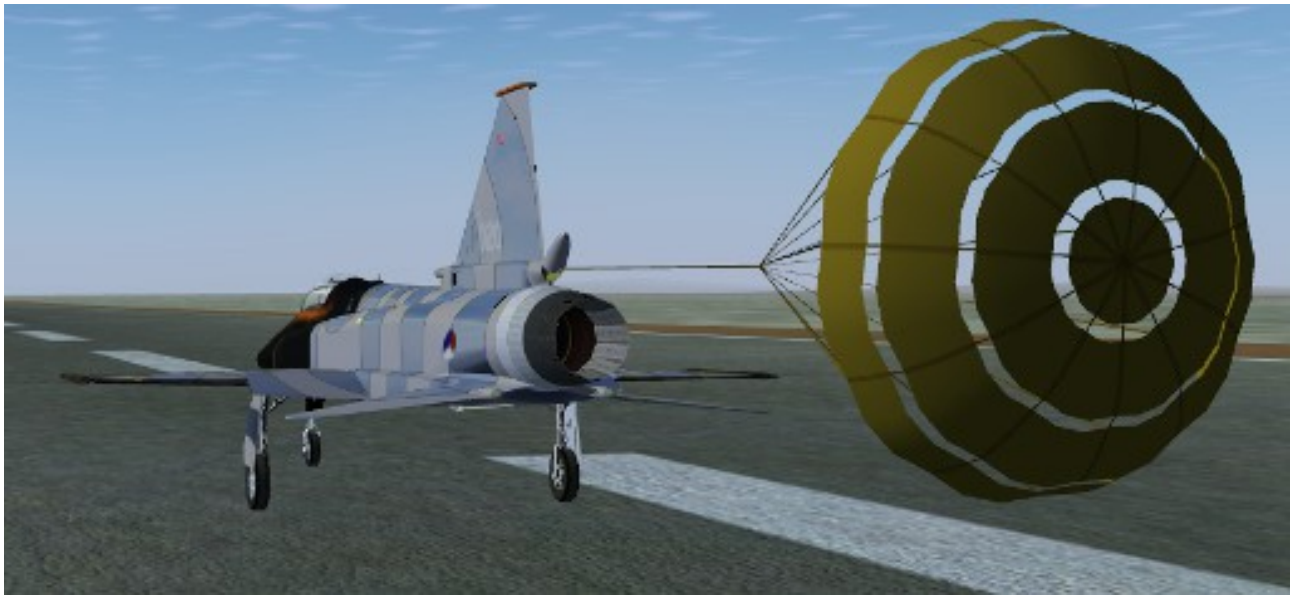
Electrical system

To be completed

Landing gear system

To be completed

Drag chute system



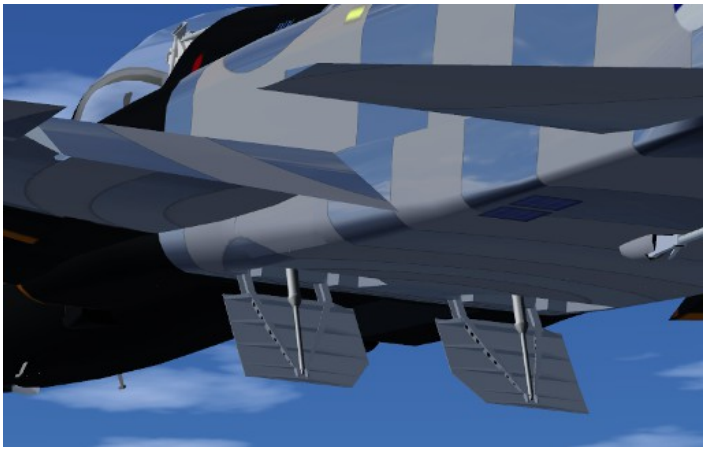
The drag chute is installed in all aircaft and is operated by a 3 position handle in the upper left part of the front panel.

Pulling once the handle (**o** key or click on the handle) will deploy the drag chute. Note that deploying the chute, or flying with a deployed chute above 400 knots (to be adjusted) will tear it away.

Pulling twice the handle will cut its lines (for instance to continue taxiing).

