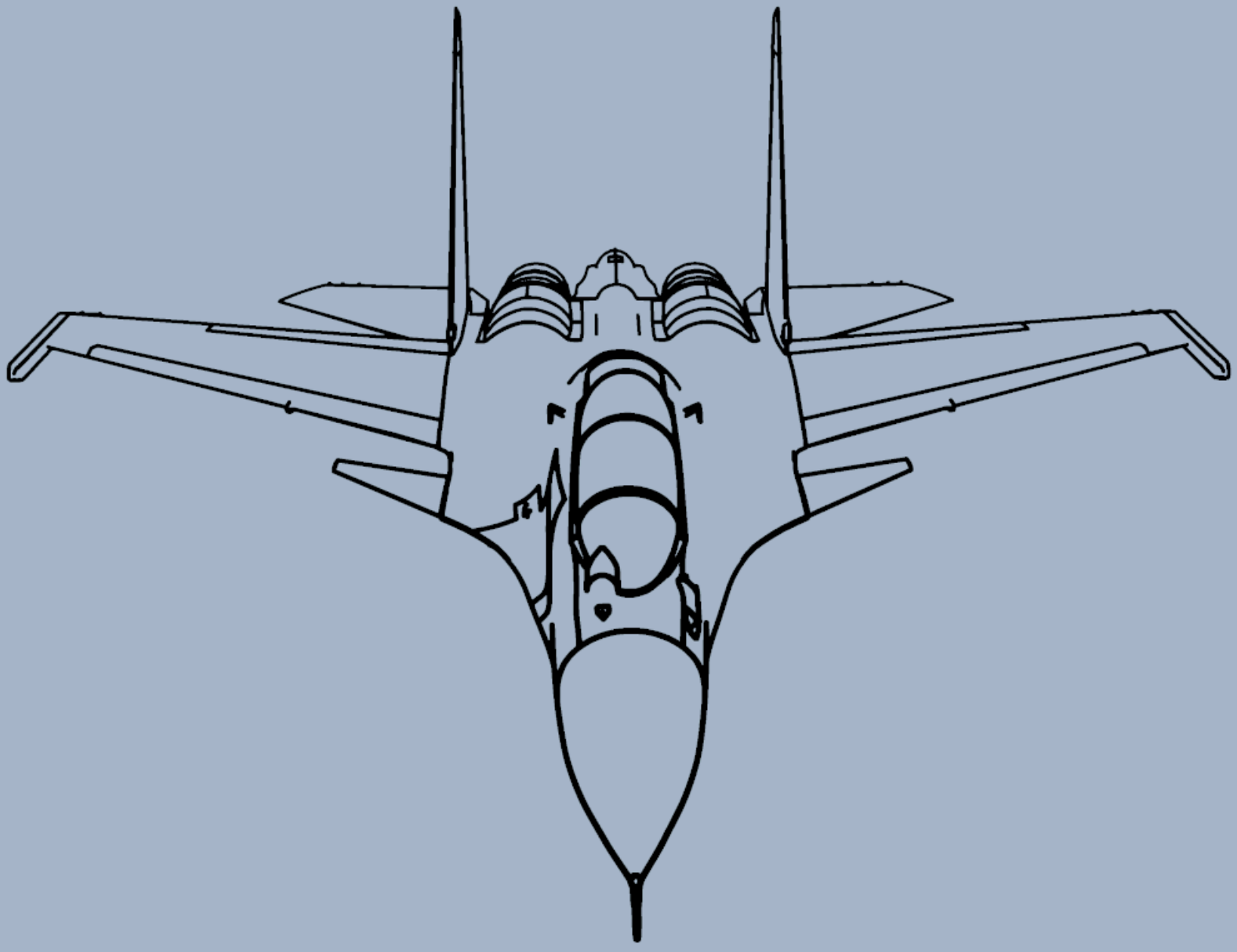
Su-30 Codename FLANKER



EFM DOCUMENTATION

DCS

INTRODUCTION

This flight model is a culmination of an entire year worth of tireless work by the dev team, testers and contributors. It is also a direct result of all the amazing support and admiration we have received and still continue to receive from our supporters and community members. We thank you all for your patience and we are very grateful for your kind words and encouragement.

The goal of this flight model is to make the aircraft behave as similar to real life as possible when it comes to flight performance and maneuverability. In order to do that, we have relied on several Subject Matter Experts along with publicly available information, videos and documentation and have made educated assumptions in cases where no clear information was available. None of the information/data we used to simulate the flight model are sensitive by nature and all information given to us by SMEs are carefully cross-examined beforehand. When designing the performance side of the EFM, we focused almost entirely on the simulation aspect of DCS rather than the game aspect. So do not expect the aircraft to perform better in cases it does not in real life.

WARNINGS & LIMITATIONS

- This is version 1.0 of EFM for Su-30 Mod and hence a number of features are currently absent and will be introduced later in the development cycle
- Not designed for keyboard users but should still function for the most part
- Damage model is relatively basic. It will be improved in the future
- Aerodynamic Autorotation phenomenon is not implemented yet
- Having atleast some Deadzone (~5 minimum) in axis tune settings for Roll, Pitch and Yaw is mandatory
- Due to SDK limitation, majority of the new animations we added are client side only
- Some visual features may not work correctly in VR
- The mod is in Beta. So expect bugs, glitches and performance issues
- This is not an official paid module so keep expectations realistic

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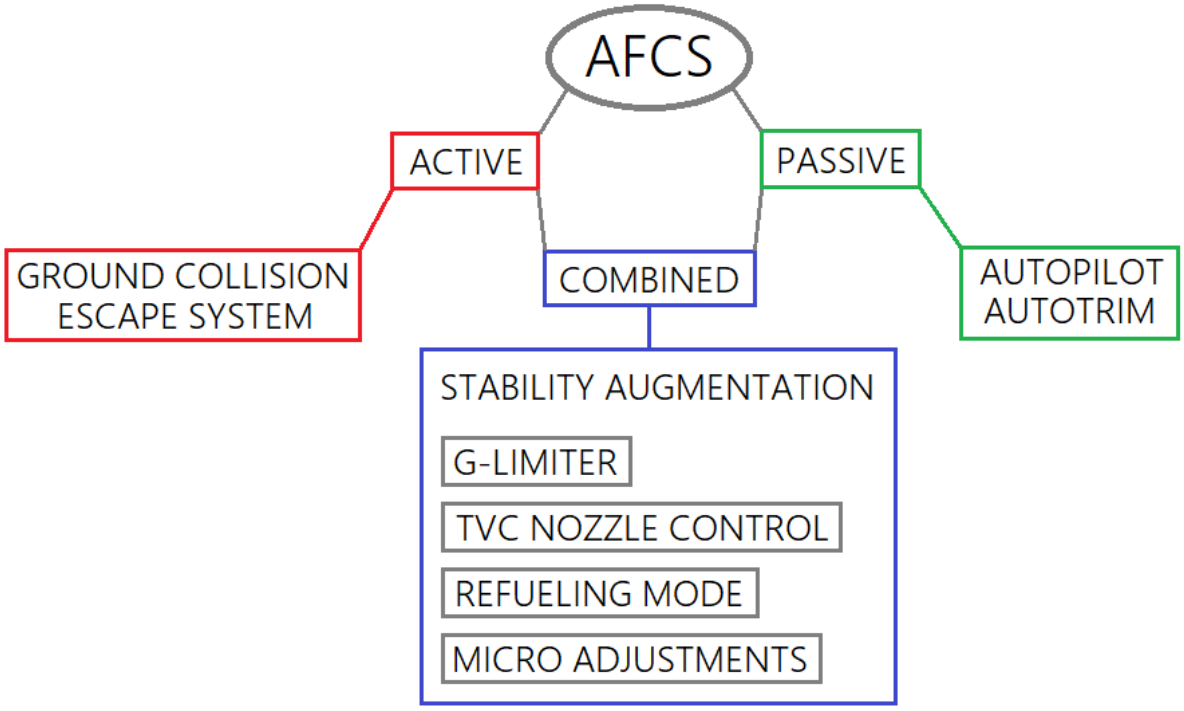
METHODOLOGY 1.0

The flight model is designed in a way that allows the aircraft to operate in 4 different states. Depending on the situation, these states often overlap (You can maybe think of it like multiple overlapping circles in a Venn diagram). Interaction among states and the transitions based on pilot input and external variables are designed to be seamless. Following is a brief description of each state. Note that the 4th state is only partially implemented in current iteration of the EFM

1) AFCS – Automatic Flight Control System:

This state corresponds to the flight computer performing different actions. Some of these actions involve taking control away from pilot, some work passively in the background, some augment pilot input and others limit the pilot from putting the aircraft in unsafe situations. AFCS can be categorized and subcategorized as shown in the diagram below:



Each of these subsystems will be discussed in detail in later chapters

2) Basic Maneuverability:

This state is common for all aircraft in DCS, where you utilize the common aerodynamic forces and moments to move or rotate the aircraft to achieve basic flight. This state is simulated based on realistic implementation of forces and moments.

3) Super Maneuverability:

This state can be achieved with Thrust Vector Control(TVC). In this state, the aircraft engine nozzles provide specific directional thrust which are not in the traditional aerodynamic axes. As a result, components of these off-axis forces can generate enough angular moment to rotate the aircraft. Because the moments are being generated by the engine and not by the control surfaces, TVC is not susceptible to low airspeed, angle of attack or angle of slide and thus provides unparalleled freedom in maneuvering, specially at lower speeds. Some voice warnings related to stall and high alpha are not played when TVC is active for the same reason. Turning TVC ON will also disable safety features like GCES.

4) Unstable/Imbalance State:

This state includes differential thrust (due to split throttle or engine failure), damaged control surface(s), missing wings/stabs/rudder etc. or some combination of all these things. Currently this state is implemented only partially and we will make improvements in future iterations of the EFM.

FLY BY WIRE 2.0

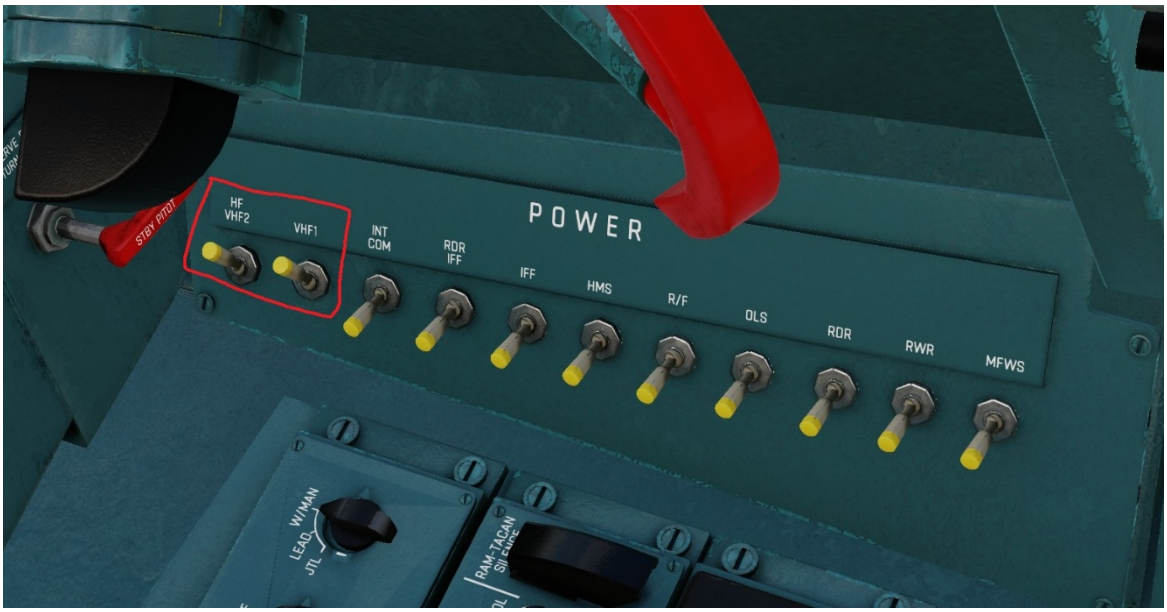
The Su-30MK/SM are modern Flankers that boast digital fly by wire with quadruplex redundancy. The main goal of this system is to provide stable and consistent maneuver performance while maintaining the structural integrity of the airframe.

Unlike the Su-35 and Su-27, there is no dedicated button in the cockpit that allows the pilot to disengage pitch damping portion of this system. Hence there is no way to perform Cobra in this aircraft. You will be able to perform maneuvers that look similar to Cobra but are not Cobra. Proper Cobra maneuver involves gaining very high alpha in very short time, using the belly of the plane as a massive airbrake to bleed most of your speed and gain minimal altitude in the process.

This is not the primary focus of the EFM and the process will change in future.

