Saab AJS 37 Viggen

FlightGear Flight Manual

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Introduction

The Saab 37 Viggen

The Saab 37 Viggen is a Swedish, supersonic, single-seat military aircraft, notable for its short takeoff and landing capability offered by a thrust reverser. It was developed in the 1960's, entered service in 1971, and was retired in 2005. While the Viggen was intended as a multi-role aircraft, it never truly achieved that goal—unlike its successor the JAS 39 Gripen. Instead, the Viggen was developed into a multitude of versions for different roles: surface attack (AJ 37), reconnaissance (SF 37, SH 37), and fighter interceptor (JA 37).

Specification (AJS 37)

Wing span	10.60m
Length	16.30m
Height	5.81m
Main wing area	46.00m^2
Max takeoff weight	ca. 20000kg
Max static thrust	65.6kN dry, 115.6kN with afterburner

FlightGear Model

This flight manual is intended for the Saab 37 Viggen model for the FlightGear flight simulator. The model is available through FlightGear's official hangar FGAddon. Alternatively, development versions can be found in the Github repository[1]. Two variants of the Viggen have been developed in this model:

JA 37D A modernised fighter interceptor version from the 1990's. It notably features some of the glass instrument panels used in the JAS 39 Gripen.

AJS 37 Primarily a surface attack version, which resulted out of a modification programme providing some existing Viggens with limited multi-role (attack, fighter, and reconnaissance) capabilities.

This version of the manual is for the AJS 37.

Compatibility Note This manual was designed for version 4.319 of the Viggen model. Minimum supported FlightGear version is 2018.3.x. Using the latest stable FlightGear version is generally recommended.

