DRAFT

Сухой Су-26М

Flight Manual

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1 Disclaimer

2 General description

The Su-26M is a single seat unlimited aerobatics aircraft designed by the Sukhoi design bureau in early eighties to provide a decisive edge to soviet pilots.

It is power by a radial Venedyev M14-P radial reciprocating engine, with a 360Hp output, moving either a two bladed, paddle-like propeller, or, on later models, a 3 blade constant speed MT propeller.

The main structural feature is a carbon fiber-epoxy wing (CFRP) weighing 85Kg (180 pounds) and stressed to 24g ultimate load. This was the result of aggressive maneuvering required by competition flying over-stressing soviet-union's previous Yakovlev aerobatics planes.

Also innovative is the extensive use of titanium for a general aviation aircraft. The landing gear is a single titanium arch acting as the strut and the spring. Exhaust collectors and engine diaphragm-like gills are also made of this heat-resistant and relatively light-weight material.

The fuselage itself is more conventional with a truss of high strength steel covered with plastic panels.

The original Su-26 was soon to be built in an updated variant (Su-26M) and export began early after (as soon as 1986) with a specific variant being developed (Su-26MKh).

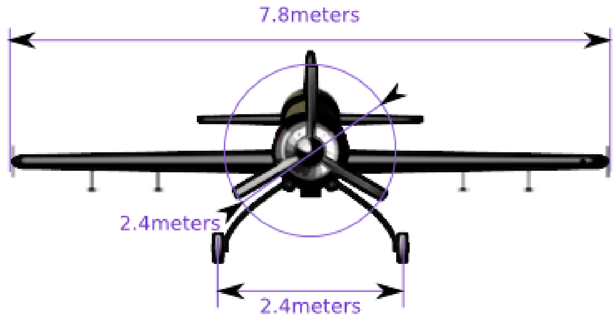
Export versions often have improved avionics suite (the original is only equipped for VFR flight with no radio navigation capability at all) and other modifications such as external tanks, and English labels.

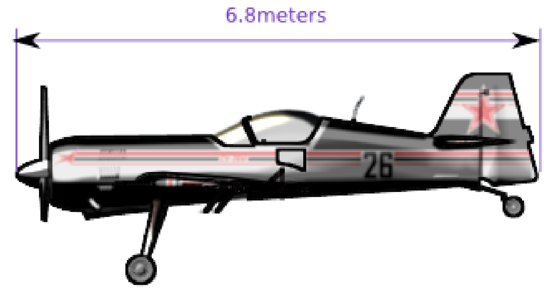
Later developments include the twin seater Su-29, and the more powerful and lighter Su-31 (some versions being equipped with a lightweight ejection seat).

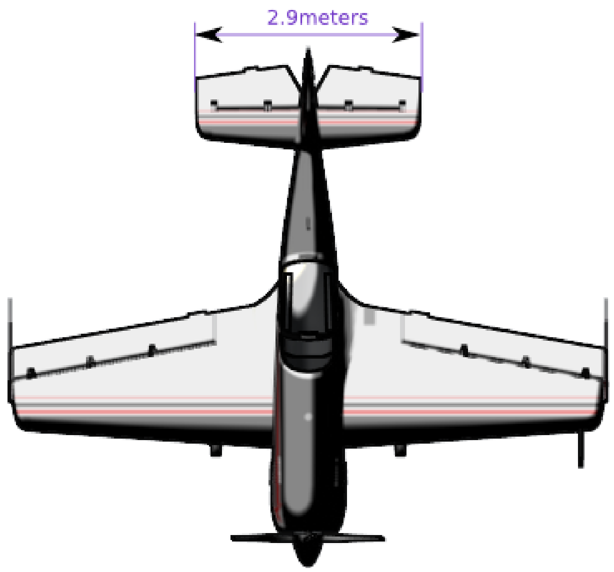
In order to handle the first class performance of the airframe, the pilot position has been tuned to improve resistance to prolonged exposure to high g's. This translates into the pilot being seated with the backrest reclined at 45 º from the fuselage centerline and with his (her) feet resting high on the pedals. Keep in mind that continuous 12g's is not far from buckle limits for the back !

The variant modeled can be considered to be representative of the Su-26Mkh (МХ in Cyrillic) with minimum avionics fit.