1. Start by turning on Battery Power by enabling these switches:

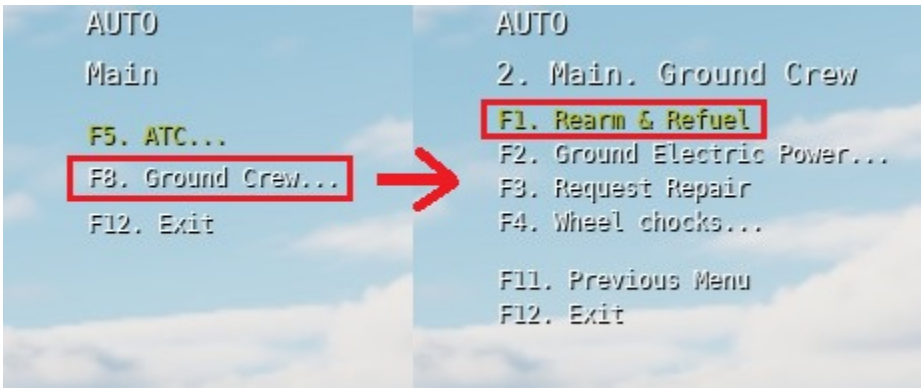
2. Then enable VHF1 and VHF2 switches from POWER panel:



3. Turn on these 4 switches from Distribution Switchgears panel:

4. At this point the Radio should be operational. Check and confirm:

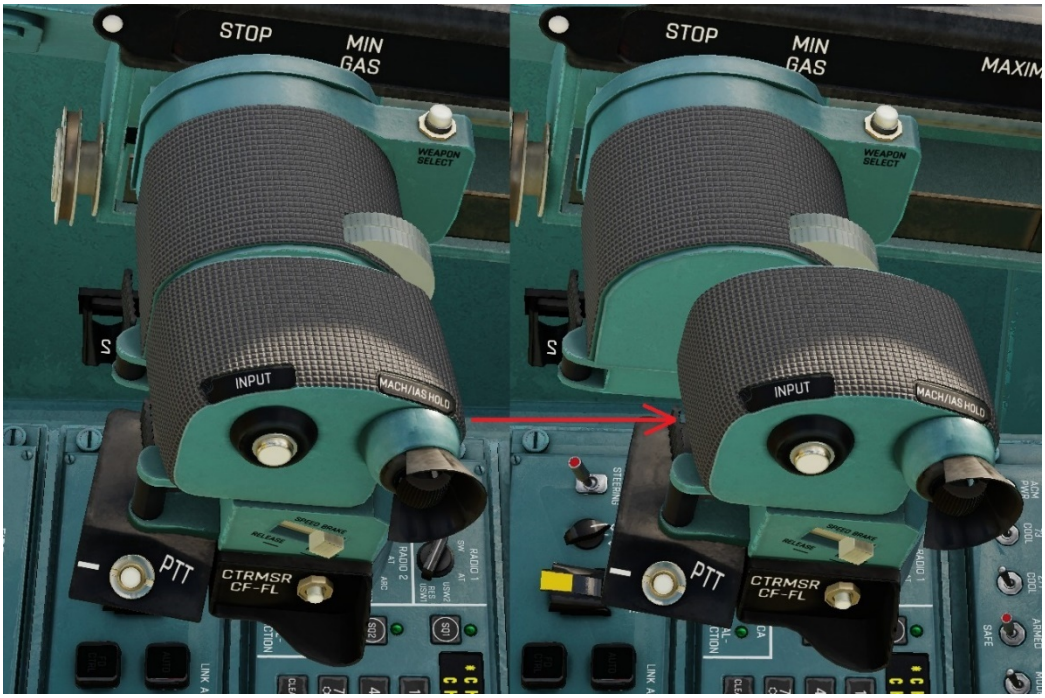
5. You should now be able to rearm and refuel if you need to. Press "\" or "RShift+\" to bring up communications menu then "F8" -> "F1" will bring up rearming menu. Wait for this process to be over before moving to next step. Note that you cannot contact ATC at this state of startup. If you don't need to refuel/rearm, skip this step.



6. Now we will start the Right Engine. Press and hold the "RH" button until the green cursor disappears. After that the RPM will start rising for Right engine. Keep an eye on the analog RPM gauge and wait for the needle to reach 25%

7. Use the following keybind to push Right Throttle past the detent:

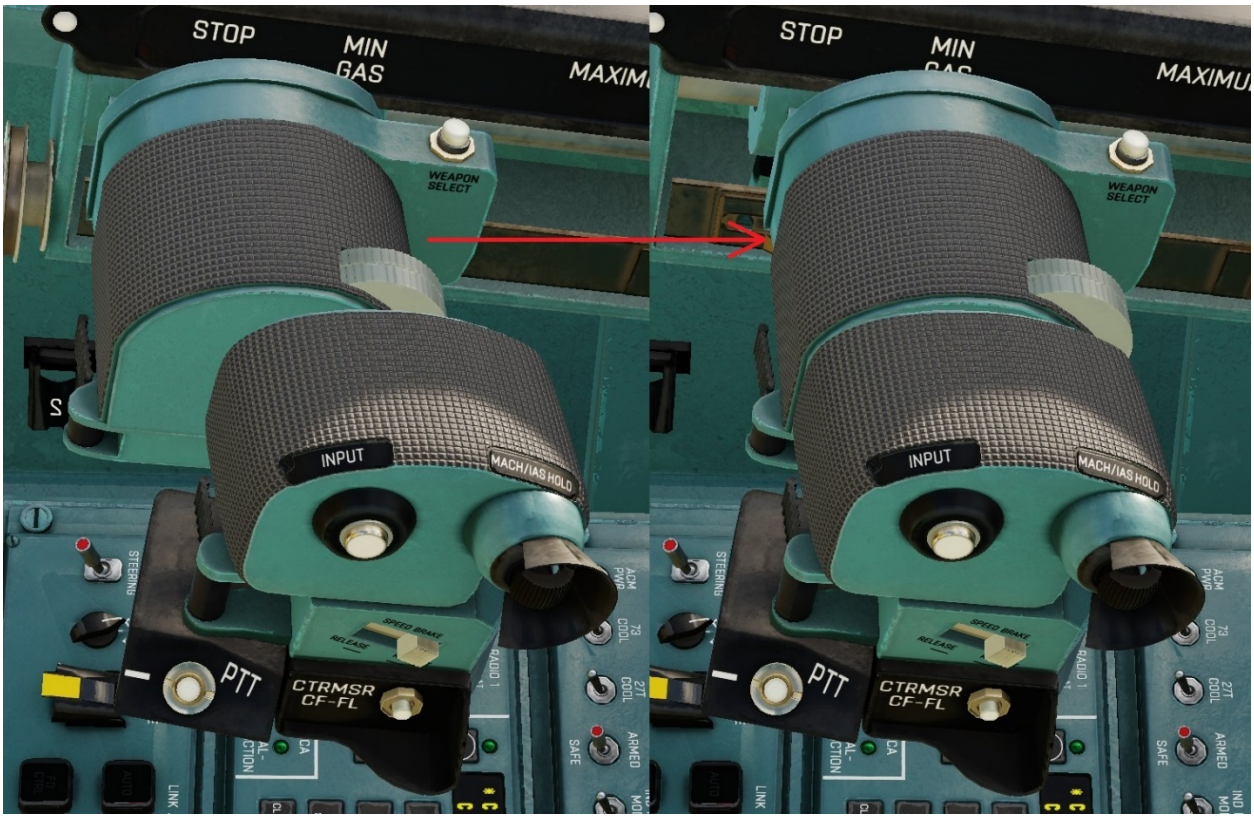
Left Throttle IDEL detent	Systems	RAlt + End
Right Throttle IDEL detent	Systems	RCtrl + End



8. Now we will start the Left Engine. Press and hold the "LH" button until the green cursor disappears. After that the RPM will start rising for Left engine. Keep an eye on the analog RPM gauge and wait for the needle to reach 25%

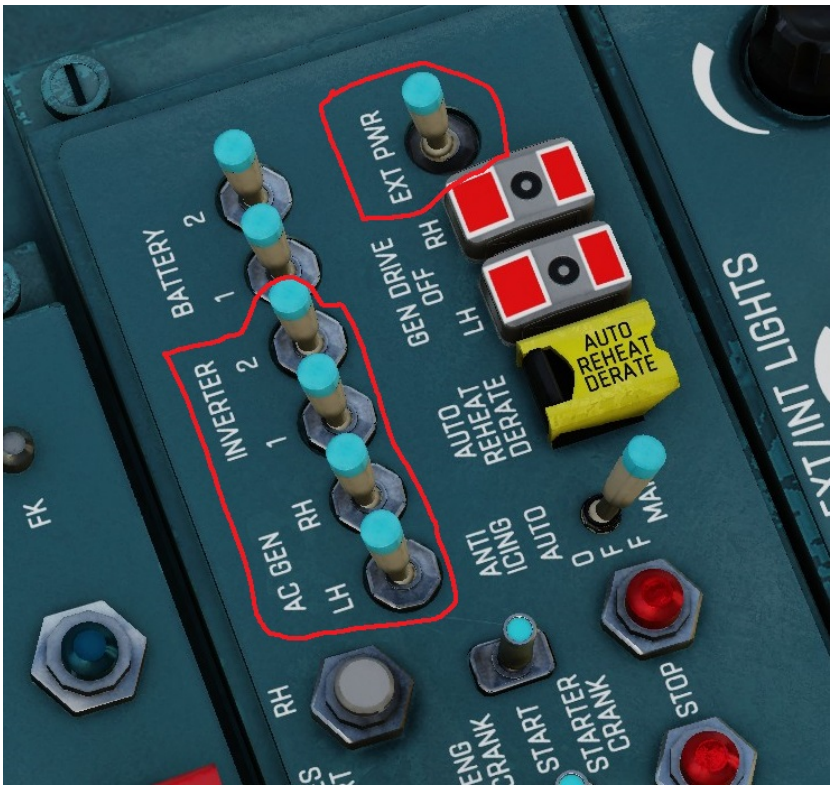
9. Use the following keybind to push Left Throttle past the detent:

Left Throttle IDEL detent	Systems	RAlt + End
Right Throttle IDEL detent	Systems	RCtrl + End



10. Observe analog RPM gauge and wait for both needles to reach 70%:

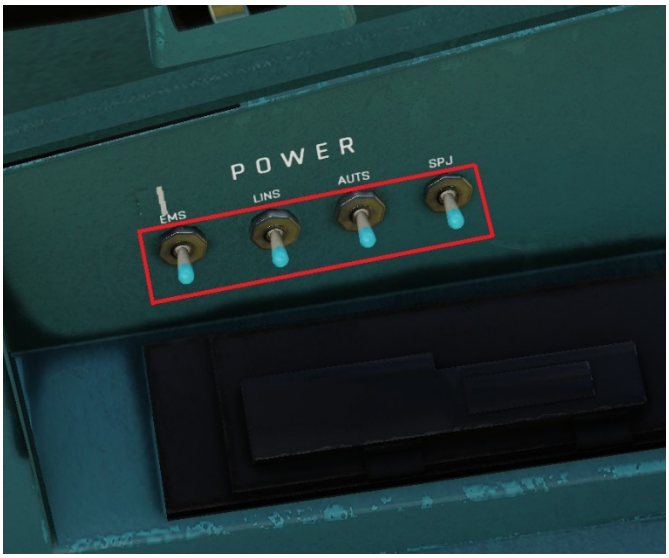
11. Turn on AC Generator, Inverter and Ground Power:



12. Turn on all remaining switches in Distribution Switchgears panel:

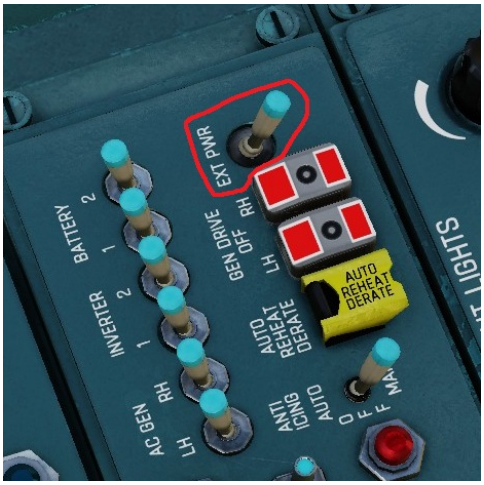
13. Turn on all remaining switches in 1st Power panel:

14. Turn on all switches in 2nd Power panel:



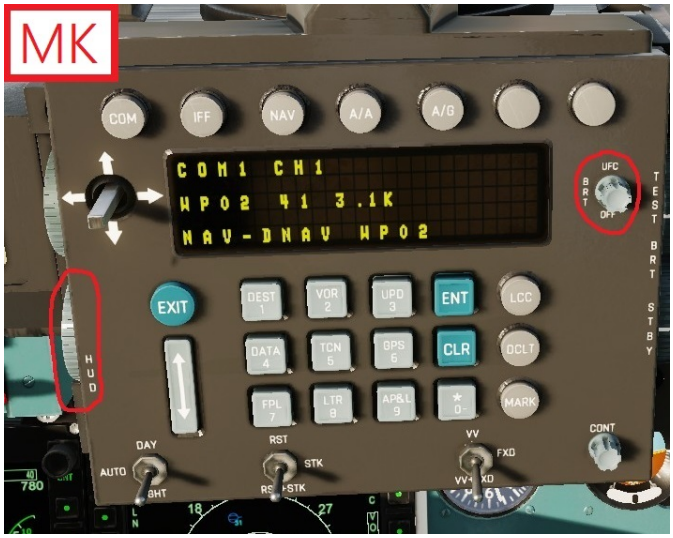
15. Close your canopy if you haven't already. Either use this handle or press "LCtrl+C":

16. Turn off Ground Power:

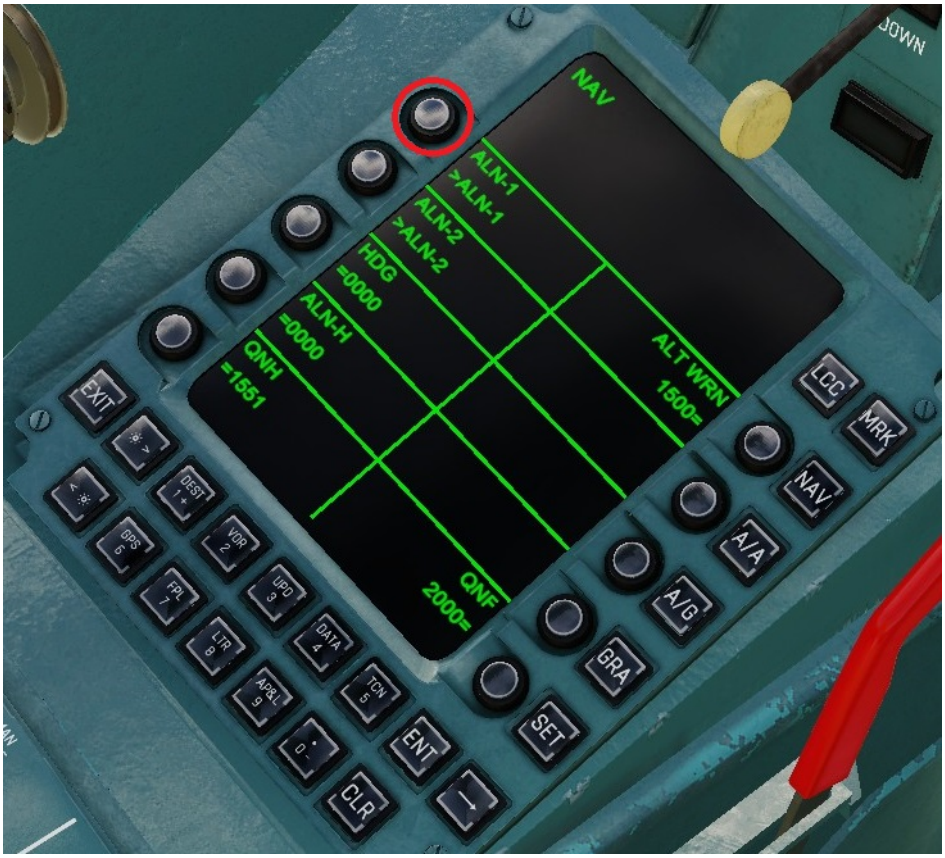


17. Observe the left-most MFD which should show ALIGNMENT page. There are 2 options here. "Accelerated" and "Normal". "Accelerated" is fast but will be less accurate. "Normal" is slower but more accurate. INS is not fully implemented at the moment so what you pick doesn't matter. So we will go with the faster one for now:

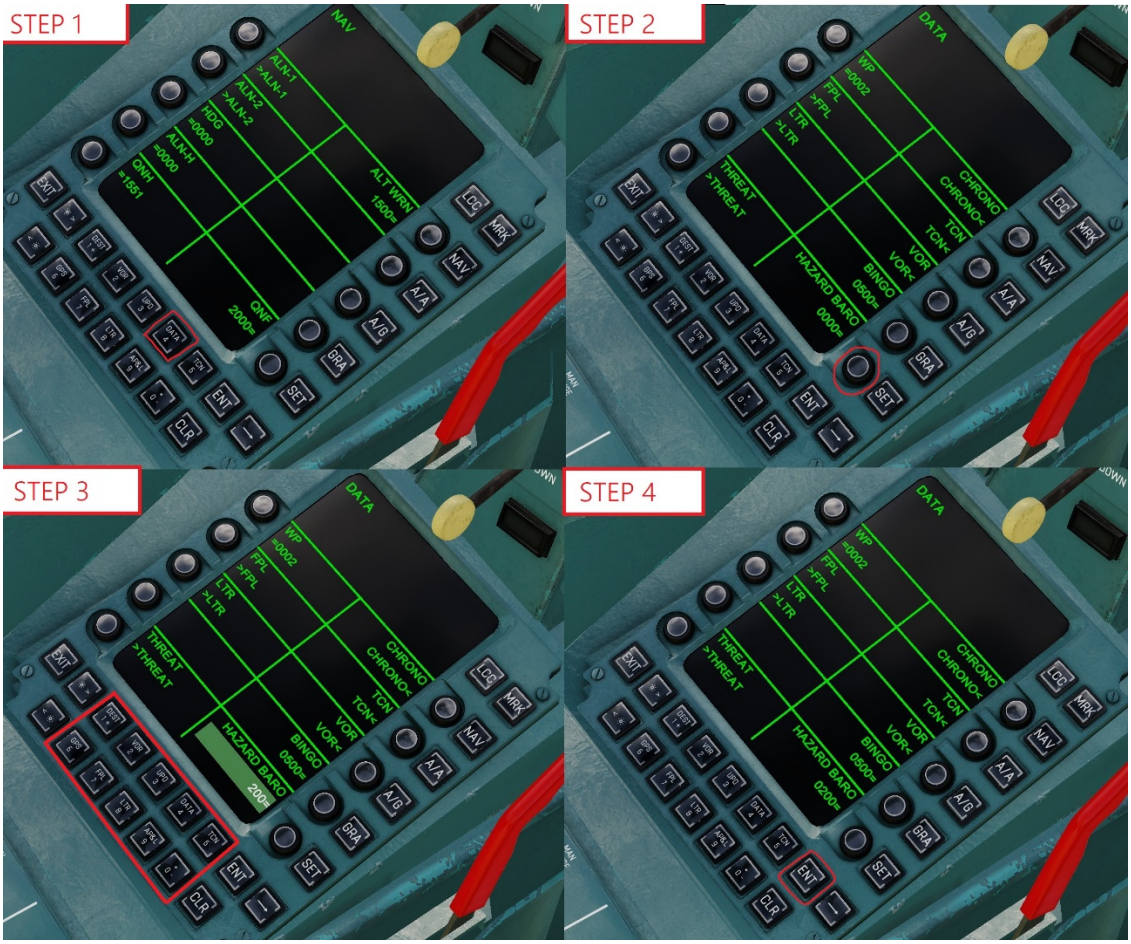
18. While the Alignment is going on, go ahead and rotate these two knobs to enable the HUD and UFCP Screen. You can also use them to adjust brightness.



19. Now we will wait for the Alignment to complete. After its done, you'll see "ALIGNMENT READY" on the MFD. Go to the PS-5D and press this button twice:



20. If you want, you can set the barometric Hazard Altitude for GCES by following the steps below. Whatever value you put, GCES will consider that altitude as the hard deck:



21. Turn on Nosewheel Steering:

22. If you see "Hydraulics Failure" warning as shown in 1st image, ignore it and simply press the Master Caution switch as shown in 2nd image:

With that, the Cold Start is basically done. You can now Taxi and takeoff.

HUD INDICATORS 4.0

This flight model includes a partial rework to the HUD. While we are still unable to make it fully custom; we managed to rework the symbology and optimize their positioning in the HUD glass. By using the VV/FXD switch on the UFCP, the user can cycle between 3 implemented modes of the HUD:

1. hybrid FC3 + custom symbology (default and currently preferred mode)
2. FC3 HUD from Su-33 (only shows basic information)
3. Custom HUD (while it arguably looks the coolest, it is the least useful; aside from displaying basic information as well as partially - navigation and ILS symbology, it will not allow you for anything more. It will not display anything related to target locking, aerial refueling, radar. This HUD mode; while currently not very refined, is the preferred HUD development route if custom avionics-related problems are solved in the future.

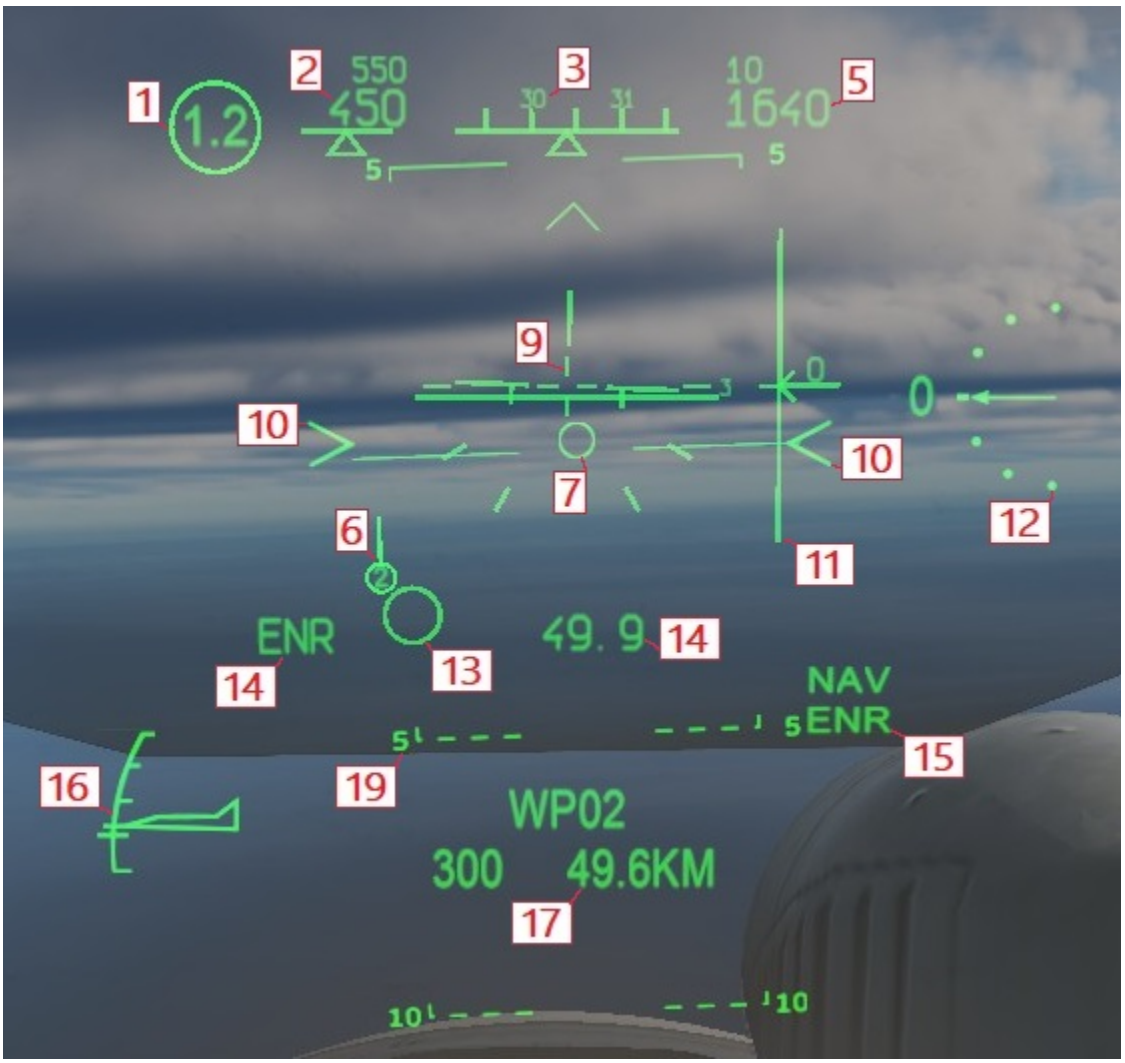
SM HUD:

1. **Load factor indicator** - it simply shows the current G load.
2. **Speed indicator** - Part of the FC3 HUD
3. **Heading tape** - Part of the FC3 HUD
4. **Heading to selected waypoint** – Only visible when **Waypoint marker(6)** is off HUD limits
5. **Altitude indication** - Part of the FC3 HUD
6. **Waypoint marker** (In the picture it is off the HUD limits)
7. **Flight path marker** - Will show you the actual direction your plane moves in
8. **Watermark (waterline/azimuth)** - Shows your nose position. Place it on the horizon line to get pitch angle of 0. Unique to MKM/SM variants.
9. **Bank indicator** - Part of the FC3 HUD
10. **Acceleration chevrons** - Greatly assists pilot with speed control. For the SM, MKM variants - the chevrons are slaved to the bank indicator. To hold your TAS, you need to align them with the 'wings' of the bank indicator.
11. **Sink rate (vertical speed) indicator** - Redundant indicator from FC3 HUD; we had no way of removing it.
12. **Sink rate -** Actual Su-30 style vertical speed indicator.
13. **Navigation marker** - Part of the FC3 HUD
14. **HUD mode and distance to waypoint** - Part of the FC3 HUD
15. **Current master mode/sub mode name -** Will also show selected weapon name when in combat modes.
16. **Angle of attack indicator -** Display range is from -10 to +30deg. When using the TVC Maneuver mode, it will be replaced by a circular symbol to allow you to track the AOA in full 360deg(Shown in 2nd image above).
17. **Current waypoint; Heading to WP; Distance to WP**
18. **Artificial horizon line**

Place your FPM on the horizon line to maintain altitude (sink rate 0) Place your watermark on the horizon line for pitch angle 0. The vertical distance between FPM and watermark is proportional to your angle of attack; the horizontal distance - to your angle of slide.

Be aware; so far we were not able to eliminate the following bugs: the HUD color (Shrek green instead of mint green) and FC3 HUD being always visible at night (to switch to the custom HUD, we lower FC3 HUD brightness as we know of no way to switch it on/off completely as required during flight).

MK HUD:



Same as SM with following exceptions:

7. Flight path marker – Can dynamically turn into a simple circle to declutter HUD

8. Watermark – Not present in MKI/MKA

10. Acceleration chevrons - Greatly assists pilot with speed control. For the MKI, MKA variants they are slaved to the flight path marker. This means, when the chevrons are above the FPM - the plane is accelerating along its flight path; when they are below - the plane is decelerating. Line them up with FPM to hold your true airspeed

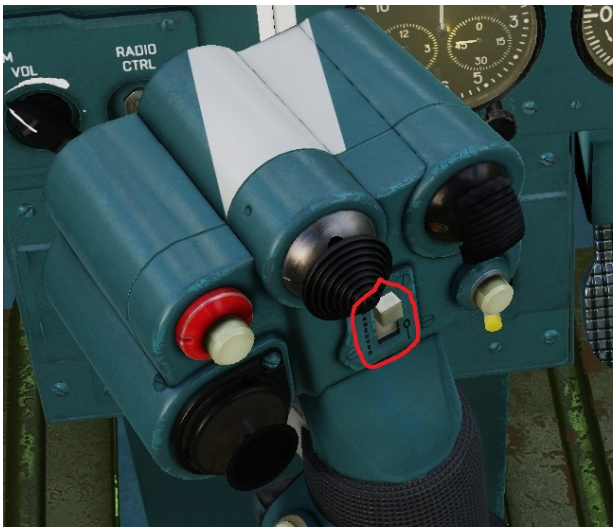
19. Pitch Ladder - Provides a level flight reference along with a reference for climbs and descents. Arranged in 5 Deg intervals

To turn on TVC, first turn on this switch. You can keep it on for the full duration of your flight if you want.