Once the chute is spent it can be repacked in the aircraft only on the ground by use of the ground handling menu.

Speed brake system



The F-20 has two hydraulically actuated, electrically signaled speed brakes.

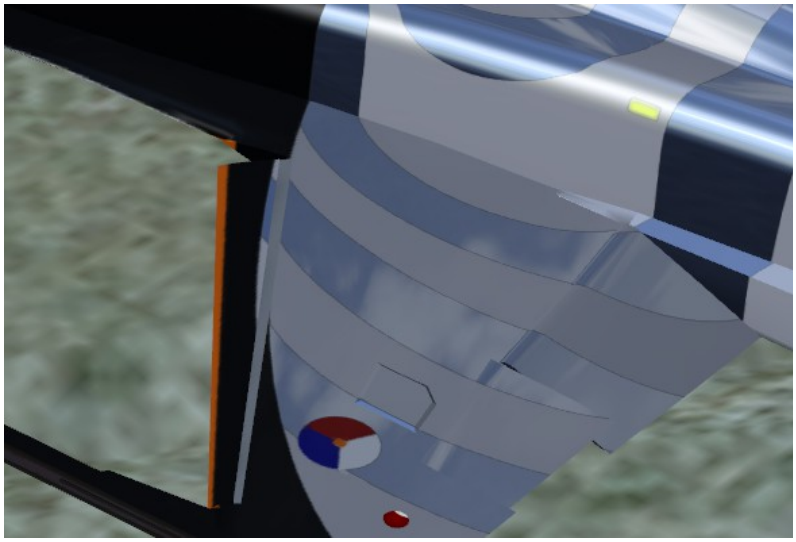
They are powered by the utility hydraulic system and the essential DC bus.

The controls for the speed brakes are on the throttle in the form of a spring loaded two way switch. Pulling the switch aft extends the speed brakes (**e** key) pushing it forward retracts them (**r** key).

The speed brakes can be left at any intermediate position.

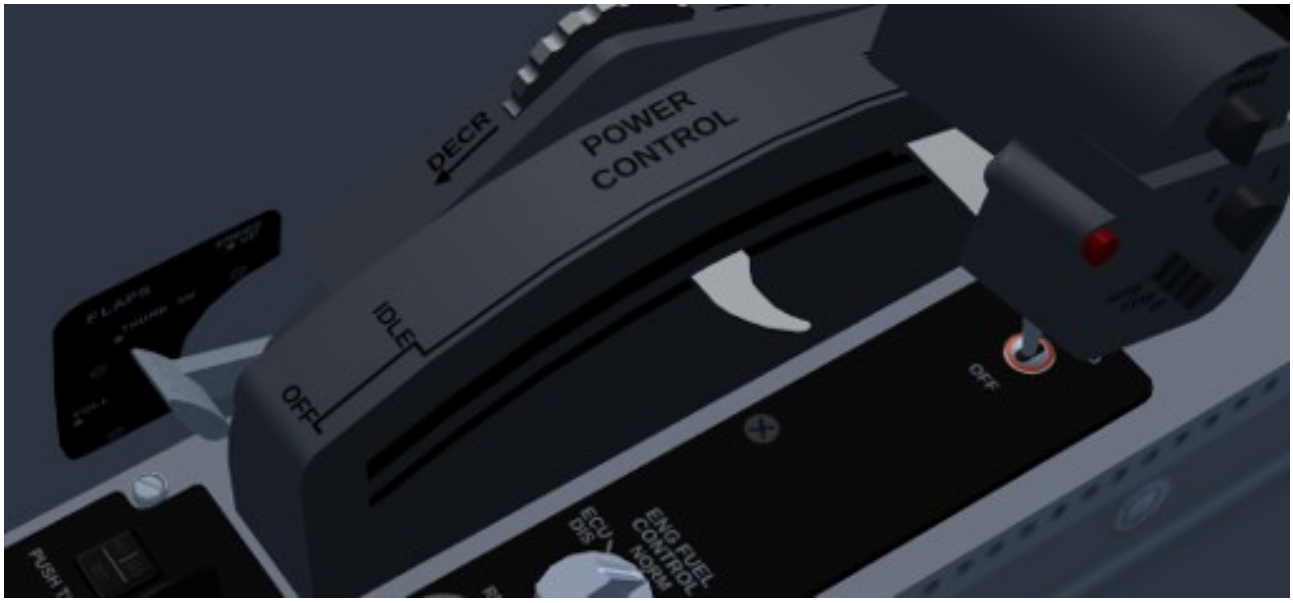
Full extension is 45º, restricted to 35º when a centerline store is carried