[1] `https://github.com/NikolaiVChr/flightgear-saab-ja-37-viggen`

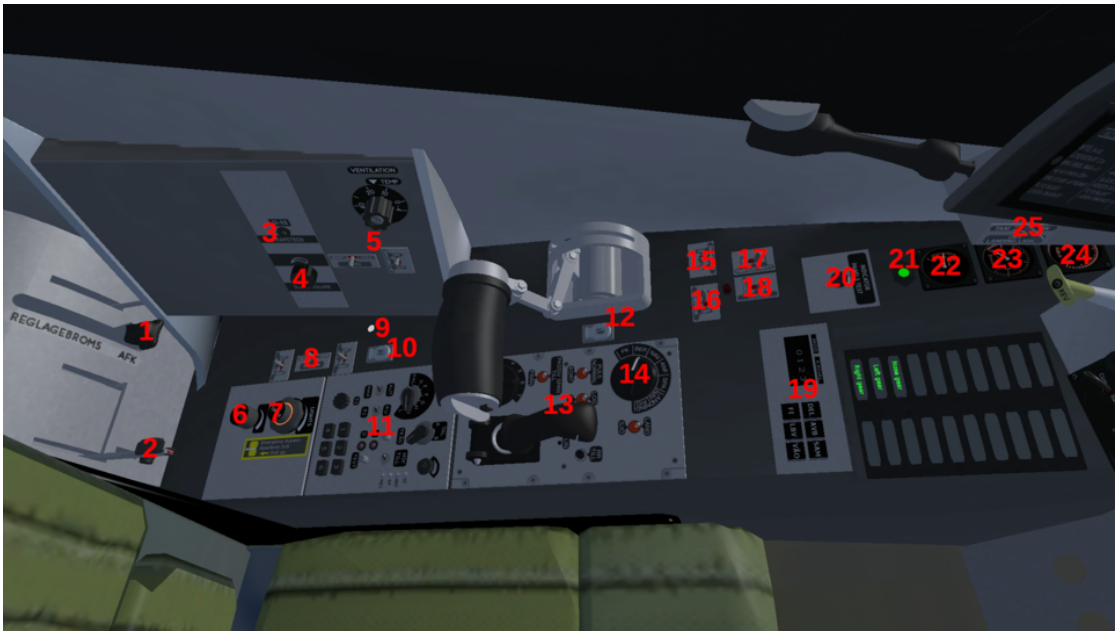
Part I

Aircraft Description

1. Cockpit Overview

1. Thrust reverser status light
2. Thrust reverser handle
3. Autopilot pushbuttons/lights
4. Autothrottle lights
5. Airspeed/Mach indicator
6. Radio frequency selector
7. Angle of attack indicator
8. Master warning lights and button
9. HUD brightness knobs
10. Attitude/director indicator (ADI)
11. Altimeter
12. Central indicator (CI)
13. Parking brake handle
14. Clock
15. HUD settings switches
16. Backup attitude indicator
17. Backup altimeter
18. Backup heading indicator
19. 'Weapon released' light
20. G-meter
21. Backup airspeed indicator
22. RPM indicator (N2)
23. Afterburner zone lights
24. Engine pressure ratio indicator
25. Transonic / low speed reverse light
26. Waypoint type / number indicator
27. Waypoint distance indicator
28. Fuel gauge
29. Left warning lights panel (cf. fig. 2.1).
30. Right warning lights panel (cf. fig. 2.1).

Figure 1.1: Cockpit—front panel



1. Autothrottle lever
2. Landing gear lever
3. IR missile quick select
4. Warning sounds volume
5. Air conditioning controls
6. Instruments light knob
7. Panel light knob
8. Backup trim controls
9. Yaw trim centered light
10. Trim reset button
11. Radio control panel (not implemented)
12. Canopy jettison button
13. Radar control panel (not implemented)
14. Main mode selector knob
15. Engine start switch
16. Generator switch
17. Master power switch
18. Fuel cutoff switch
19. Radio channel selector KV1 (not implemented)
20. Warning lights test button
21. Roll trim centered light
22. Pitch trim indicator
23. Brake pressure indicator
24. Cabin pressure indicator
25. Taxi/landing lights switch

Figure 1.2: Cockpit—left panel

1. Automatic fuel regulator switch
2. Afterburner cutoff switch
3. Emergency ram air turbine switch
4. Pitch gearing switch
5. Fuses panel
6. ILS switch
7. Weapons panel
8. Countermeasures panel
9. Manual fuel control switches
10. Ignition plug switch
11. Nozzle position indicator
12. Exhaust temperature indicator
13. Oxygen pressure indicator
14. Oxygen cutoff switch
15. Radar altimeter switch
16. DME switch—no functionality
17. Navigation panel
18. TILS channel selection knob
19. TILS channel group switch
20. Windshield defogging knob
21. Test panel
22. Data panel (not implemented)
23. RWR control panel
24. Transponder
25. Formation lights switch
26. Navigation lights switch
27. Anti-collision lights switch
28. Identification transponder panel
29. Formation lights intensity knob

Figure 1.3: Cockpit—right panel

2. Instrumentation and Indicators

2.1 Flight Instruments

Altitude Indicator (fig 1.1:11) The long pointer is graduated in 100m, the short one in 1000m. The indicator can only display altitudes in the range 0–10km, after which it will cycle back to 0.

The knob is used to set reference pressure, which is displayed in hPa on a digital counter. Pulling the knob (click the center of the knob) sets the altimeter to the standard reference pressure 1013hPa. The pressure counter is covered with the text 'STD' in this case.

The altimeter requires AC power. A red-white flag indicates power failure.

Airspeed/Mach Indicator (fig 1.1:5) The airspeed indicator is graduated in km/h on a pseudo-logarithmic scale, up to 1400km/h. The airspeed indicator is fully mechanical.

The digital Mach indicator has a range of M 0–2.5. It is partially covered at M <0.4. The Mach indicator requires AC power. A red-white flag indicates power failure of the Mach indicator (but not of the airspeed indicator).

The knob controls an index on the airspeed scale, with no functionality.

Heading Indicator (fig 1.1:12) The heading indicator forms a ring around the radar display (CI). The heading scale ring itself rotates, and is read against a fixed index. A second yellow moving index indicates bearing to the next waypoint. The heading indicator requires AC power. A red-white flag indicates power failure.