1.1 Dimensions







Wing Area 11.83 square meters

Empty weight 679Kg

Max Gross Weight 830Kg

Main fuel tank capacity .... 60 liters

1.2 Performance

VMO 430Km/h/

Ceiling 4000m/

Range (with auxiliary tanks) 800Km/

Maximum roll rate ....360°/s

Maximum g...+12/- 10 (24 ultimate)

Stall speed 1g...105Km/h

Take off speed 120Km/h

Approach speed 165Km/h

Landing speed 115Km/h

High speed cruise 310Km/h

Long range cruise 290Km/h

Take off distance 160m

Landing distance 250m

1.3 Powerplant

The power plant consists of a 9 cylinders radial, supercharged, Venedyev M-14P, with an output of 360hp.

The lubrication and fuel system of this engine are designed to provide unlimited inverted flight time.

Among the peculiarities of this engine are automatic mixture control, compressed air starter, dual ignition system (one for start the other for operation)...

The automatic fuel/air mixture control is a mechanical device based on an aneroid barometer. This precludes the use of mixture control for the pilot, thus reducing workload. Nevertheless, it is said to slow engine response somewhat.

The compressed air starting device consists of an air compressor mounted on the engine (separate from the supercharging compressor), a reservoir, water separation device, and associated piping and valves.

The air starting device blows air into the cylinders in sequence in order to provide the cranking motion to the engine. 3 start attempts can be performed with the standard pressure in the reservoir. After the engine is started the compressor will recharge the reservoir.

The advantages of this system are the ability to support long storage times without discharging, and capability to stand cold weather operation, both quite difficult to achieve with battery powered, electrical starters, and quite important in Russian winters.

1.4 Systems

2 Cockpit

2.1 Overview

2.2 Instruments

2.2.1 Indicated Air Speed (СКОРОСТЬ *skorosty*)

Air speed is displayed in Km/h.

The yellow sector painted on the bezel indicates the VMO (maximum operative speed)

2.2.2 Altimeter (ВЫСОТА *vysota*)

Barometric altitude is measured in meters.

Barometric setting is provided in millimeters of mercury (1013 hPa = 760 mmHg = 29.92 in.Hg)

A reference table for barometric setting is provided in the leaflet placed on the card holder. It is common practice in former soviet union to set the barometric reference to QFE (the altimeter shows 0 when on ground instead of airfield elevation as in QNH setting)

The barometric reference is set using the knob located below the altimeter

2.2.3 Chronometer/clock

This is a standard clock/chronometer. Since dead reckoning is the only navigation method with standard avionics suite, this is a central instrument.

2.2.4 Boost pressure (НАДДУВ *Nadduv*)

Given in millimeters of mercury. Since the M-14P is equipped with a centrifugal compressor this value replaces manifold pressure of normally aspirated engines. For the same reason, this value exceeds current atmospheric pressure at full throttle.

2.2.5 Inlet temperature

To be completed

2.2.6 Tachometer

To be completed

2.2.7 Triple engine indicator

This indicator provides fuel pressure (yellow chip), oil pressure (horizontal needle) and oil temperature (vertical needle).

Pressures are given in kilograms per square centimeter and temperature in degrees Celsius.

2.2.8 Volt-meter

To be completed

2.2.9 G-meter

Two such instruments are located close by the CG. One of them is inverted to handle large negative g's that the Su-26 can reach. They have maximum g needles that can be reset with a push button for the next flight.

2.2.10 Radio panel

2.3 Controls

2.3.1 Flight controls

2.3.1.1 Stick

The stick is conventional with a peculiarity that the it does not self center due to tuning of mass and aerodynamic balance. This allows dispensing with trims on the actual aircraft.

Since this feature cannot be replicated on common gaming joystick, trim use is advisable, especially since engine torque provides a strong tendency to roll at neutral stick

2.3.1.2 Rudder pedals

Rudder pedal are hinged at the top and double as brake pedals. Differential braking is possible for ground steering

2.3.2 Engine controls

2.3.2.1 Air starter

Single push button (actually a paddle) actuating a valve to initiate the start sequence

2.3.2.2 Magnetos

2.3.2.3 Priming pump

2.3.2.4 Throttle

2.3.2.5 Propeller pitch

Propellers installed in the Su-26, both 2 and 3 blade, are of the constant speed type. This is achieved by adjusting pitch of the propeller in order to absorb the torque generated by the engine.