Wing flap system



The F-20 flap system uses leading edge and trailing edge flaps for three functions :

- High lift for take off and landing
- Automatic maneuver flaps
- Provide the most adapted configuration for long range and loiter flights



The flap handle located besides the throttle allows the selection of three modes (throught the use of the mousewheel on the lever):

- Forced full
- Thumb switch controls
- Emergency Up

The default mode is thumb switch control which permits a selection (keys **d** and **f**)of three submodes

- Auto

- Fixed
- Up

The auto schedule will adapt high lift system position according to angle of attack, speed, altitude and gear position to maintain optimum maneuvering flight conditions and control. In this mode, gear extension results in full flaps application

Fixed mode places the flaps in a position intended to maximize the lift to drag ratio

The up mode allows flying the aircraft without parasitic motion related to the automatic schedule, even though those are minimized by the flight control system

To be completed

Flight control system

The F-20 is equipped with a mechanical flight control system supplemented by a high authority control augmentation system (CAS).

Primary control is achieved by the use of conventional ailerons, all moving stabilizer in pitch only and rudder all hydraulically actuated.

The CAS actually provides almost fly by wire behavior while retaining high authority in case of system failure. The CAS provides the following augmentation

Roll

The roll rate is directly commanded as a function of stick deflection, doubled with aileron-rudder connection to prevent roll coupling phenomena

Yaw

The yaw law besides the ARI also provides limits in lateral load factor as well as yaw damper function and null side-slip with the rudder centered

Pitch

The pitch control law with the gear up is a g-demand law with a mild limit of angle of attack at low speed and pitch stabilization throughout. It should be noted that for most of its CG envelope the F-20 is pitch unstable without the CAS to promote maneuverability.

The g-demand law ensures that almost no trim is needed in this condition as releasing the stick will put the aircraft in a 1-g condition without roll, regardless of thrust excursions.

The aircraft can be controlled up to 30 degrees AOA.

For landing, once the landing gear is down, the CAS will bias pitch to increase speed stability. The aircraft needs to be trimmed for speed as the throttle will be used to control the flight path angle

To be completed

Communication, navigation, IFF

To be completed

Inertial navigation system

To be completed

Environment control system

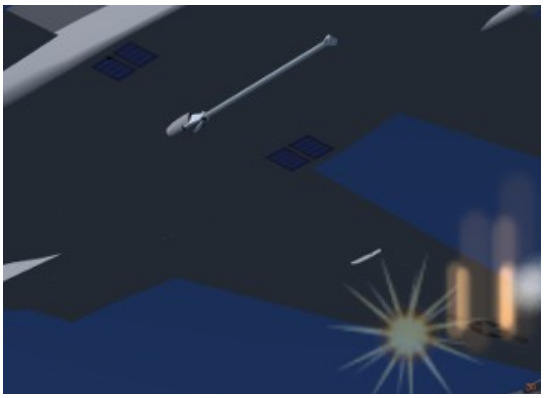
To be completed

Anti-icing system

To be completed

Counter-measures

Expandables



The F-20A carries 4 ALE-40 counter measure dispensers, the F-20 carries two of them, Each dispenser carries 30 rounds which can be either chaff or flares.

The selection of countermeasures to be launched is achieved on the corresponding control panel on the left console.

To be completed

In order to operate the CMDS (countermeasure dispenser system), first select a mode on the corresponding knob (mousewheel) and depress the red throttle launch button (**ctrl-f**)

Radar Warning Reiceiver

To be completed

External pod

To be completed

Anciliaries

To be completed

Keyboard controls summary

Shift-q.....toggle engine idle detent
f.....flaps thumbswitch forward
d.....flaps thumbswitch back
e.....extend speedbrakes
r.....retract speedbrakes
Ctrl-f.....release expendable countermeasures
g.....toggle landing gear