Attitude/Director Indicator (fig 1.1:10) The ADI consists of a sphere which rotates in 3 axes, indicating pitch, roll, and course. The two flight director needles (horizontal and vertical) show ILS deviation for landing. The ADI requires AC power. A red flag indicates power failure.

Angle-of-Attack Indicator (fig 1.1:7) The AoA indicator is graduated in degrees, from -4° to 30°. When on the ground, the indicator displays pitch angle instead of AoA. The AoA indicator requires DC power. In case of power failure, the pointer returns to the -4° position.

Accelerometer (fig 1.1:20) The accelerometer shows G-load (acceleration along the vertical axis), between -2g and +9g. A second pointer shows the maximum (positive) acceleration reached. The button resets the maximum acceleration pointer. The accelerometer is fully mechanical.

Clock (fig 1.1:14) The clock has two scales: the inner one indicates time, and the outer one is used for the stopwatch. The lower-left knob is used to adjust time. The top-right button controls the stopwatch. The first push starts the stopwatch, the second push stops it, and the third push resets it.

Waypoint Distance Indicator (fig 1.1:27) Indicates the distance to the next waypoint. At distances <40km, the scale is graduated in km. At distances >40km, the scale is graduated in Nordic miles (1mil = 10km), and indicates distances up to 400km. A small screen indicates the unit in use, as either 'km' or 'mil'.

Destination Indicator (fig 1.1:26) Indicates the type and number of the next waypoint. The first character indicates waypoint type: B for regular waypoints, L start and landing bases. The second character indicates waypoint number, or S for the starting base.

2.2 Backup Instruments

Backup Altimeter (fig 1.1:17) The long pointer is graduated in 100m, the short one in 1000m. The indicator can only display altitudes in the range 0–10km, after which it will cycle back to 0. The knob is used to set reference pressure, which is displayed in hPa on a digital counter. The backup altimeter is fully mechanical.

Backup Airspeed Indicator (fig 1.1:21) The backup airspeed indicator is graduated in km/h on a pseudo-logarithmic scale, up to 800km/h. It is fully mechanical.

Backup Heading Indicator (fig 1.1:18) The backup heading pointer indicates aircraft heading on a fixed scale. The backup heading indicator requires AC power.

Backup Attitude Indicator (fig 1.1:16) The backup horizon indicates pitch and roll angles. The display is mechanical, but the gyro uses AC power. A red-white flag indicates power failure. The instrument will continue to function with reasonable accuracy for a few minutes after loss of AC power.

2.3 Engine Instruments

RPM Indicator (fig 1.1:22) The RPM indicator shows high pressure compressor speed (N2), on a scale graduated up to 110%. It requires AC power.

Engine Pressure Ratio Indicator (fig 1.1:24) The EPR indicator shows the pressure ratio between the intake and the outlet of the turbine. It requires AC power.

Exhaust Gas Temperature Indicator (fig 1.3:12) The EGT gauge indicates gas temperature after the turbine (before the afterburner) in °C. It requires DC power.

Nozzle Position Indicator (fig 1.3:11) The nozzle indicator shows the position of the engine exhaust nozzle and the current afterburner zone. It requires DC power.

Afterburner Zone Indicator (fig 1.1:23) The afterburner zone lights activate to indicate the afterburner zones (1 to 3) commanded by the throttle lever position. The lights are commanded purely by the throttle position, and not the afterburner zones which are actually lit: for instance moving the throttle in the afterburner zone during thrust reverse causes the lights to activate, despite afterburner being inhibited during reverse.

Fuel Gauge (fig 1.1:28) The fuel gauge indicates fuel quantity as a percentage. Under standard conditions, the gauge indicates 107% with full internal tanks, and 132% with the external tank in addition. A second black-white pointer indicates required fuel quantity (not implemented). The fuel gauge requires AC power.