The lever is used to change the pitch in order to adapt the propeller to higher speed, or to provide more thrust for the climb.

2.3.2.6 Engine gills

This lever actuates the titanium diaphragm located in front of the engine in order to control temperature of the engine (warm up in cold conditions for instance).

2.3.2.7 Shut-off valve

Used in emergency (engine fire) to shut down engine fuel feed.

2.3.2.8 Fuel gauge

Simple transparent pipe connected to the fuel tank.

2.3.3 Electrical

2.3.4 Canopy controls

2.3.4.1 Ventilation flap

Given the surface of the canopy and power of the engine, the cockpit can be somewhat warm in simulated summers. The Su-26 canopy has a ventilation flap too cool down the pilot ... Or at least let him hear the hiss of the wind...

2.3.4.2 Canopy jettison

2.3.4.3 Canopy opening latch

3 Basic flight

3.1 Take off

Take off characteristics are a consequence of two factors : tail sitting landing gear, huge power.

The tail sitting stance provides limited forward view and creates P-factor (asymmetric flow on the propeller inducing gyroscopic yaw).

The huge power to weight ratio makes full throttle take-offs very difficult since the torque will have the aircraft roll and yaw before full aileron and rudder authority can be reached. The advantage though is that the take off run is extremely short and can be made with the tail still sitting on the ground !

A more conventional take off will be achieved with small application of throttle (TBD mm.Hg boost pressure approx.) which will make roll and yaw easily controllable. In this case it is advisable to let the aircraft accelerate to 150 Km/h (tail will raise) and perform a standard take off rotation.

Take off at higher settings will require sharp reflexes as well as large control inputs as the aircraft starts to depart wings level attitude.

3.2 Cruise/navigation

3.3 Landing

To be completed

The model in flightgear has a heavy tendency to nose over when braking hard. Use of differential braking or very little brake pressure is needed to keep control of the trajectory once on ground.

3.4 Stall and spin recovery technique

The Su-26 being an aerobatic aircraft is very easy to control during stall and post-stall flight regime.

Control surfaces are over sized and control is retained even though lift has degraded. That means that the aircraft can be held in stall indefinitely but can be recovered as easily.

Recovery technique is classical, releasing the stick, letting the nose drop and resuming normal flight after speed has been recovered.

The main issue with stall is the high torque of the engine that makes it roll slowly eventually initiating a spin. Nevertheless spin entry is very easily avoided with rudder and aileron (the model in the sim will not spin unless you force it to).

Spin recovery, while being a nightmare for many aircraft, is very easy in the Su-26 : center the stick and rudders, wait for the nose to drop into a dive, and perform standard dive pull out.

One notice about pull outs : over control is very easy on such an aircraft, and even at full throttle the aircraft can be made to stall. This will take the form of the g loading suddenly dropping. Other symptoms in real life would be buffet and abrupt change in control forces.

It is fairly easy yo enter this regime in the most inappropriate moment. When coming out of a high speed dive, pulling hard on the stick will first increase incidence and g forces ... until stall when the aircraft will suddenly feel like going straight ahead (quite not actually but much more than if some restraint had been applied on the stick).

As this kind of input is a normal “panic” behavior, it can be treacherous. In real life though, if the dive was high speed, the sizing element would be g-loading getting unbearable for the pilot (black out, loss of consciousness, or severe injury).

4 Aerobatic maneuvers

4.1 Loop

Loops are conceptually easy (just pull the stick) but hard to perform nicely

The perfect loop is a perfectly round circle entered and exited at the same level. That implies a lot of work in the process :

- The pull out should be made at high speed with a hard pullout (watch out for dynamic stall though
- As the aircraft gets vertical airspeed will bleed, this implies that more stick should be used at the beginning than at the top of the loop, but without having the speed drop too much at the top
- Because once at the top you still need to have control to begin the descending half
- As the aircraft initiates its dive the engine must be throttled back in order to

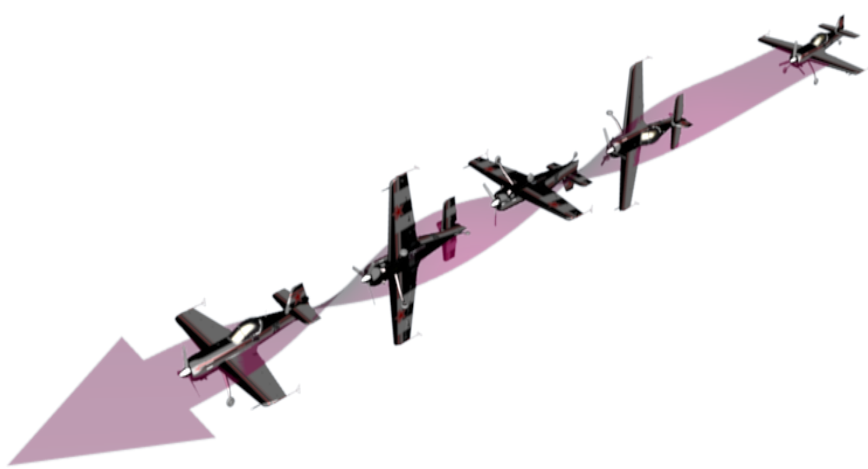
avoid exiting the loop too fast and below its entry altitude...

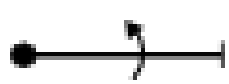
Using smoke generators, the first loops will look somewhat disappointing but then again, practice makes perfect.

Loops can also be faceted involving short and hard pull ups followed by straight flight on a short distance. The figure should form a regular polygon as seen from the side (square, octagon ...)

Finally loops can be flown in inverted flight, but in real life expect this to be very unpleasant.

4.2 Roll





The aileron roll is the most basic aerobatic maneuver. But to perform it cleanly aileron input should be used with rudder (when on the side) and stick (when inverted) to keep the aircraft flying in straight line.

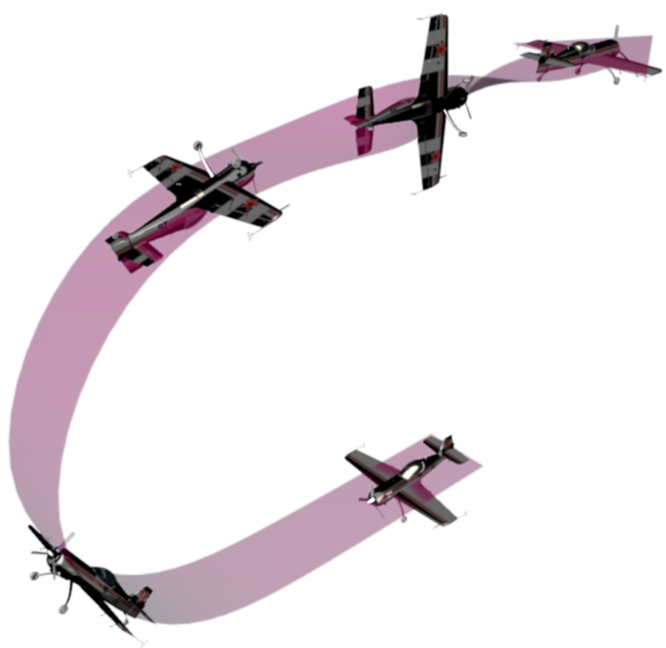
The "pilot" should keep in mind that with a maximum roll rate of 360 degrees per second, horizon cues should be taken very precisely and some anticipation should be used in order to stop the roll with the wing level.

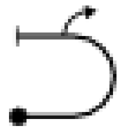
The roll can be divided with stops at some defined roll angles ("point" or "hesitation" roll). This will add some extra difficulty since the roll needs to be stopped very cleanly and held for a definite amount of time without change in trajectory.

Finally wind is a factor to take into account. As smoke generators will tell, the quality of the figure can be ruined if wind pushes the aircraft off its intended track.

Bear in mind that due to torque effects, rolls in the direction opposite to the propeller will be faster than those in the direction of the propeller.