You can also use this keybind to do the same:

Toggle Thrust Vectoring On/Off	Flight Control	S
TVC Control On/Off	Flight Control	LAlt + S

Next you want to toggle this switch on the stick to enable thrust vectoring:



Alternatively, you can use this keybind to do the same:

Toggle Thrust Vectoring On/Off	Flight Control	S
TVC Control On/Off	Flight Control	LAlt + S

You can confirm if TVC is ON if the following warning light gets turned on:

It will also add new symbology to the HUD, namely 360deg AoA indicator and ESC OFF:

You can check nozzle movement in MFD->MFWS->ENG screen:

Turning on TVC will disable GCES. It will also prevent certain audio warnings from playing. FBW will only provide maximum nozzle deflection for TVC under specific situations based on current G-Limiter setting.

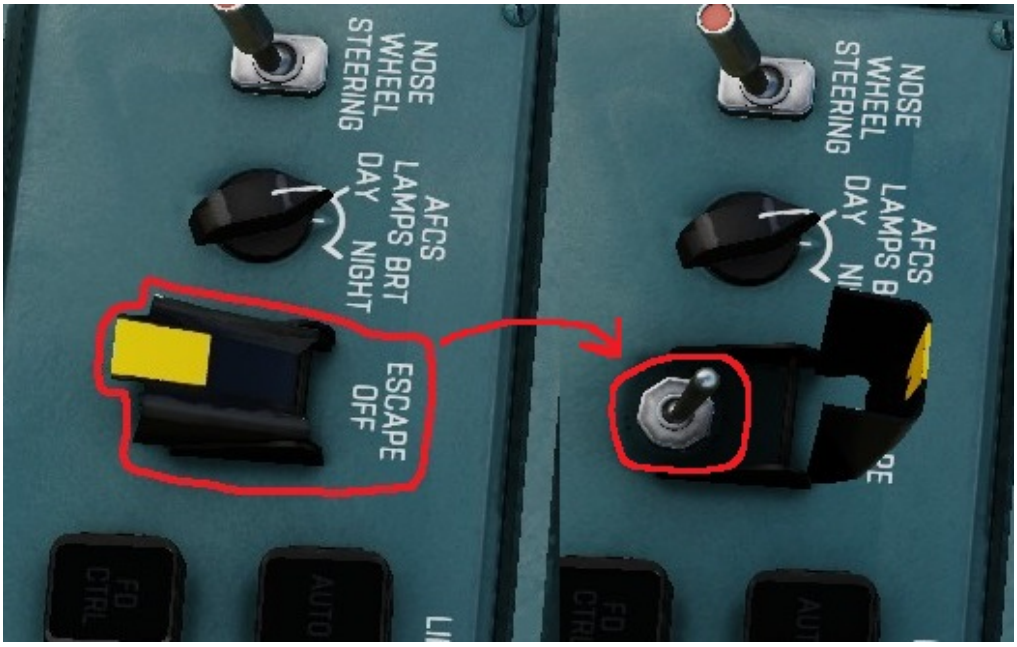
GROUND COLLISION ESCAPE SYSTEM 6.0

In the event of possible danger of crashing, AFCS will take control away from the pilot and will try to recover the aircraft. After the sequence is complete, control will be returned back to the pilot again. It works in both flat terrain and also for uneven terrain like mountains. The system is fully automatic and the only relevant pilot input it requires is the Hazard Altitude value. You can set Hazard Altitude for both Radar Altitude and Barometric Altitude. In the current version of the flight model, only Baro Altitude can be manually configured. Radio Altitude setting is currently predetermined and the ability to configure it manually will be implemented in a future version. You can check current Hazard Baro Altitude from the PS-5D Data page. If you want to know how to configure Hazard Baro value, please check **Cold Start** (Section 3.0) **Step 20**. It can be updated any time, not only during cold start.

GCES can be paused similar to Autopilot modes by holding “Pause Autopilot” keybind:

Pause Autopilot	Flight Control	LAlt + U

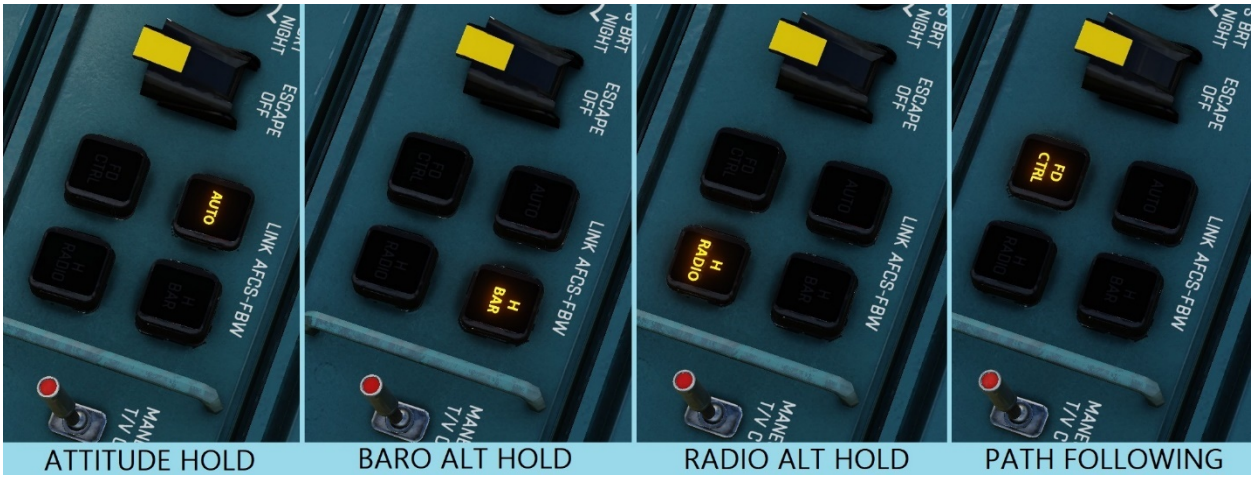
If you want to turn off GCES, flip this switch cover and toggle the switch:



When turned off, you will see this warning and also “ESC OFF” on HUD:

GCES also turns off automatically if you have Thrust Vectoring enabled. It will also fail to function in case Electric Systems have failed or shut down.

A very important part of the AFCS in Su-30 is the Autopilot. There are a total of 5 Autopilot modes, 4 of them can be activated from a cluster in left main panel and 1 from the stick. You can only activate one mode at a time. Activating a different one will reset the previous one. Following are the 4 modes in the cluster. These have to be clicked to activate:



ATTITUDE HOLD | BARO ALT HOLD | RADIO ALT HOLD | PATH FOLLOWING

1) Attitude Hold:

More commonly known as "Attitude Hold" in other aircraft. This will maintain current gamma angle and current roll state.

2) Barometric Altitude Hold:

This will maintain current altitude using the barometer. If your bank angle is less than 10deg, it will reorient the plane to 0deg bank. Otherwise it will keep the bank angle as is.

3) Radio Altitude Hold:

This will maintain current altitude using the radio altimeter. If your bank angle is less than 10deg, it will reorient the plane to 0deg bank. Otherwise it will keep the bank angle as is. This Autopilot mode is not implemented in the current version of the flight model.

4) Path Following:

This is a fairly advanced form of autopilot where the aircraft follows a predetermined path that can be set by the pilot using waypoints. This Autopilot mode is not implemented in the current version of the flight model.

Following is the mode on the stick:

5) Auto Level:

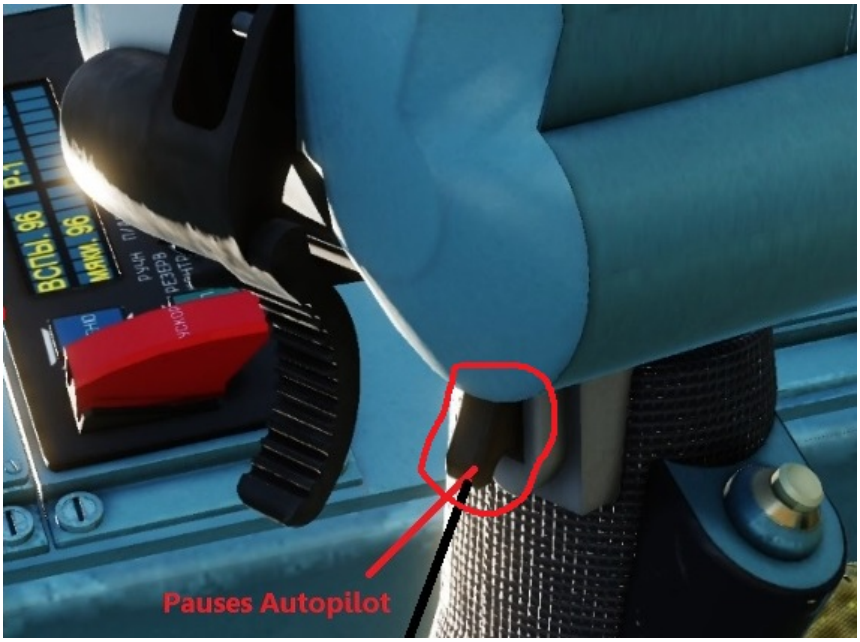
This mode will automatically bring your aircraft back to level flight. You can activate it by either clicking the button on the stick as shown above. Or you can use this keybind:

Auto Level	Flight Control	LCtrl + U

All autopilot modes can be paused by holding "Pause Autopilot" keybind:

Pause Autopilot	Flight Control	LAlt + U

Physical location of Autopilot Pause button:



All autopilot modes can be reset by pressing “Auto Reset” keybind:

Auto Reset	Flight Control	U

Or by clicking this button on the stick:

Aside from manual pause/reset button(s), there are several other conditions that can force automatic pause /reset of currently active autopilot mode or prevent activating autopilot:

1. Angle of Attack > 15
2. More than 90% stick input in roll or pitch axis
3. If gears are deployed
4. If Thrust Vectoring is ON
5. While GCES is active and conducting recovery process
6. If Electric System has failed/turned off

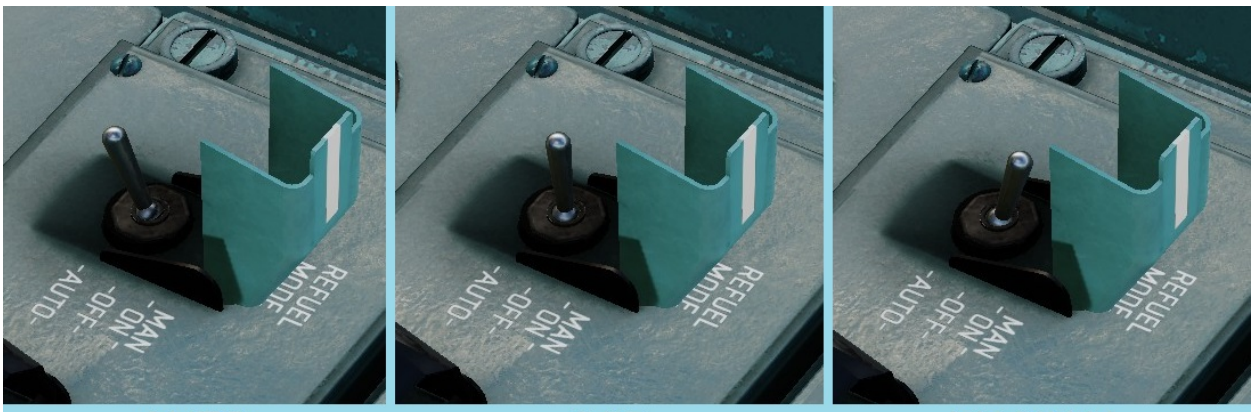
While any autopilot mode is active, it is possible for the pilot to perform slight corrections by adding small stick inputs. The system is smart enough to adjust its behavior as required.

REFUELING MODE 8.0

This is part of AFCS Stability Augmentation system. It makes it easier for the pilot to align the aircraft during In-Air-Refueling process by increasing input sensitivity of the stick. By default it is set to AUTO mode.

If you wish to configure the mode, first flip the cover of this switch:

Inside you will find a three-position switch:



1) Auto: Will engage refueling mode when the refueling probe is extended and disengage when the probe is retracted. Note: To extend refueling probe, use following keybind:

Refueling Boom	Systems	LCtrl + R

2) Off: Will keep refueling mode turned off unless turned back on or set to AUTO.

3) Manual: Will keep refueling mode turned on unless turned off or set to AUTO.

During refueling, MFD->MFWS->RFL page will show how much fuel you have taken under the LOAD box and also your total fuel amount:

Also, keep in mind that when you extend the probe and engage refueling mode(or it engages automatically), the probe is flooded with fuel to make sure no air gap/bubble is created during fuel transfer from the tanker. In real life this process takes 2 minutes. For gameplay purposes we decided to use 20sec for now. When the process is complete, flight computer will notify you through voice notification. At the moment, there is no penalty for taking fuel while this process is active. But that may change in the future.

G-LIMITER 9.0

This is another part of the AFCS Stability Augmentation System. It takes pitch input from the pilot and augments the control surface motions to maintain a safe performance threshold. As stated earlier, the main goal of the FBW is preservation of the integrity of the airframe and G-Limiter is one of the key components of that. The system is highly dynamic and can keep track of what payloads you are carrying. It then adjusts the limit value based on type and amount of payload. It is also able to distinguish between different types of payload under the same category. The limiter value adjusts automatically in real time as you launch/jettison payload or rearm. G-Limiter will also determine the maximum allowed nozzle deflection amount for Thrust Vector Control in different speeds; i.e. the lower the G-Limiter value, the lower your speed needs to be to gain higher nozzle deflection.

The basic ruleset in current implementation is following:

Rule 1. If you have Brahmos equipped, then limit will be 6.0G.
Rule 2. If you have atleast one KAB-1500 equipped(any variant), then limit will be 6.5G.
Rule 3. If you have any other Air-to-Ground ordinance equipped, then the limit will be between 7.5G to 6.5G based on how many pylons have Air-to-Ground ordinance.
Rule 4. In clean configuration or while carrying any amount or type of Air-to-Air ordinance, the limit is set to the maximum allowable value of 9.0G.

Rules high in the list supersede Rules low in the list.

It is important to keep in mind that this system is not designed to be exactly perfect. It will do its best job to prevent you from crossing the limit but you may often go very slightly past the current limiter value.