2.4 Warning Lights Panels

Figure 2.1: Left and right warning panels (fig 1.1:29 and 30)

Fire (x2) Engine fire (blinking).

Fuel distrib Fuel distribution system failure (blinking, steady if hydraulics failure).

X-Tank fuel Blinking: external fuel tank pump failure. Steady: external fuel tank pump inactive due to low engine RPM.

Tank pump Fuel pump failure (blinking, steady if electrical failure).

Gear Blinking: gear up at low speed and altitude. Steady: landing gear extending/retracting.

Stuck in rev. Thrust reverser engaged and failed (blinking).

Nose/Left/Right gear Gear down and locked (steady).

Speedbrake Blinking: speedbrakes failure. Steady: speedbrakes extended.

Electrical Failure in electrical system (blinking).

Elec. Reserve Emergency ram air turbine failure, or abnormal engagement (blinking).

Hydraulic 1/2 Low pressure in hydraulic systems (blinking).

Auto throttle Steady: normal auto-throttle disengagement. Blinking: abnormal auto-throttle disengagement, or failure. Pull auto-throttle to off (up) position to reset.

No reverse Failure of thrust reverse of tertiary air intake (blinking).

Hydr. Reserve Low pressure in backup hydraulic system (blinking).

Oil pressure Low pressure in engine oil system (blinking).

Oil temp. High engine oil temperature (blinking).

Flightstick,Attitude,Altitude Abnormal disengagement of corresponding or higher autopilot mode (blinking). To reset, acknowledge master warning, then press any autopilot button.

Fire GTS Fire in engine start system (blinking).

Pitch gearing Failure in elevator reduction gearing (blinking).

Cabin alt. Low cabin pressure (blinking).

Canopy/Seat Failure of canopy or ejection seat (blinking).

Ignition sys Engine ignition active (blinking).

Start sys Engine start sequence in progress (steady).

Man. fuel reg Automatic fuel regulation disengaged (steady).

Central CPU Main computer failure (blinking).

Primary data Flight data computer failure (blinking).

Inertia nav. Inertia navigation central aligning (steady).

Radar Radar failure (blinking).

Transponder Identification transponder failure (steady).

Alpha Failure in angle of attack sensor (blinking).

Oxygen Oxygen supply closed, or low pressure (blinking).

Outlet temp High exhaust gas temperature (blinking).

Fuel amount Low fuel quantity (blinking).

Weapons Weapon systems failure (blinking).

2.5 Other Indicator Lights

Master Warning (fig 1.1:8) The master warning consists of two flashing red lights, together with a sound warning. It generally lights up together with a light on the warning panels. Pressing the button between the lights acknowledges the warning. Depending on the nature of the warning, the master warning lights may remain steady after acknowledgement.

Reverser (fig 1.1:1) Green light, indicates that the reverser handle (fig 1.1:2) is pulled, and the reverser is armed (but not necessarily active).

Autopilot (fig 1.1:3) Three green pushbuttons/lights. Used to select one of the autopilot modes: stability assist (STICK/SPAK), attitude hold (ATT), altitude hold (ALT/HÖJD). When an autopilot mode is active, the light for it and any lower mode are lit. The lights can blink to indicate special flight conditions under which the autopilot is not fully functional.

Autothrottle (fig 1.1:4) The orange A/T (AFK) light indicates that autothrottle is active. The pushbutton/light 15,5° is used to select the high-alpha landing mode (requires landing gear down).

Transonic / Low Speed Reverse(fig 1.1:25) Yellow light, indicates that the aircraft is in the transonic regime.

On the ground, it instead lights up when the reverser is active at low airspeed, indicating a risk of hot air ingestion and engine fire. A low throttle setting (EPR<1.4) should be maintained in this case.

3. Control Panels

3.1 Main Mode Selector

The main mode selector knob fig 1.2:14 is located on the radar panel, next to the throttle. It selects an aircraft main operation mode, corresponding to different phases of a flight. The knob can be rotated with the keybindings M / ⇧+M.

3.1.1 Main Modes

FK/TST Built-in test. Not implemented (does the same as BER/PRE).

BER/PRE Standby mode. Used during start-up and taxi. The displays (HUD and CI) are turned off in this mode.

NAV Navigation mode. Used during most of the flight, including takeoff.

ANF/CBT Combat mode. Allows using weapons. See chapter 6.

SPA/REC Reconnaissance mode. Not implemented (does the same as NAV, minus the takeoff submode).

LANDING NAV Instruments landing mode. Requires the destination airport to be set in the route manager. It enables inertia navigation guidance for the approach, and ILS guidance for the final.

LANDING P/O Visual landing mode.

3.1.2 Example of Use

A typical flight may use the following modes. Initially, the mode is BER/PRE. Shortly before takeoff (e.g. when entering the runway), the mode is switched to NAV. In order to use weapons, the mode is switched to ANF/CBT, then back to NAV when resuming normal flight.

In general, LANDING mode is selected up to 20km away from the destination. LANDING NAV mode will give indications to follow a full approach pattern, and enables ILS guidance for final, if available. LANDING P/O simply gives a target glide slope indicator on the HUD, to help with visual landing. One can also begin the approach in LANDING NAV mode, and later switch to LANDING P/O to finish the approach visually.

3.1.3 Alternative Landing Approaches

For the LANDING NAV mode, the approach pattern can be changed by the following operations (called 'flip-flop').

- Switching to LANDING P/O, then back to LANDING NAV select the short approach mode, with a 10km final instead of a 20km final.
- Switching to NAV, then back to LANDING NAV resets the landing mode. A new approach pattern starts, with a long (20km) final. (any non-landing mode can be used instead of NAV).

Part II

Operation

4. Generic FlightGear Operations

4.1 Key Bindings

A summary of the key bindings can also be found in Help ⟩ Aircraft Help.

General

M / ⇧+M Rotate main mode selector knob clockwise/counterclockwise.

K / J Extend/retract airbrakes (press for ca. 2s for full extension). When the landing gear is down, airbrakes retract as soon as K is released.

ctrl+B Toggle airbrakes (simplified airbrakes control). When the landing gear is down, airbrakes retract as soon as ctrl+B is released.

← Toggle thrust reverser

⇧+R Set reference altitude (goal altitude displayed on HUD).

⇧+H Cycle HUD brightness.

I Display target type/callsign on HUD.

⇧+I Toggle between english/imperial and swedish/metrics display modes.

⇧+PageUp / ⇧+PageDown Raise/lower seat position.

O Open/close canopy.

ctrl+E ×3 Eject

J Jettison drop tank (in flight only).

⇧+S Acrobatic smoke.

ctrl+Y Ask tower for landing airport information (requires runway selected in route manager).

View

Q Reset view.

ctrl+Q Zoom on radar display.

ctrl+⇧+Q Zoom on HUD.

Autopilot

ctrl + T Autopilot stability assist mode.

ctrl + W Autopilot attitude hold mode.

ctrl + A Autopilot altitude hold mode.

ctrl + D Disengage all autopilot modes.

ctrl + S Toggle autothrottle lever.

ctrl + G Autothrottle quick disengage.

ctrl + ← / ctrl + → Trim yaw, or adjust autopilot heading/bank angle.

Radar Controls

R Toggle radar.

Y Use flight controls to controls radar cursor.

[/] Decrease/increase radar range (positions: 15km, 30km, 60km, 120km).

N Select next radar track.

⇧ + N Select center-most radar track.

ctrl + N Set next waypoint as radar target.

⇧ + F Unlock radar track.

Combat

C Cycle weapons.

U Select IR missile

⇧ + U Uncage IR missile seeker (requires lock). Held: cage/reset IR missile seeker.

⇧ + E Toggle trigger safety.

E Fire weapon.

Q Release flare/chaff.

4.2 AJS 37 Menu

The menu AJS-37 contains Viggen-specific dialogs and menus. The following entries are present.

Select Livery There is a variety of liveries available, both historical and fictional.

Auto start/stop Lets you start and stop the plane without needing to switch switches etc. yourself. The progress is shown in the top centre of the screen in blue text. The final notification of the start-up sequence is 'Engine ready'. The shut-down sequence is done, when the aircraft is dark.

Repair Repairs system failures when on the ground. In case of a full crash, this option is mostly useless; one should restart instead, for instance with Location » Select Airport.

Fuel/Loadout The fuel slider allows quick selection of fuel quantity, while ensuring proper fuel balance. Fuel quantity is indicated as a percentage, which corresponds to the fuel gauge reading. A level of 100% corresponds slightly less than full internal tanks.

The loadout selection buttons in the rest of the screen allow fast selection of preset historical weapon loadouts. The button Clean loadout removes any loaded weapon. The button Reload ammo/flares reloads ammunition for guns, rocket pods and bomb racks, as well as flares.

Compared to the standard dialog Equipment » Fuel and Payload, this dialog is quicker and ensures some realism, but allows less choices.

Performance monitor Display aircraft performance (mostly for development).

Systems monitor Display internal status of some systems (mostly for development).

Toggle external power External electrical power, normally used for startup. An electrical power truck is shown to the right of the aircraft when enabled. Only available when fully stopped.

Options Viggen specific configuration options, see section 4.3.

4.3 AJS 37 Options

The dialog AJS-37 » Options contains the following configuration options.

HUD line width Allows to improve HUD visibility if necessary.

G-suit quality Changes resistance to blackout under high G-load.

Cockpit labels in Swedish Enable historical Swedish cockpit, instead of the English translation.

The cockpit translation is far from complete: parts of the cockpit will be in English, and others in Swedish, regardless of this setting.

This option is for *physical labels* only, and should not be confused with the next one which affects displays.

HUD/TI in metric units and Swedish Change the unit system and language used in displays. Shortcut: ⇧ + I.

This option is for *displays* only and should not be confused with the previous one which affects physical displays.

Rust on fuselage Purely visual. Only available when using the Atmospheric Light Scattering (ALS) FlightGear renderer.

Rust in cockpit Purely visual. Only available when using the Atmospheric Light Scattering (ALS) FlightGear renderer.

Enable multiplayer damage Allows to deal and receive damage from other compatible aircrafts (other Viggens, F-14, F-15, F-16, M-2000, MiG-21, etc.) in multiplayer. This requires *both* involved aircraft to enable damage.

For fairness, this option can only be toggled when stopped on the ground. It also enforces some realism options: blackout, normal simulation speed, no external views, and disabling fuel, payload and repair menus while in flight.

5. Standard Procedures

To come! Please check FlightGear built-in checklists Help » Aircraft Checklists in the meantime.

6. Weapons Operation

6.1 Generalities

The generic weapon employment procedure is the following.

1. Main mode selector to ANF/CBT. (fig 1.2:14, shortcuts M/⇧+M). Combat mode will only be enabled in the air with gear up and locked. In combat mode, the HUD presentation changes slightly. Weapon type is indicated in the lower left, ammunition in the lower right.
2. Select the weapon type with C, or U to select IR missiles.
3. Unsafe the trigger with ⇧+E. This arms the selected weapon.

   For gun, rockets, and bombs, the aim (or CCIP) indicator appears on the HUD. Missiles will start looking for a target.

   Trigger unsafing is normally done once the target is in sight or on radar, and the choice to engage it has been made.
4. For missiles, ensure that the missile has locked onto the target.
5. Fire the weapon with E.
6. Secure the trigger with ⇧+E.

6.1.1 Trigger Safety Usage

The trigger safety role is not merely to prevent unintentional fire. It is an import part of the fire control system: as a general rule, the trigger safety arms the selected weapon. As a consequence, improper use of trigger safety will prevent weapon usage. Below are some errors and caveats to look out for.

- Unsafing the trigger arms the selected weapon. Thus it must be done *after* entering combat mode and selecting the desired weapon.
- If a new weapon is selected while the trigger is unsafe, the new weapon will not be armed (until the trigger is safed and unsafed again).

  Similarly, if the trigger is kept unsafe while exiting combat mode, upon re-entering combat mode, the weapon will not be armed.
- After firing a missile, the next missile is only selected upon securing the trigger. It is not possible to fire several missiles in succession without securing the trigger in-between.

6.2 Rb 05A

The Rb 05A is a remote-controlled missile. It is primarily intended for use against ground and naval targets, but can also be used against slow-manoeuvring air targets thanks to a proximity fuse. The missile is guided visually by the pilot. A flare at the back of the missile helps the pilot to keep sight of it (fig. 6.1).

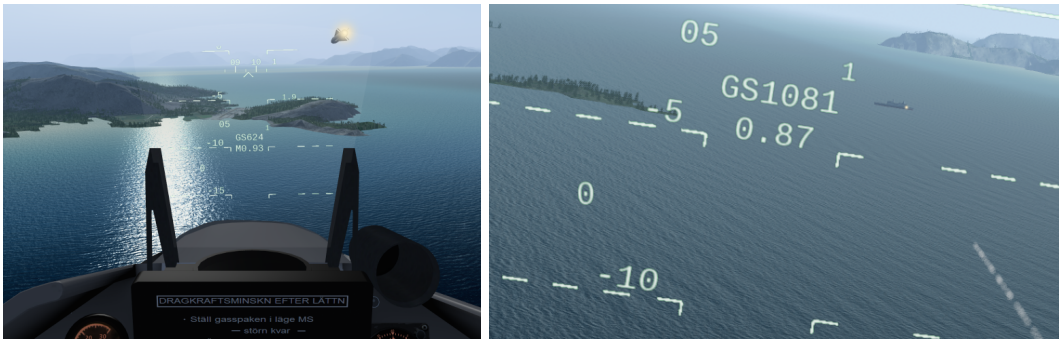


Figure 6.1: Rb 05A flare for visual guidance. On the left, the missile is entering the pilot's field of view just after launch. On the right, the missile is about to hit the target ship, and the missile flare is visible over the ship

6.2.1 Controls

In flightgear, there are two options to control the Rb 05A (note: these controls are the same as for the JA 37 radar cursor).

- Bind the controls to a joystick axis File > Joystick Configuration. The controls are named Cursor Horizontal and Cursor Vertical.

  Alternatively, manually edit the joystick configuration files to bind the properties

  ```
  /controls/displays/cursor-slew-x
  /controls/displays/cursor-slew-y
  ```

- Press Y to use the main flight controls (joystick, mouse, arrow keys, whatever you use to control the aircraft) to instead control the Rb 05A. Normal flight controls are restored by pressing Y again. A ground collision warning will also immediately restore normal flight controls.

  It is recommended to enable autopilot before doing so.

6.2.2 Procedure

1. Main mode selector to ANF/CBT. (fig 1.2:14, shortcuts M/⇧+M).
2. Select the Rb 05A (cycle weapons with C).
3. Once in firing position, consider engaging autopilot in ATT or HÖJD/ALT mode to reduce pilot workload.
4. Identify the target visually.
5. Unsafe the trigger and fire within 9km of the target.
6. After 1.7s, missile controls are enabled. At this point, it should be well within the pilot field of view.
7. When the missile hits, take evasive manoeuvres, secure the trigger, and switch to NAV mode.

Remarks.

- Recommended speed is 700-1150 km/h.
- Recommended attitude is a level flight or slight dive, so as to not loose sight of the target and the missile.
- Recommended altitude is 300-400 meters above ground.
- The target do not need to be directly in front of the aircraft as the missile can be guided considerably to the side. However, doing so makes it harder to aim the missile, and reduces effective range.
- The missile flies for ca. 24 seconds, giving it a maximum effective range of ca. 9 km.
- It is easiest to aim the missile using the collimation principle: try to keep the missile flare covering the target at all time.