4.3 Immelman





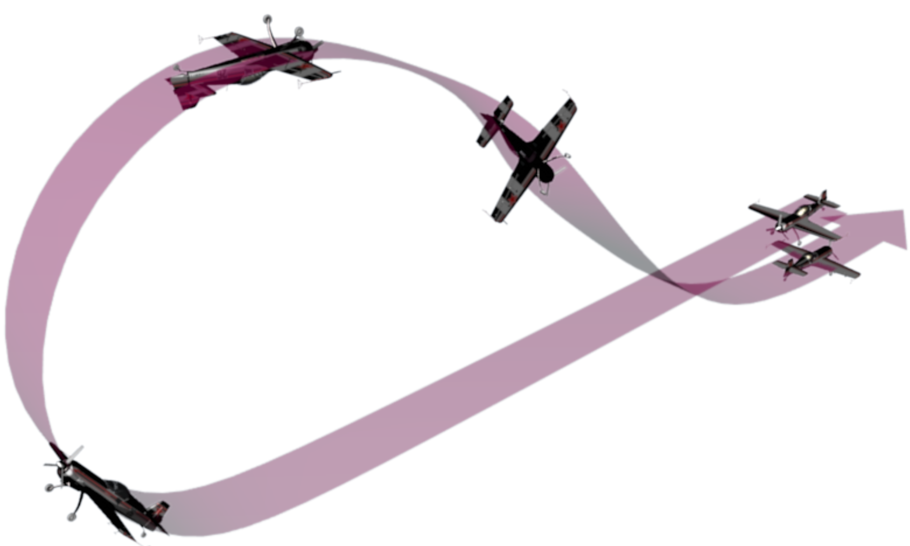
This simply is half a loop followed by half a roll which will leave the aircraft at a higher altitude going in the direction opposite to the one at the beginning of the maneuver.

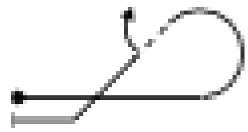
The Immelman is named after a German ace of WWI.

The mirror maneuver, that is, half a roll to inverted flight followed by half a loop is named a split- S.

The criteria of quality for an Immelman are the same as those for a loop and a roll, that is round trajectory and neat roll angles (which imply fighting a lot against the engine).

4.4 Half Cuban eight





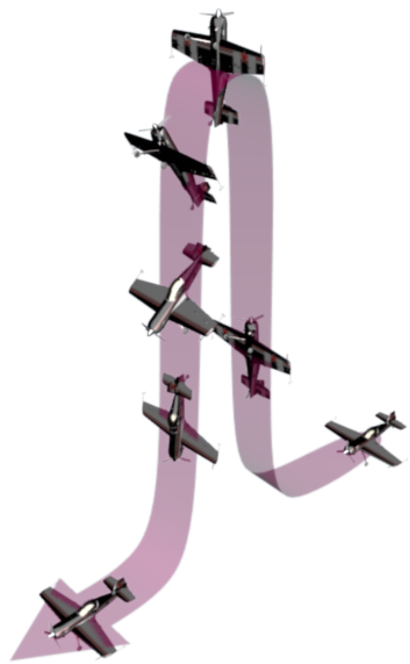
The half Cuban eight is an Immelman where the the loop is continued until the aircraft is nose down at an angle of 45 degrees.

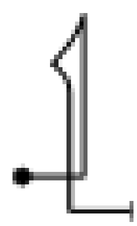
During this dive the aircraft is rolled back to wings level. A brisk pull up is initiated to recover horizontal flight at the level of entry into the maneuver.

2.1 Cuban eight

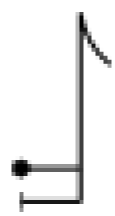
The Cuban eight, as could be expected, is two half Cuban eights back to back.

4.5 Tail slide

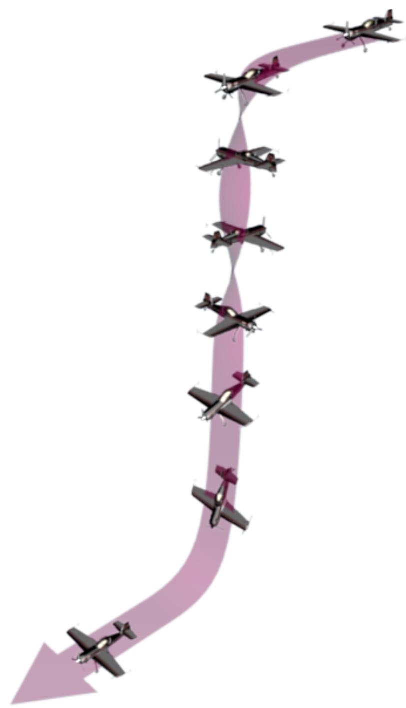


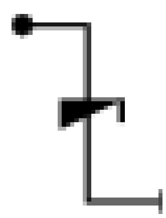


4.6 Hammerhead



4.7 Spin





4.8 Snap roll

5 Sources

6 Acknowledgments

7 License