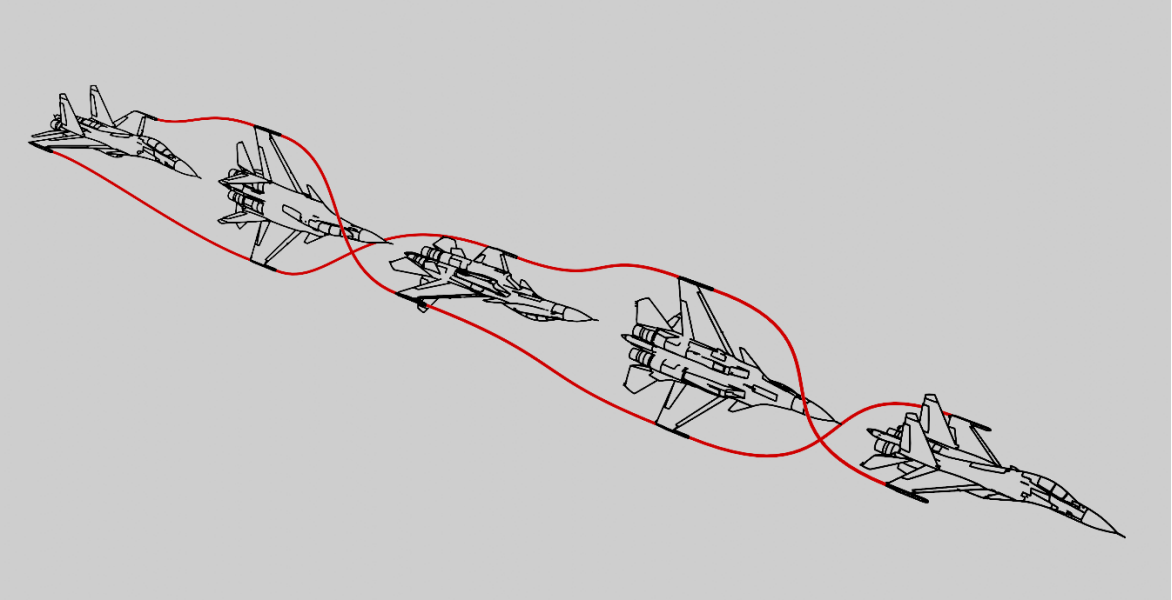
AUTOTRIM 10.0

This is one of the primary forms of Micro Adjustments. Although it is referred to as Auto Trim, it is not related to the actual trim, i.e. it does not move the flight stick and it also does not influence/interfere with the manual trim input from the pilot. Instead, it monitors pitch and uses elevators to stop unwanted pitch movement. The system only works when manual trim is set to 0 or after applying trim reset. There is between 1 and 1.5sec reaction delay so it is by no means a perfect system. We hope to make it better in the future.

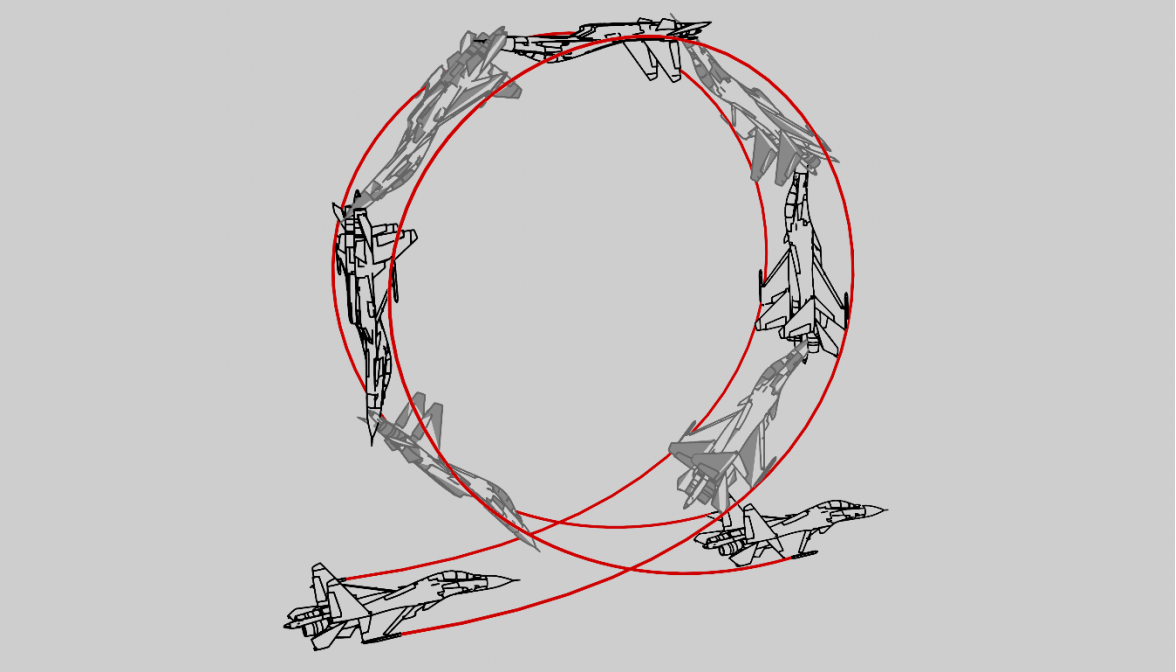
Below is a list of diagrams for 14 maneuvers. They are split into 3 different categories depending on whether the Su-30 can do it or not and also if it requires TVC or not:

1) Maneuvers that can be done with or without TVC:

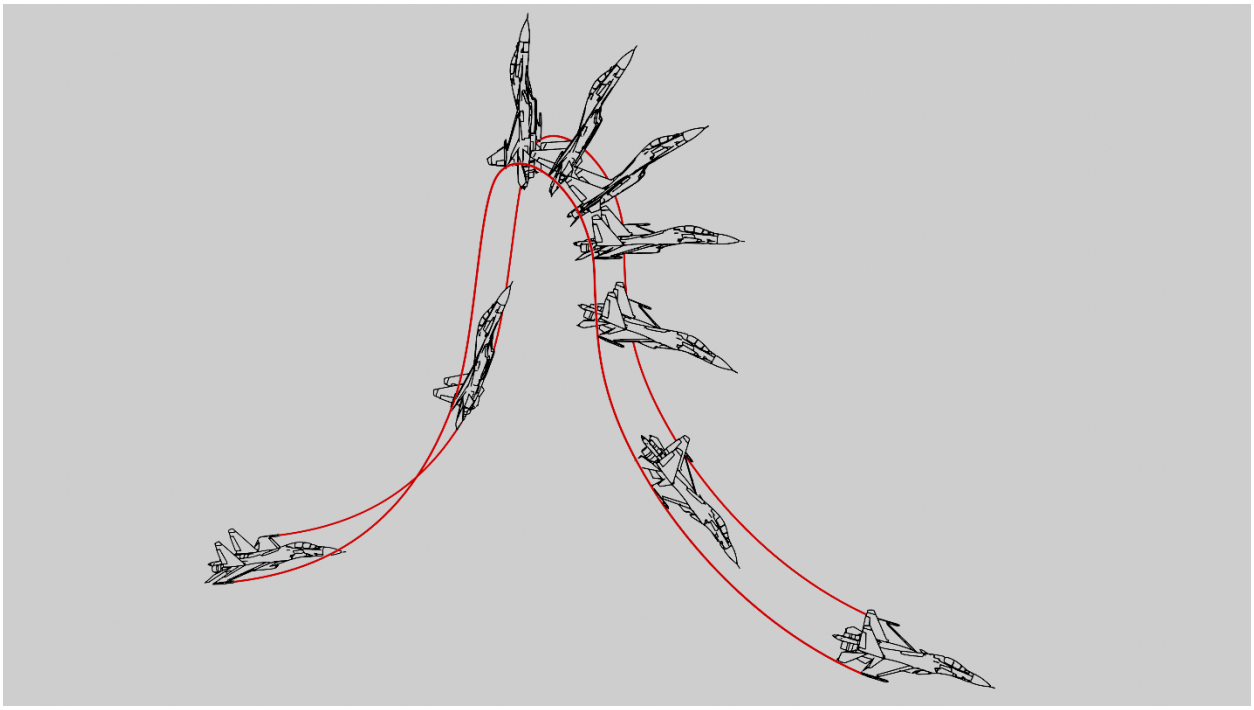
Aileron Roll:



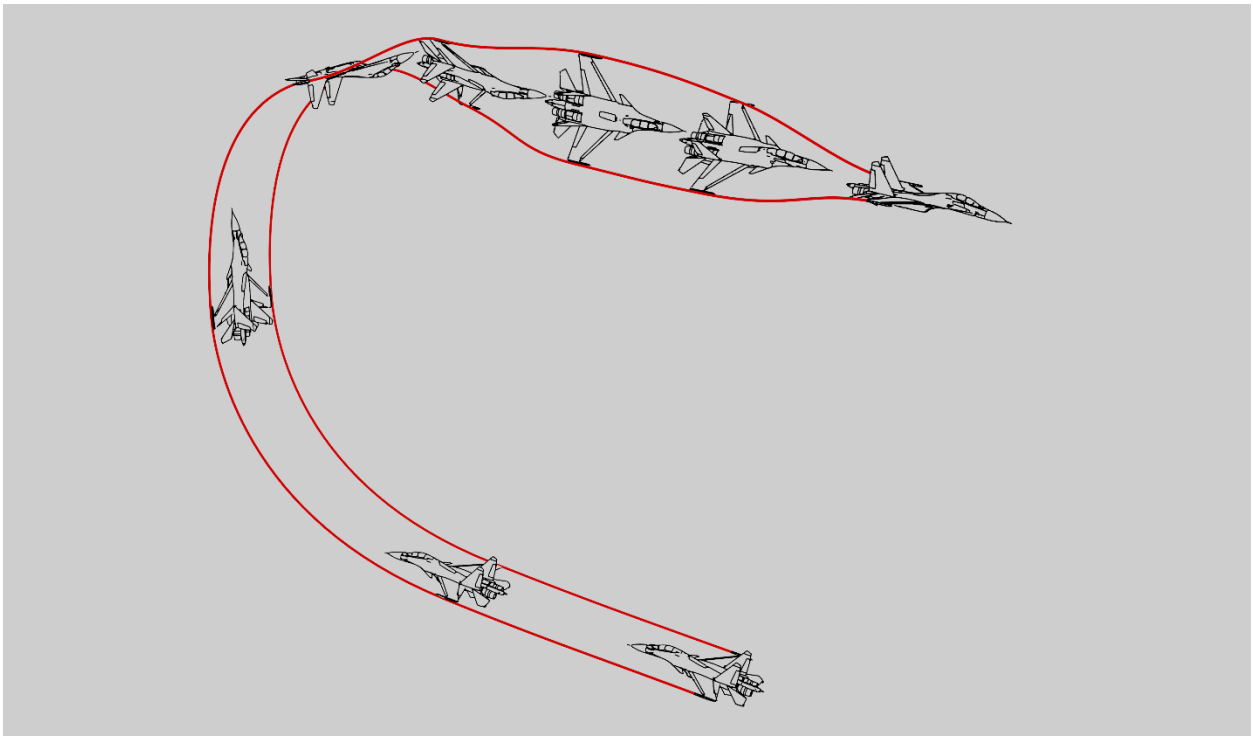
Frolov Circle:



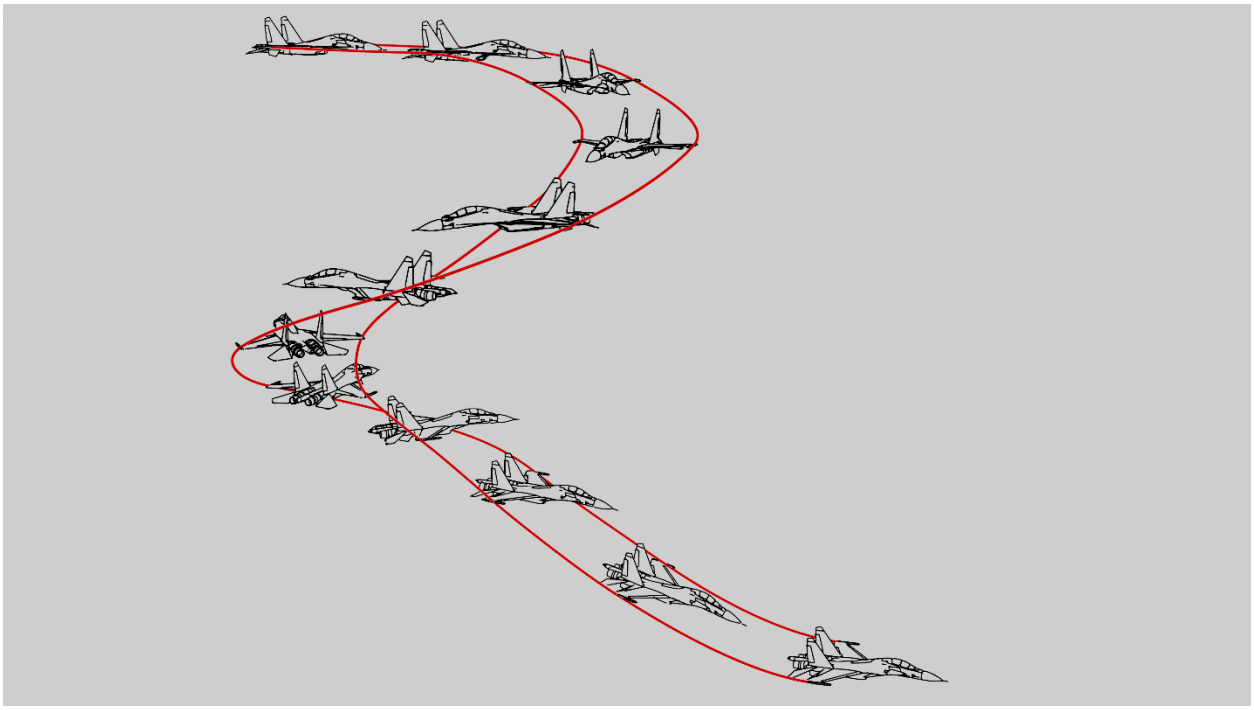
Kvochur's Bell:



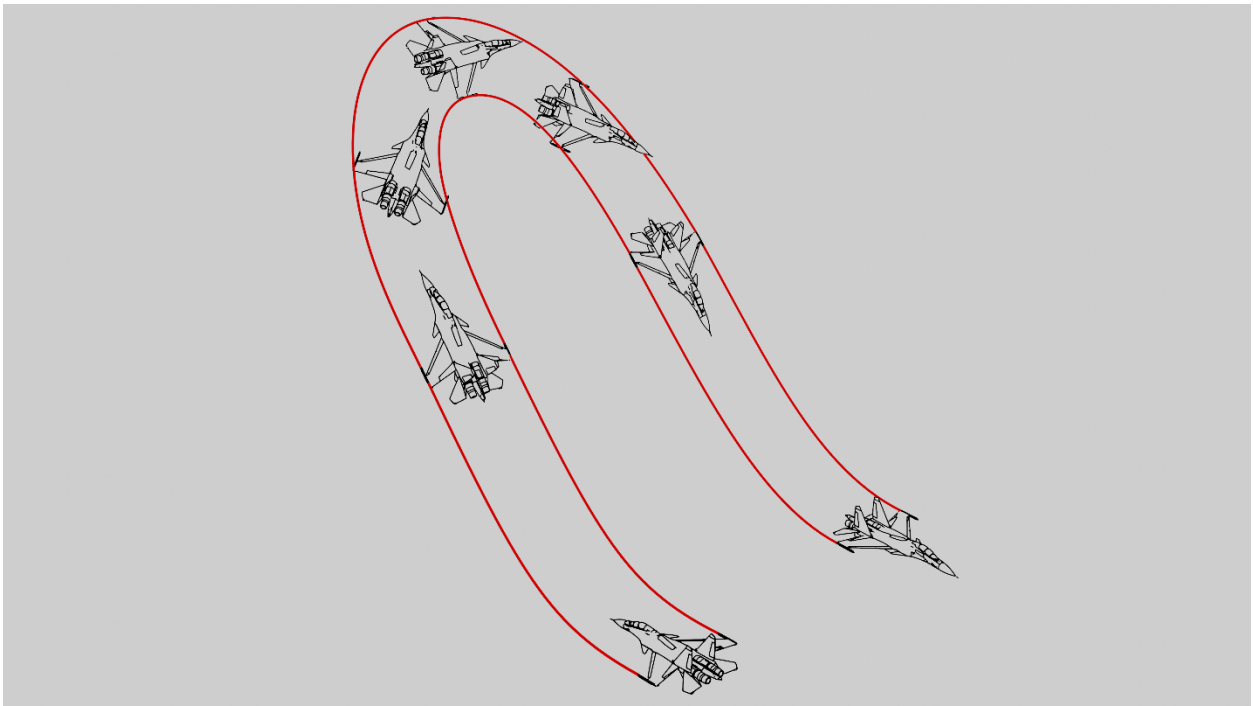
Immelmann:



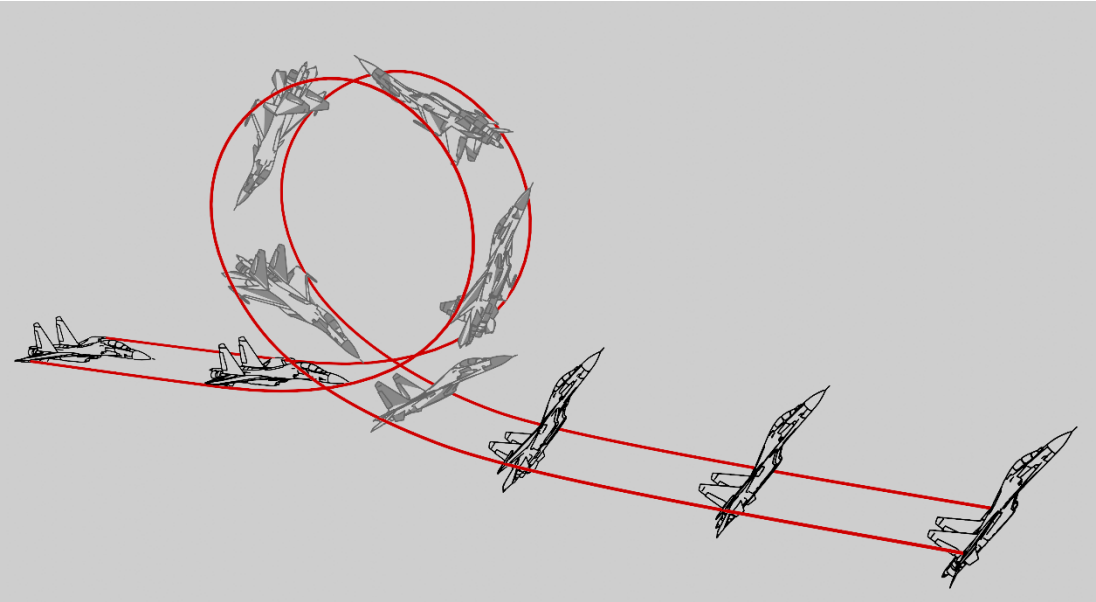
Flat Corkscrew:



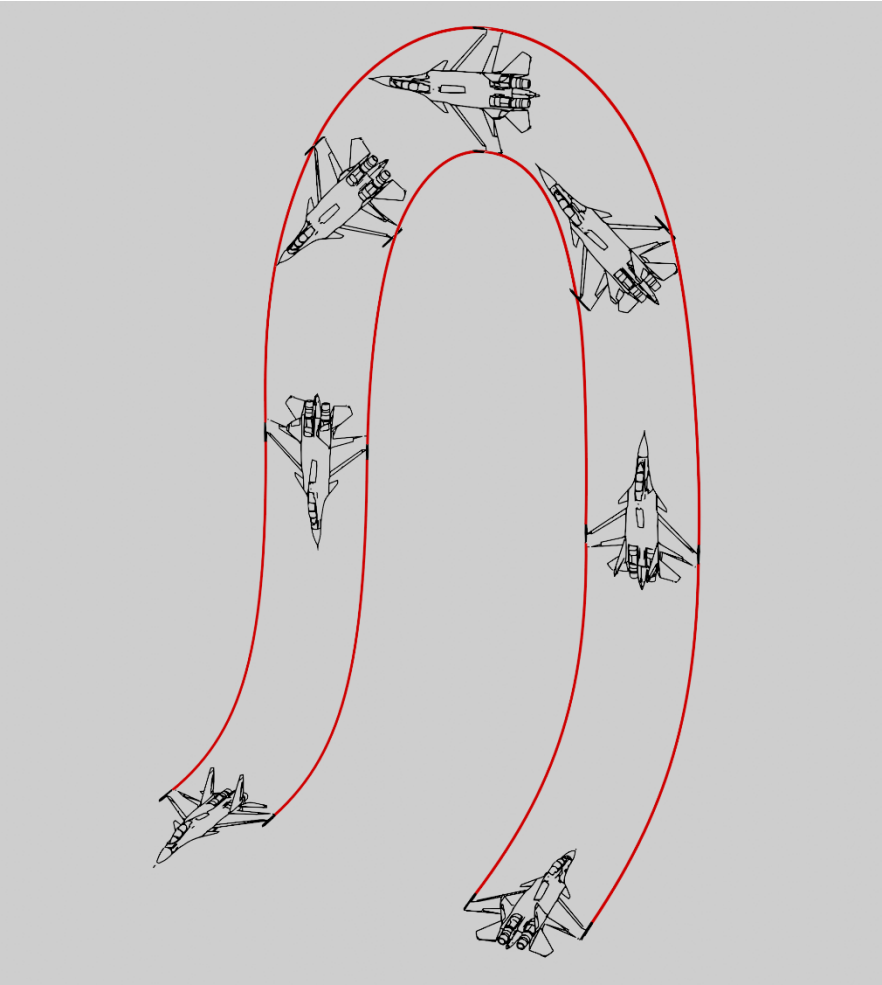
Ranversman:



Hanging on Blades:

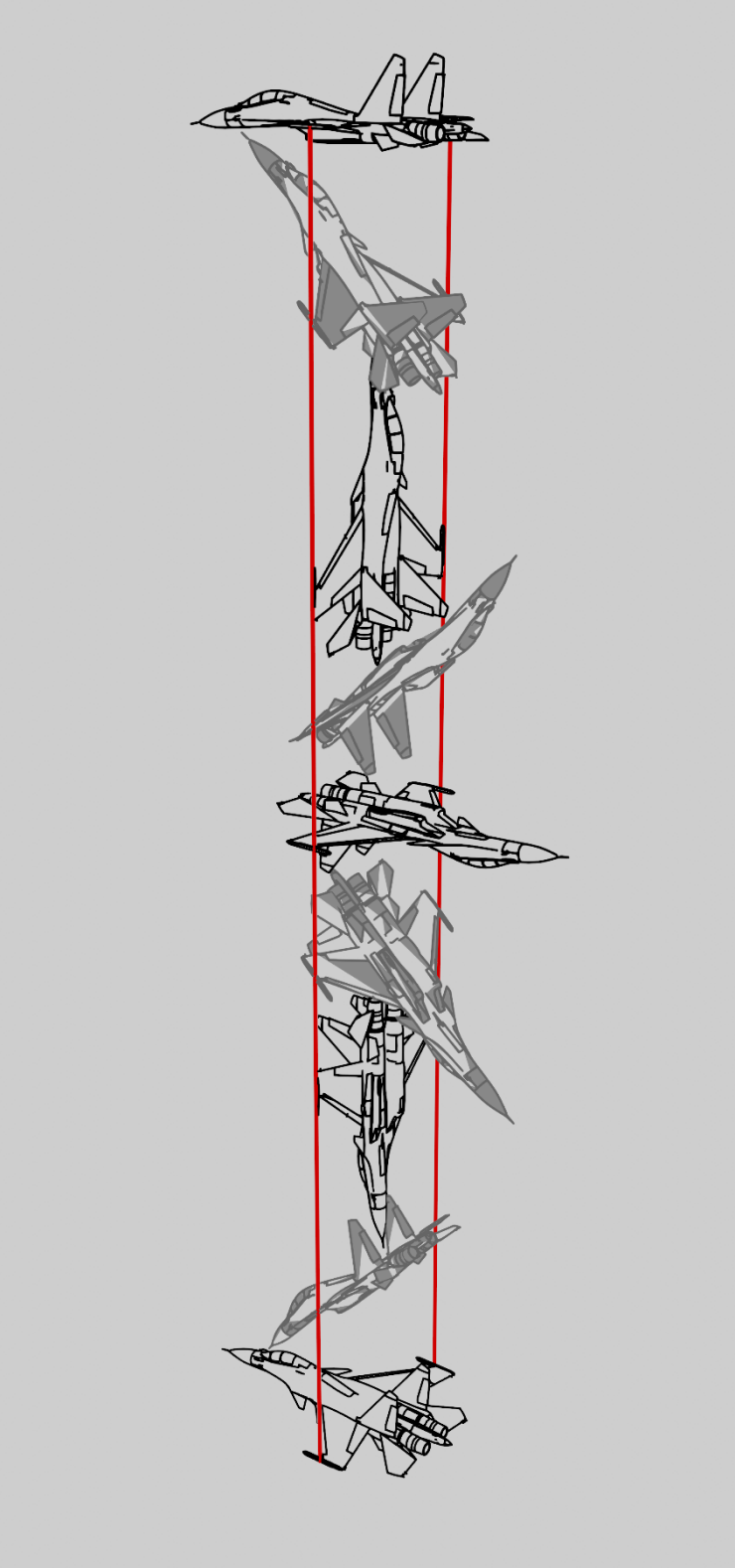


Hammerhead:

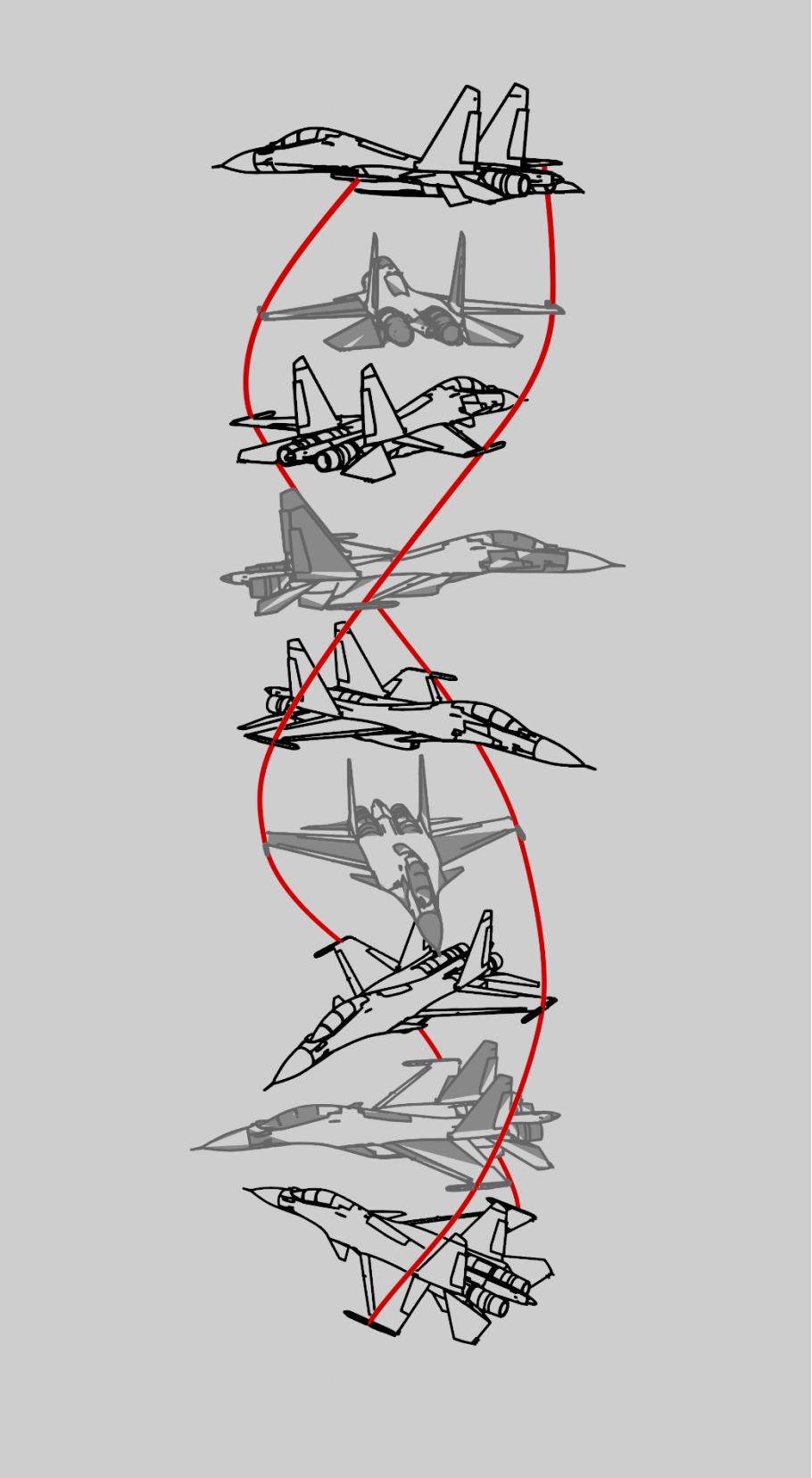


2) Maneuvers that require TVC:

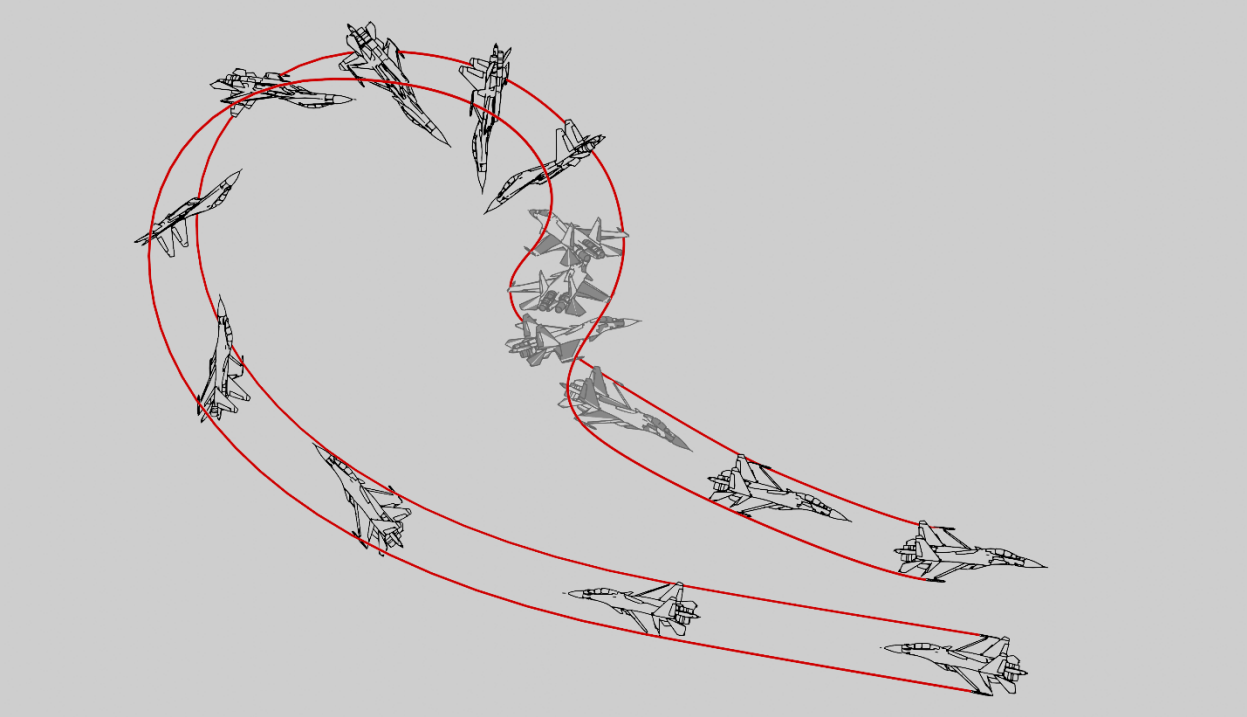
Somersault:



Falling Leaf / Flat Spin:

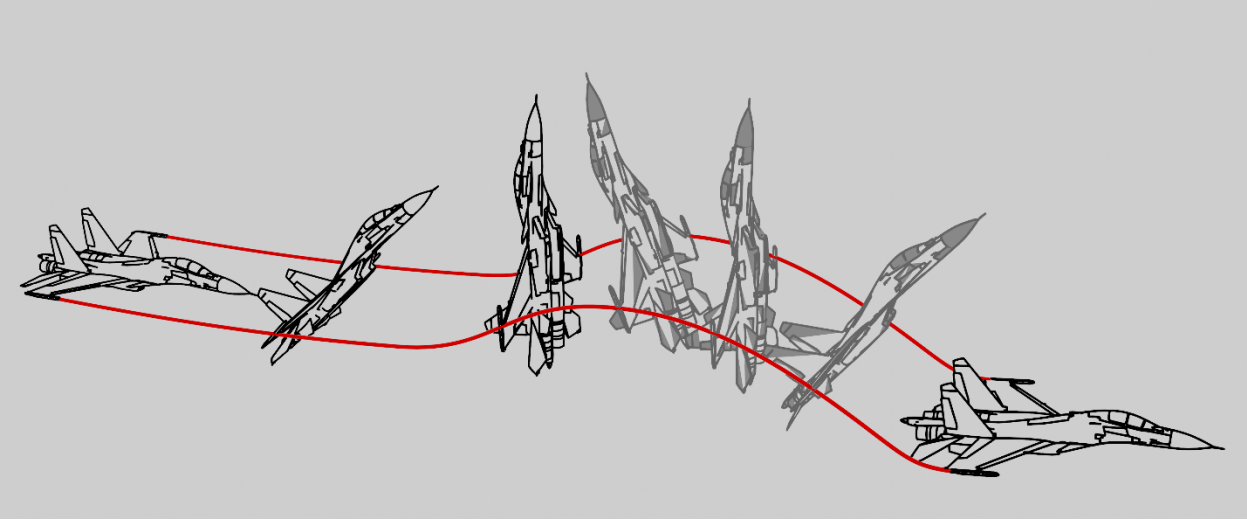


Loop Tumble Yaw:

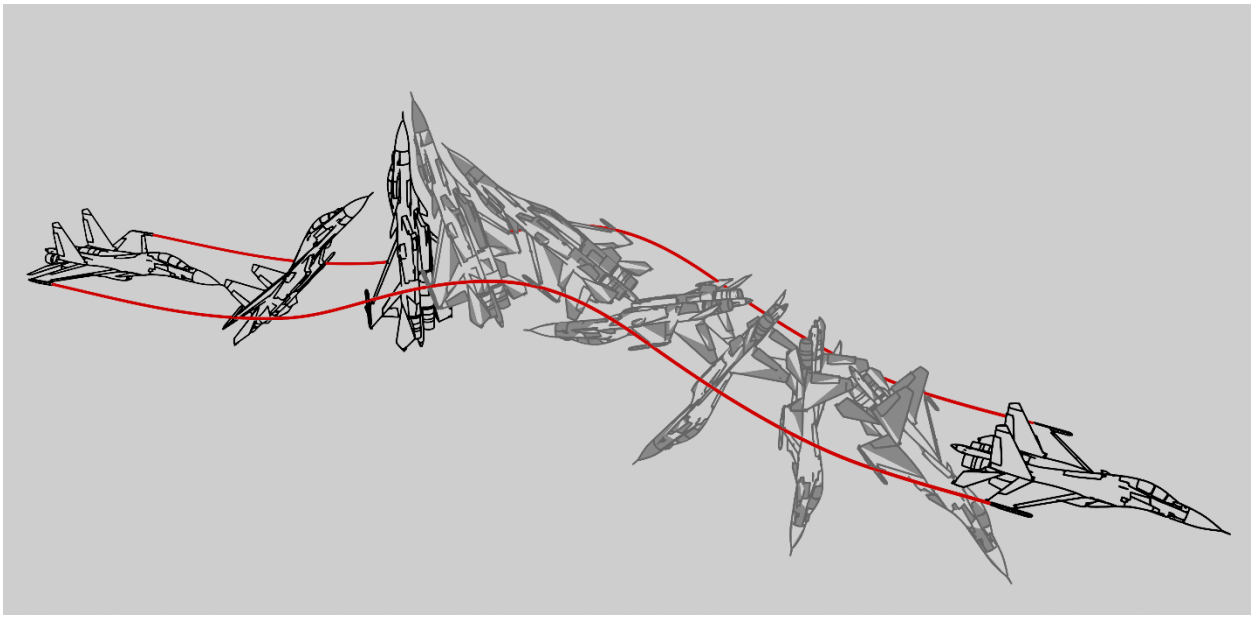


3) Maneuvers that Su-30 cannot do or do at slower pace:

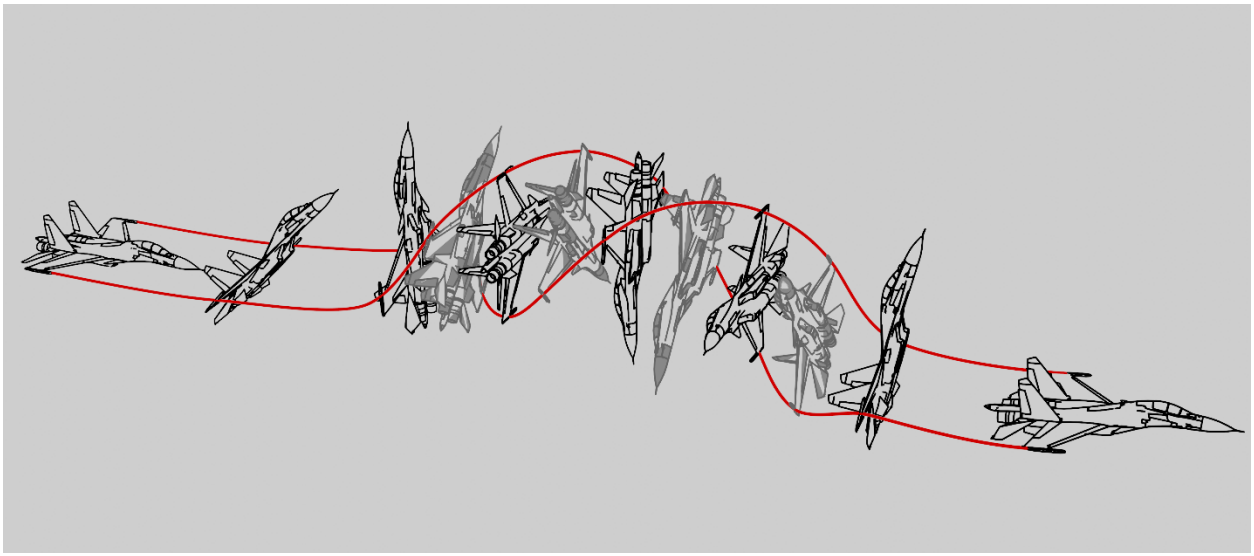
Pugachev's Cobra:



Kulbit:



Blinchik (**Блинчик**) a.k.a Pancake – The infamous Top Gun Maneuver:



ANIMATIONS & APPEARANCE 12.0

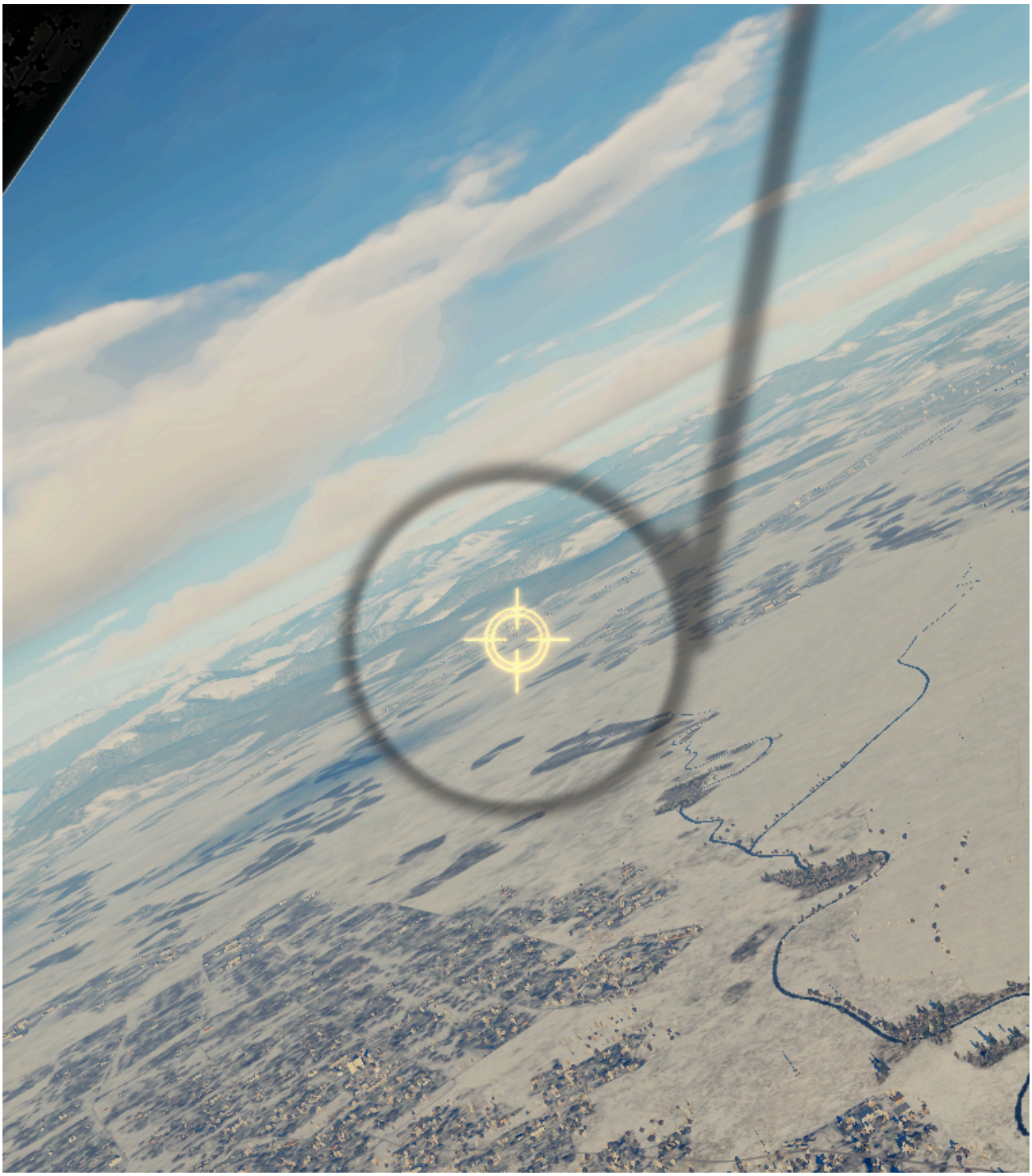
Several new very immersive animations have been added that are directly related to the flight model. Unfortunately most of these animations are client side in the current implementation due to lack of SDK. Following are brief description of some of the notable ones:

1) LERX Vortex and Overwing Vapor: Depending on airspeed, temperature, pressure, angle of attack and angle of slide, the flight model will attempt to simulate Vortex and Overwing Vapor formation:

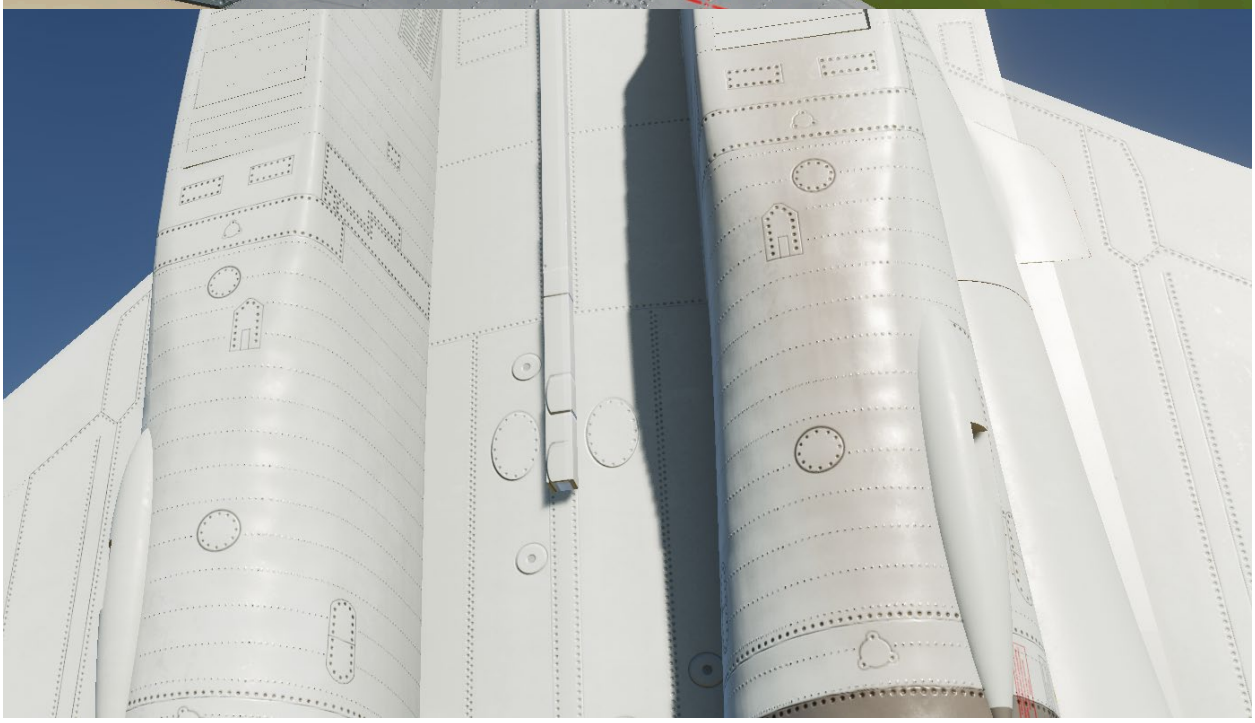
2) Shock Collar: Shock collar or more commonly known as “Vapor Cone” forms when an aircraft flies at transonic speed in air that contains very high amount of water content. Because we do not have access to SDK, the current implementation is relatively basic and the shape is not perfect. We will try to improve it in the future if possible.

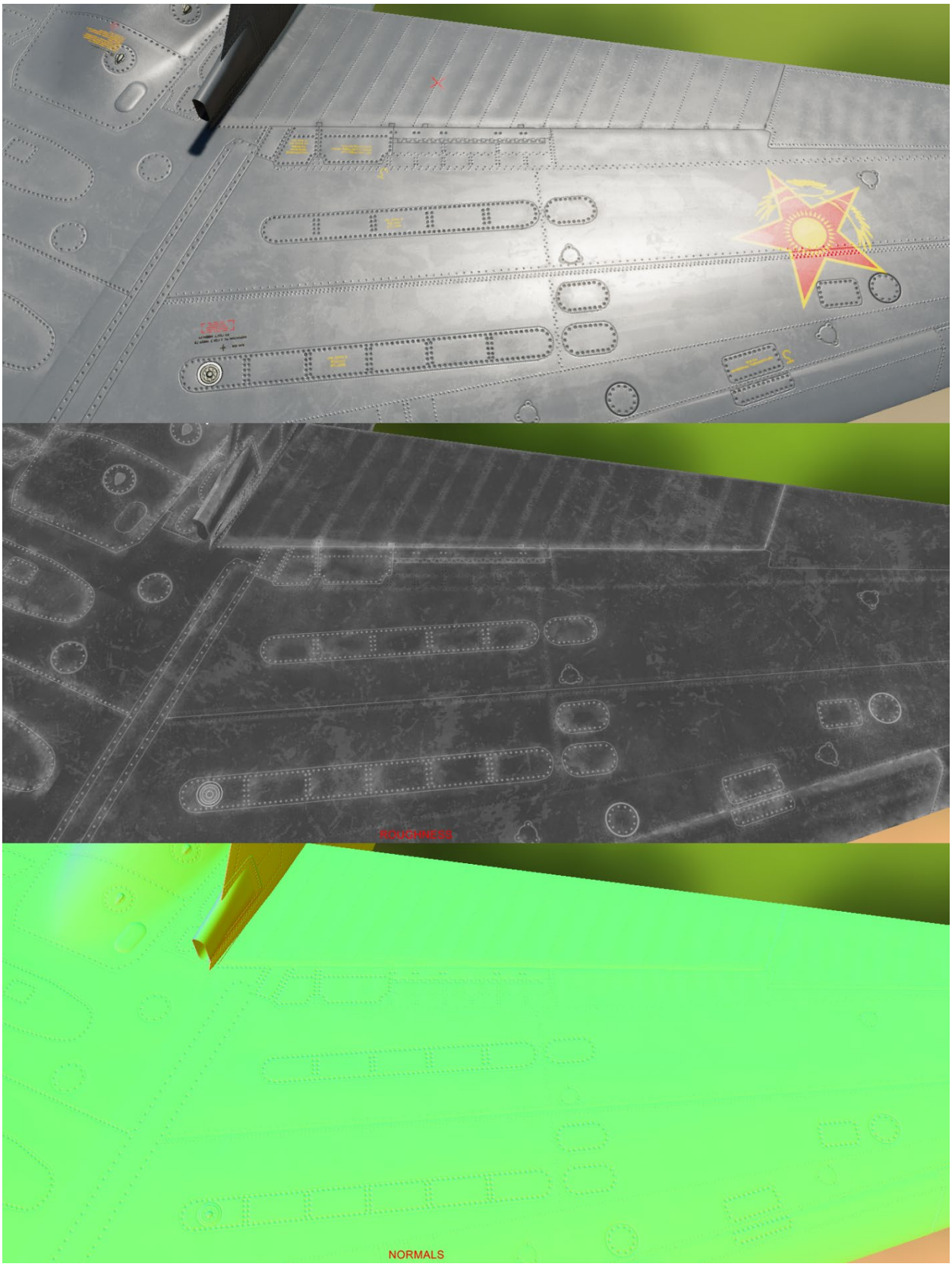
As long as you fly at transonic speed really close to water surface at very low temperature(Ideally 0deg Celsius or lower), you will be able to observe this unique phenomenon:

3) New SURA Reticle: We have updated the appearance of the reticle for the SURA helmet mounted queuing system. Note that this may not scale properly in some screens and/or aspect ratios



4) New Exterior Textures: We updated the exterior textures to better reflect how the painted sections look in real life. The strange veiny and excessively worn nature of the old texture was entirely removed and replaced with more accurate and detailed normal map as well as new more sophisticated paint material. We also added a number of new liveries.

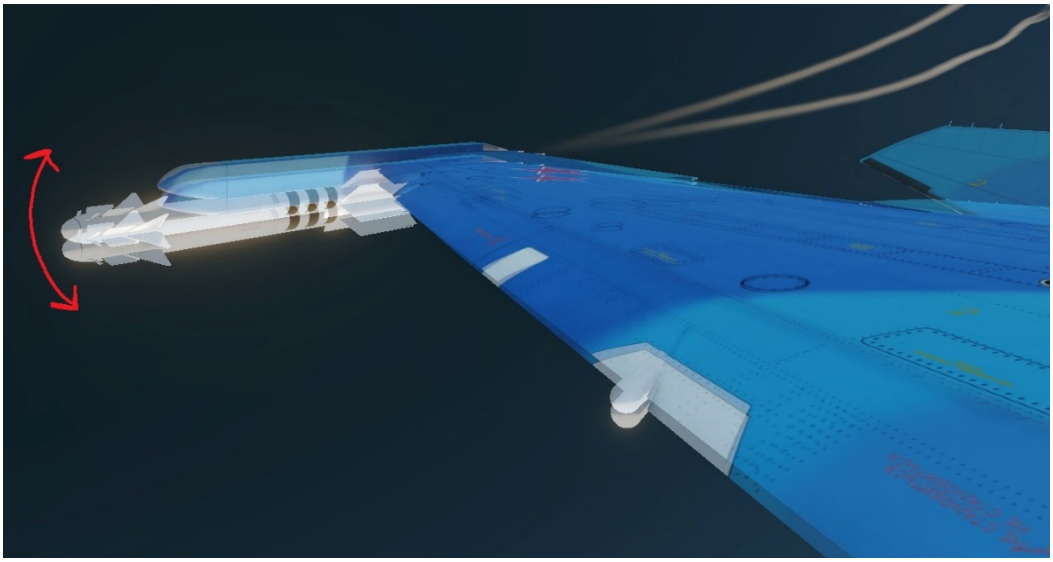



ROUGHNESS
NORMALS

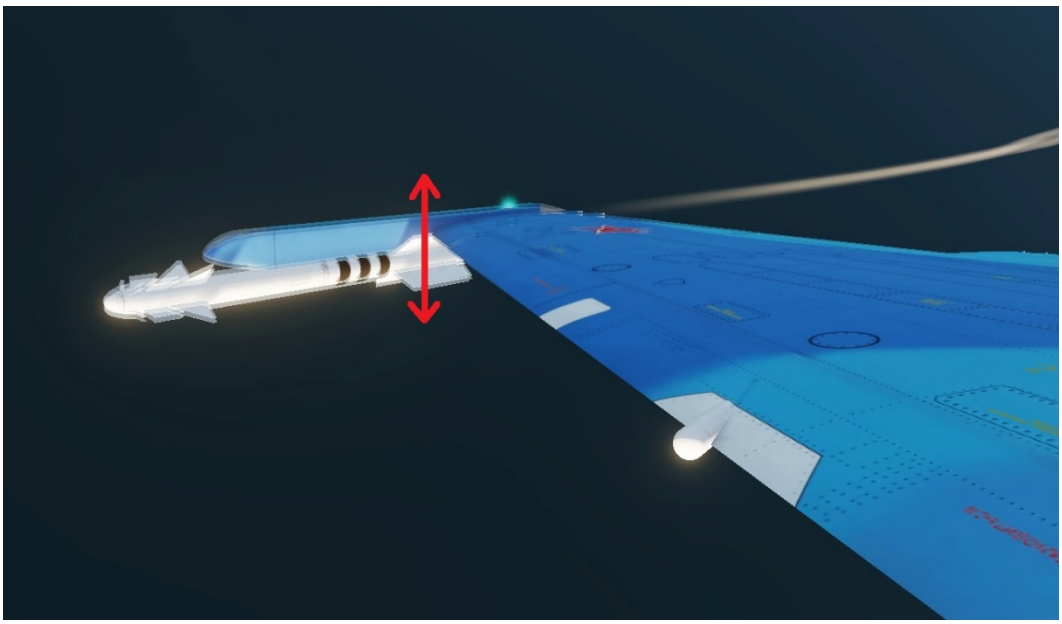

ҚАЗАҚСТАН ӘӘК

5) Vibration, Flutter and Flex: Wings and Vertical stabilizers will now bend, shake and flutter in all kinds of ways depending on dynamic pressure, angle of attack, g-force etc. The amplitude and frequency depend on the specific values of above variables and more. In case of wings, the total mass on the wingtip pylon will also have an effect on amplitude and frequency. These are very difficult to showcase using photos so it is best to experience them in game. Here are some photos sort of demonstrating a few examples:

Wing Flex:



Wingtip Flutter:



Vertical stabilizers vibrating: