JUNKERS JU-88 A-1

GUIDE BY CHUCK

PERFORMANCE SHEET

	(Unit)	SPITFIRE Mk Ia 100 oct	HURRICANE Mk IA Rotol 100oct	BLENHEIM Mk IV	TIGER MOTH DH.82	BF.109 E-4	BF.110 C-7	JU-87B-2 STUKA	JU-88 A-1	HE-111 H-2	G.50 SERIE II	BR.20M
TEMPERATURES												
Water Rad Min Max	Deg C	60 115	60 115	-	-	40 100	60 90	38 95	40 90	38 95	-	-
Oil Rad (OUTBOUND) Min Max	Deg C	40 95	40 95	40 85	-	40 105	40 85	30 95	40 80	35 95	50 90	50 90
Cylinder Head Temp Min Max	Deg C	-	-	100 235	-	-	-	-	-	-	140 240	140 240
ENGINE SETTINGS												
Takeoff RPM	RPM	3000	3000	2600 FINE	2350	2400	2400	2300	2400	2400	2520	2200
Takeoff Manifold Pressure	UK: PSI GER: ATA ITA: mm HG	+6	+6	+9 BCO ON	See RPM Gauge	1.3	1.3	1.35	1.35	1.35	890	820 BCO ON
Climb RPM	RPM	2700	2700	2400 COARSE	2100	2300 30 min MAX	2300 30 min MAX	2300 30 min MAX	2300 30 min MAX	2300 30 min MAX	2400 30 min MAX	2100 30 min MAX
Climb Manifold Pressure	UK: PSI GER: ATA ITA: mm HG	+6	+6	+5	See RPM Gauge	1.23	1.2	1.15	1.15	1.15	700	740
Normal Operation/Cruise RPM	RPM	2700	2600	2400 COARSE	2000	2200	2200	2200	2100	2200	2100	2100
Normal Operation/Cruise Manifold Pressure	UK: PSI GER: ATA ITA: mm HG	+3	+4	+3.5	See RPM Gauge	1.15	1.15	1.1	1.1	1.10	590	670
Combat RPM	RPM	2800	2800	2400 COARSE	2100	2400	2400	2300	2300	2300	2400	2100
Combat Manifold Pressure	UK: PSI GER: ATA ITA: mm HG	+6	+6	+5	See RPM Gauge	1.3 5 min MAX	1.3 5 min MAX	1.15	1.15	1.15	700	740
Emergency Power/ Boost RPM @ km	RPM	2850 5 min MAX	2850 5 min MAX	2600 COARSE 5 min MAX	2350	2500 1 min MAX	2400 5 min MAX	2300 1 min MAX	2400 1 min MAX	2400 1 min MAX	2520 3 min MAX	2200 5 min MAX
Emergency Power / Boost Manifold Pressure @ Sea Level	UK: PSI GER: ATA ITA: mm HG	+12 BCO ON	+12 BCO ON	+9 BCO ON	See RPM Gauge	1.40 1 min MAX	1.3 5 min MAX	1.35 1 min max	1.35 1 min max	1.35 1 min max	890 3 min max	820 BCO ON 5 min MAX
Supercharger Stage 1 Operation Altitude	UK: ft GER: M	-	-	-	-	-	-	0 1500	0 1220	0 1220	-	-
Supercharger Stage 2 Operation Altitude	UK: ft GER: M ITA: M	-	-	-	-	-	-	1500+ (AUTO/MAN MODES)	1220+	1220+	-	-
Landing Approach RPM	RPM	3000	3000	2400	As required	2300	2300	2000	2100	2300	2400	2200
Landing Approach Manifold Pressure	UK: PSI GER: ATA ITA: mm HG	As required	As required	As required	See RPM Gauge	As required	As required	As required	As required	As required	As required	As required
Notes		Use "Rich" mixture for normal operation. Use "Lean" mixture for fuel conservation for RPM under 2600 & boost @ +1 or lower.		Boost Cut-Out Override (BCO) during takeoff often required	**Min Oil Press: 35 psi** **Max Oil Press: 45 psi**			No Abrupt Throttling	Eng. very sensitive to ata/rpm	Eng. very sensitive to ata/rpm		Boost Cut-Out Override (BCO) during takeoff often required
AIRSPEEDS												
Takeoff – Rotation	UK: mph GER/ITA: km/h	120	120	110	55	180	190	170	185	150	170	175
Max Dive Speed		420	390	260	160	750	620	720	675	600	410	600
Optimal Climb Speed		165	175	135	66	240	270	215	250	240	240	210
Landing – Approach		160	160	140	55	200	220	170	200	200	175	175
Landing – Touchdown		90	90	85	50	160	180	150	180	140	160	160

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PART 1: AIRCRAFT HISTORY

Designed by W. H. Evers and Alfred Gassner of Junkers Flugzeug- und Motorenwerke (JFM) in the mid-1930s, the Ju-88 was to be a so-called Schnellbomber ("fast bomber") which would be too fast for any of the fighters of its era to intercept. The **Junkers Ju-88** suffered from a number of technical problems during the later stages of its development and early operational roles, but became one of the most versatile combat aircraft of the war. Like a number of other Luftwaffe bombers, it was used successfully as a bomber, dive bomber, night fighter, torpedo bomber, reconnaissance aircraft, heavy fighter and even, during the closing stages of the conflict in Europe, as a flying bomb.

PART 1: AIRCRAFT HISTORY

The Ju-88 was designed as a twin engine high speed bomber that became one of the most versatile bombers in the Luftwaffe and was pretty much a “Jack of all Trades”. The A-1 is capable of level bombing, glide bombing, and dive bombing just like a Stuka. In Cliffs of Dover, it is capable of carrying a 2400 kg bomb load. In real life, it could carry an even heavier payload.

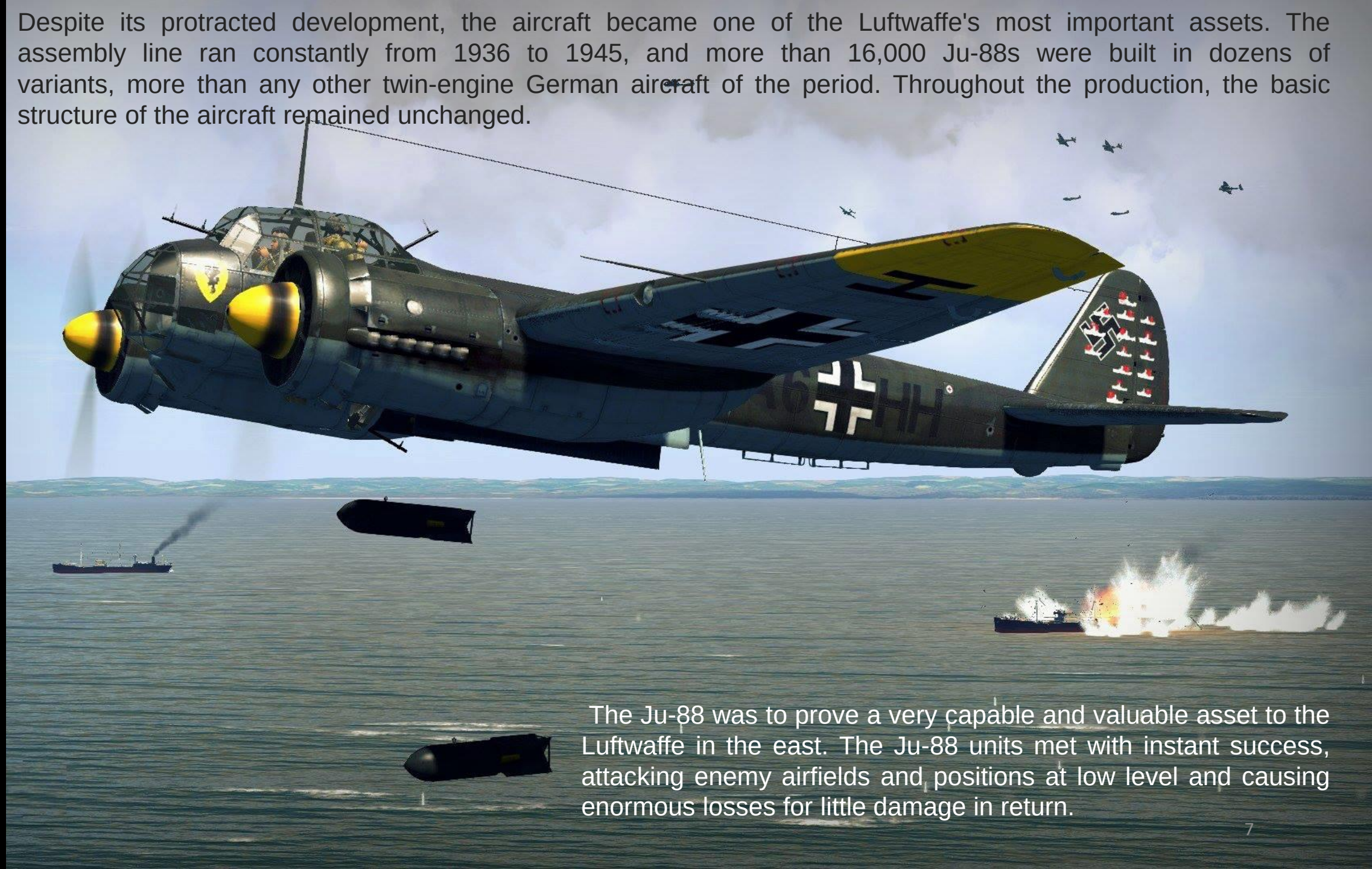
PART 1: AIRCRAFT HISTORY

It was during the closing days of the Battle of Britain that the flagship Ju-88 A-4 went into service. Although slower yet than the A-1, nearly all of the troubles of the A-1 were gone, and finally the Ju 88 matured into a superb warplane. The A-4 actually saw additional improvements including more powerful engines, but, unlike other aircraft in the Luftwaffe, did not see a model code change.

By August 1940, Ju-88 A-1s and A-5s were reaching operational units, just as the Battle of Britain was intensifying. The battle proved very costly. Its higher speed did not prevent Ju-88 losses exceeding those of its Dornier Do 17 and Heinkel He-111 stablemates, despite being deployed in smaller numbers than either.

PART 1: AIRCRAFT HISTORY

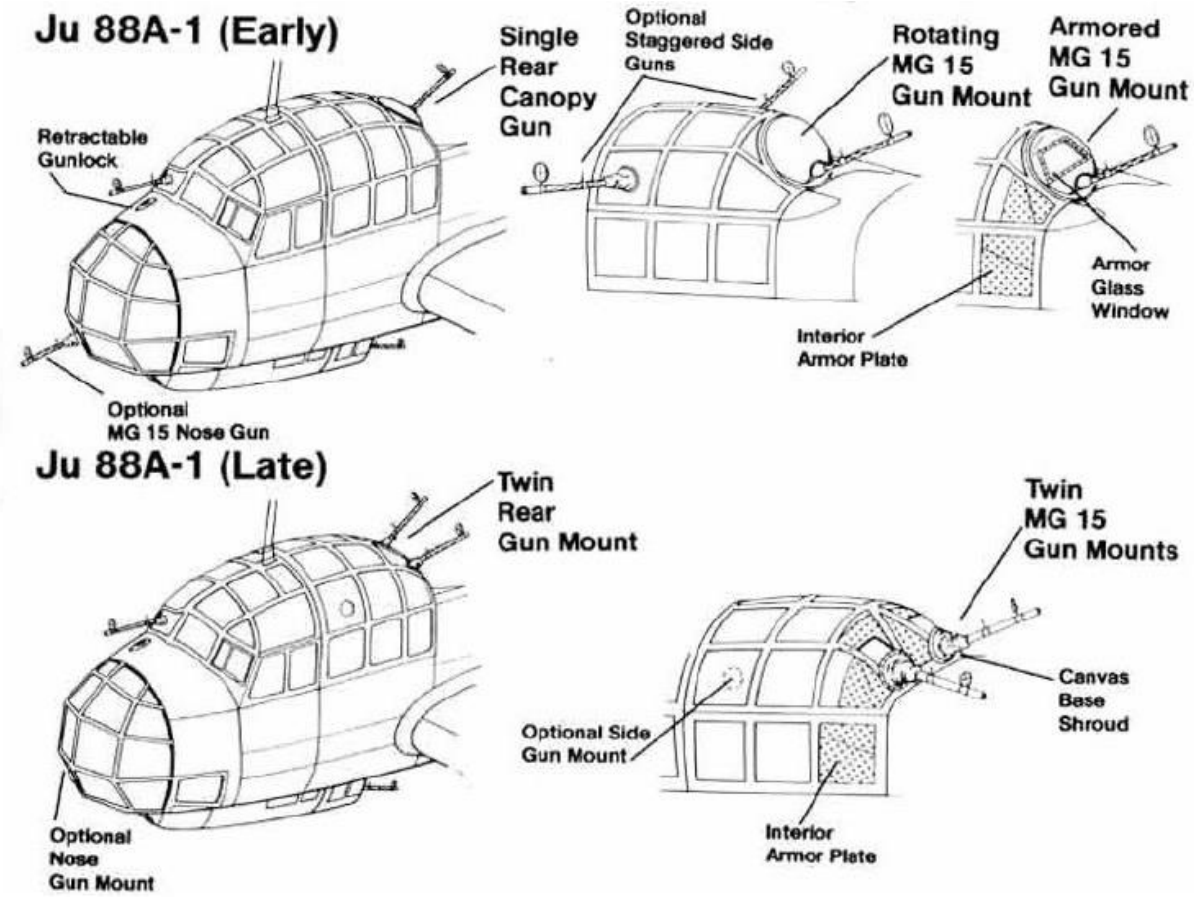
Despite its protracted development, the aircraft became one of the Luftwaffe's most important assets. The assembly line ran constantly from 1936 to 1945, and more than 16,000 Ju-88s were built in dozens of variants, more than any other twin-engine German aircraft of the period. Throughout the production, the basic structure of the aircraft remained unchanged.



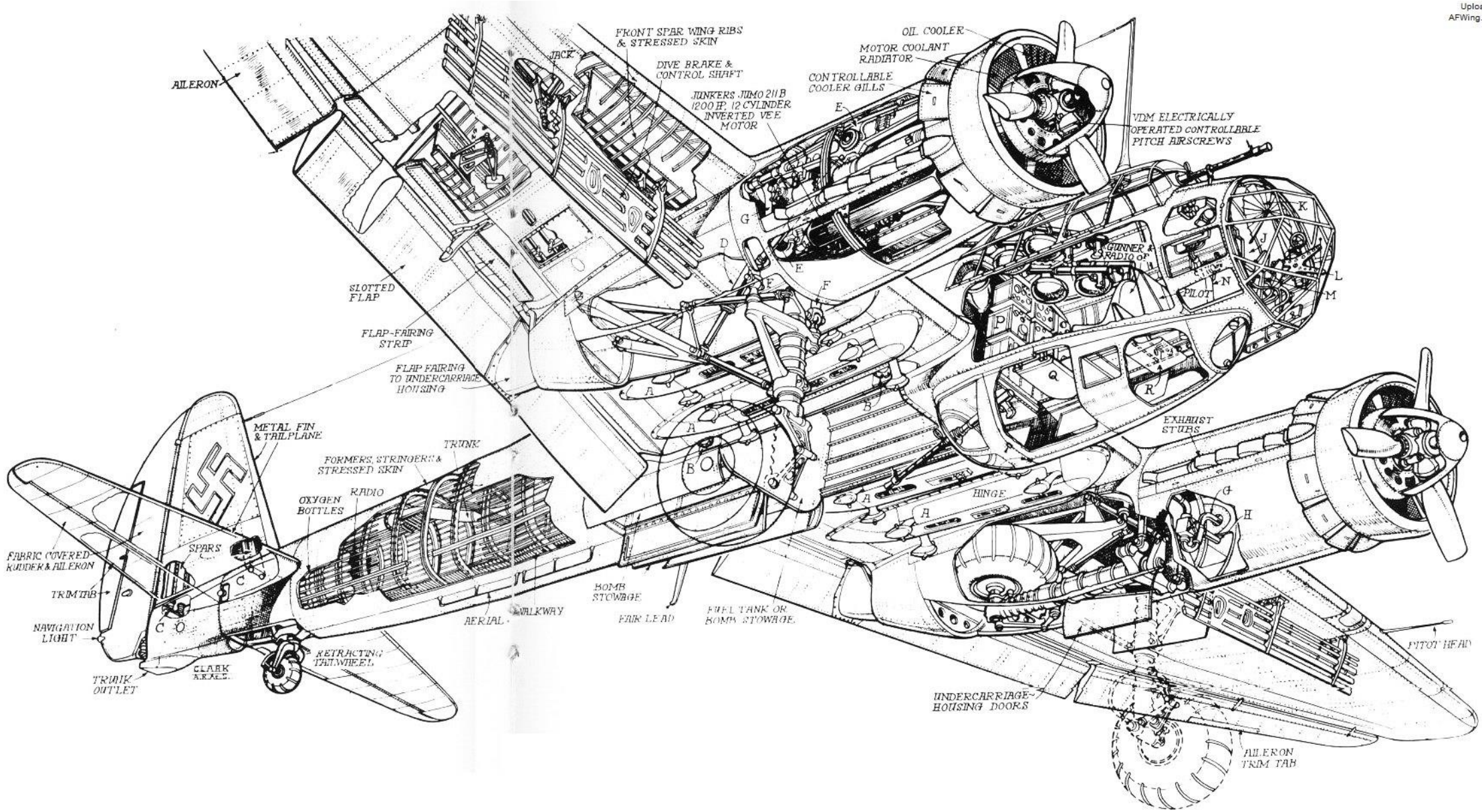
The Ju-88 was to prove a very capable and valuable asset to the Luftwaffe in the east. The Ju-88 units met with instant success, attacking enemy airfields and positions at low level and causing enormous losses for little damage in return.

PART 2: AIRCRAFT VARIANTS

	(Unit)	JU-88 A-1
TEMPERATURES		
Water Rad Min	Deg C	40
Max		90
Oil Rad (OUTBOUND) Min	Deg C	40
Max		80
ENGINE SETTINGS		
Engine & Fuel grade		Jumo 211 B-1 B-4 - 87 octane fuel
Takeoff RPM	RPM	2400
Takeoff Manifold Pressure	UK: PSI GER: ATA ITA: mm HG	1.35
Climb RPM	RPM	2300 30 min MAX
Climb Manifold Pressure	UK: PSI GER: ATA ITA: mm HG	1.15
Normal Operation/Cruise RPM	RPM	2100
Normal Operation/Cruise Manifold Pressure	UK: PSI GER: ATA ITA: mm HG	1.1
Combat RPM	RPM	2300
Combat Manifold Pressure	UK: PSI GER: ATA ITA: mm HG	1.15
Emergency Power/ Boost RPM @ km	RPM	2400 1 min MAX
Emergency Power / Boost Manifold Pressure @ Sea Level	UK: PSI GER: ATA ITA: mm HG	1.35 1 min max
Supercharger Stage 1 Operation Altitude	UK: ft GER: M	0 1220
Supercharger Stage 2 Operation Altitude	UK: ft GER: M ITA: M	1220+
Landing Approach RPM	RPM	2100
Landing Approach Manifold Pressure	UK: PSI GER: ATA ITA: mm HG	As required
Notes & Peculiarities		Engine very sensitive to ata/rpm Dive Brakes

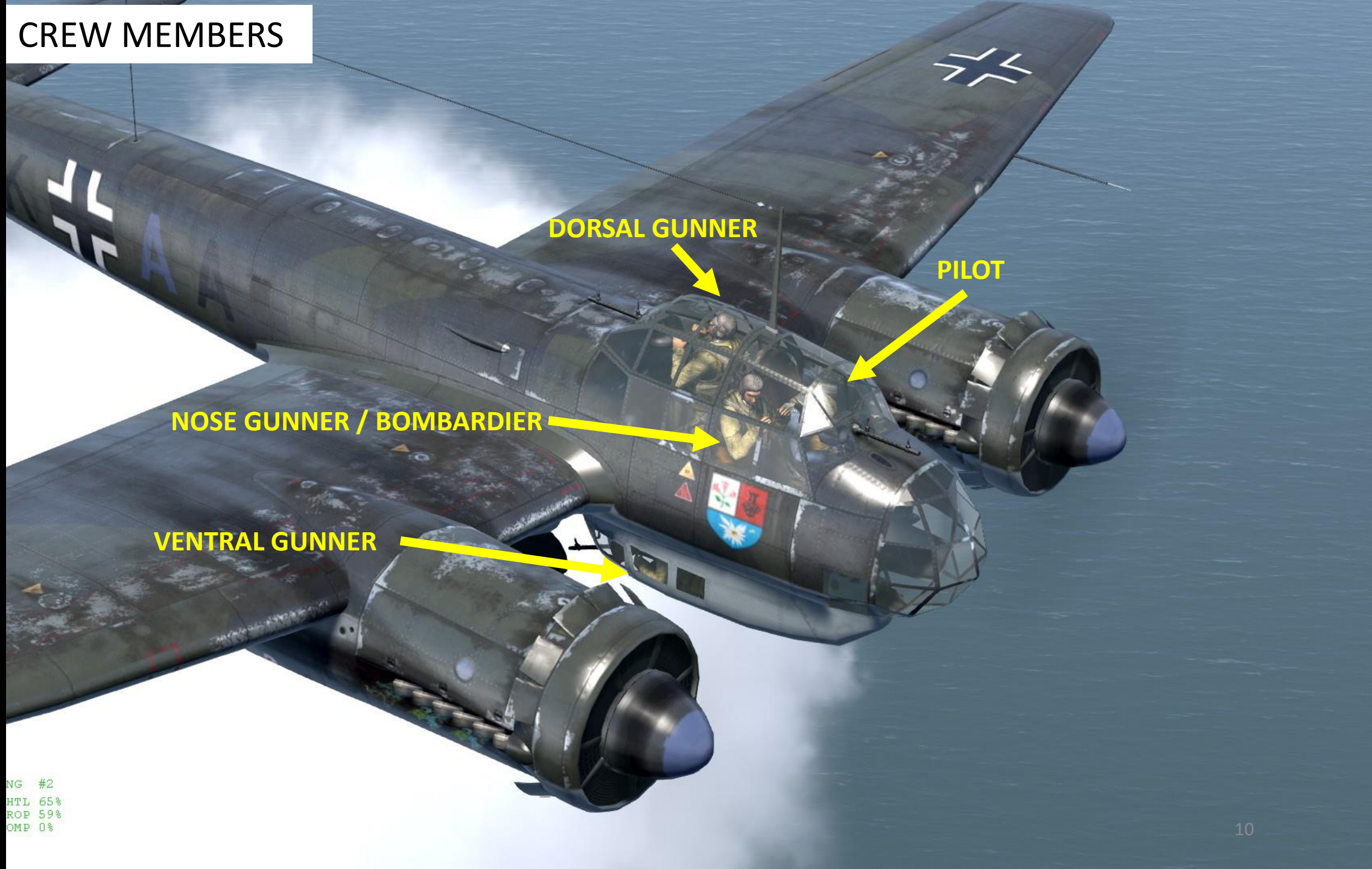


PART 2: AIRCRAFT VARIANTS



PART 3: AIRCRAFT & COCKPIT FAMILIARIZATION

CREW MEMBERS



PART 3: AIRCRAFT & COCKPIT FAMILIARIZATION

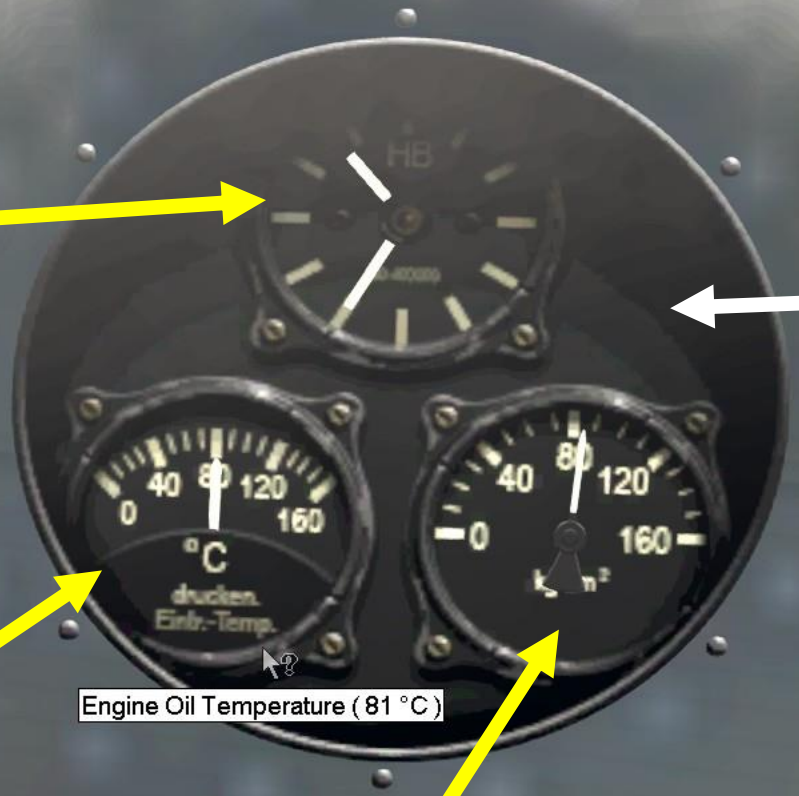
JU-88 A-1

PILOT

PART 3: AIRCRAFT & COCKPIT FAMILIARIZATION

JU-88 A-1

PILOT



PROP PITCH (MAX: 12:00)

ENGINE SETTINGS SHOWN ON NACELLE.
YES… YOU NEED TO LOOK THROUGH THE WINDOW. AND YES… IT WAS A RATHER WEIRD DESIGN CHOICE.

ENGINE OIL TEMPERATURE (DEG C)

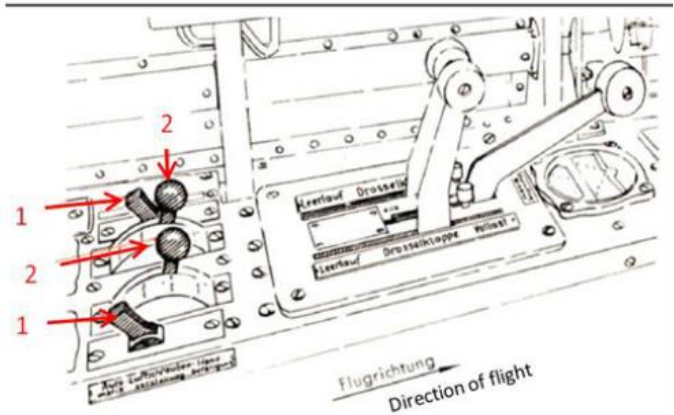
HYDRAULIC PRESSURE (KG/CM2)

PART 3: AIRCRAFT & COCKPIT FAMILIARIZATION

NOTE 1: IN THE JU-88, THE PROP PITCH WORKS JUST LIKE IN THE SPITFIRE OR HURRICANE. YOU CAN MAP YOUR PROP PITCH TO AN AXIS RATHER THAN A SWITCH (AS USED IN BF.109 AND BF.110).

NOTE 2: THE JU-88 COCKPIT IS NOTORIOUS FOR HAVING ABYSMAL VISIBILITY FOR TRACK IR USERS, WHICH IS WHY WE CAN'T SEE THE FUEL COCKS, PROP PITCH LEVERS AND WATER RADIATOR CONTROLS AS THEY ARE HIDDEN BY THE PILOT SEAT. **DON'T FORGET TO MAP FUEL COCK # 1 AND # 2 TOGGLES IN YOUR CONTROLS.** IT IS MANDATORY IF YOU WANT TO START YOUR ENGINE. MY PERSONAL KEY BINDINGS FOR FUEL COCK # 1 AND # 2 ARE **LCTRL + 1** AND **LCTRL + 2**.

Propeller controls in Il2 : Cliffs of Dover
1 = Manual/Automatic propeller pitch control selector switches
2 = Manual propeller pitch control units



Propeller pitch controls in the official operating manual, pitch control selector switches shown in automatic positions
Source: Ju 88 A-1 Betriebsanleitung (Dlm 201, March 1940)
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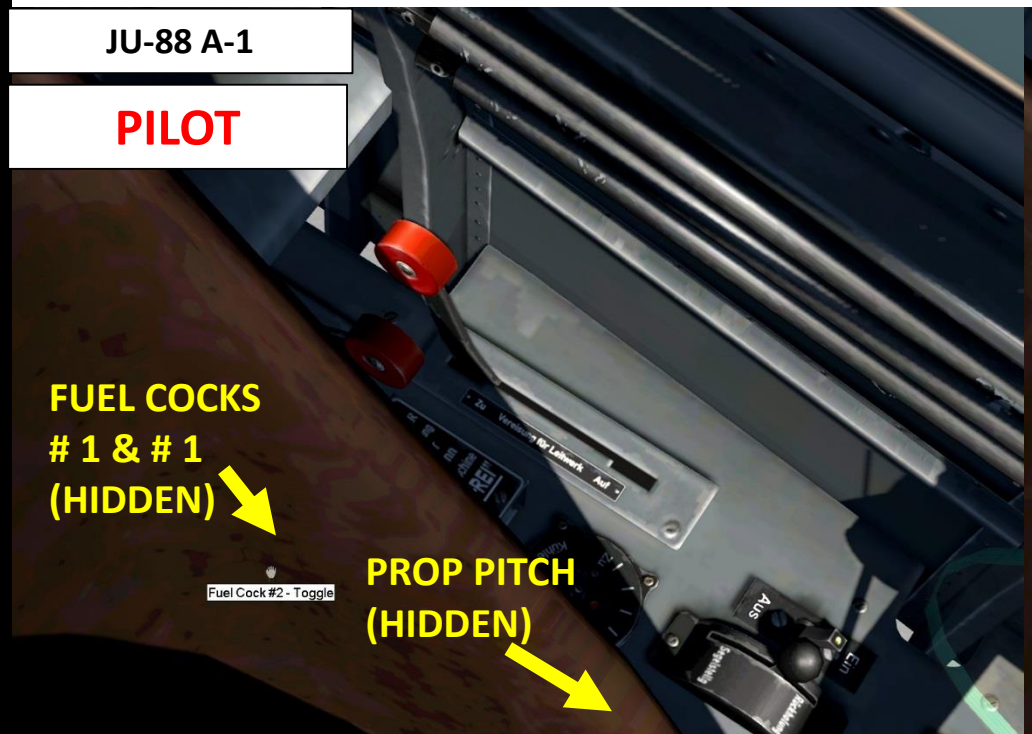
JU-88 A-1

PILOT

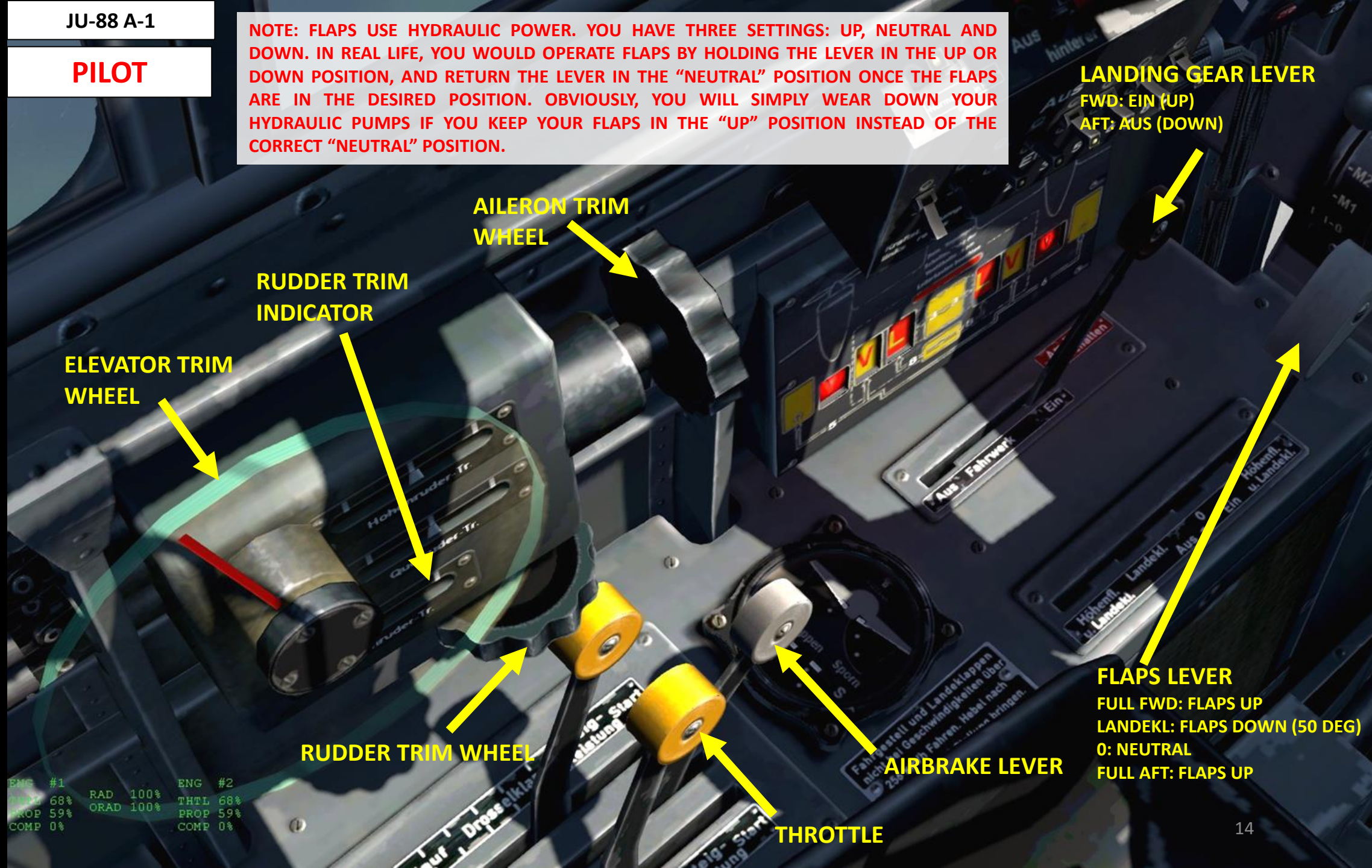


PART 3: AIRCRAFT & COCKPIT FAMILIARIZATION

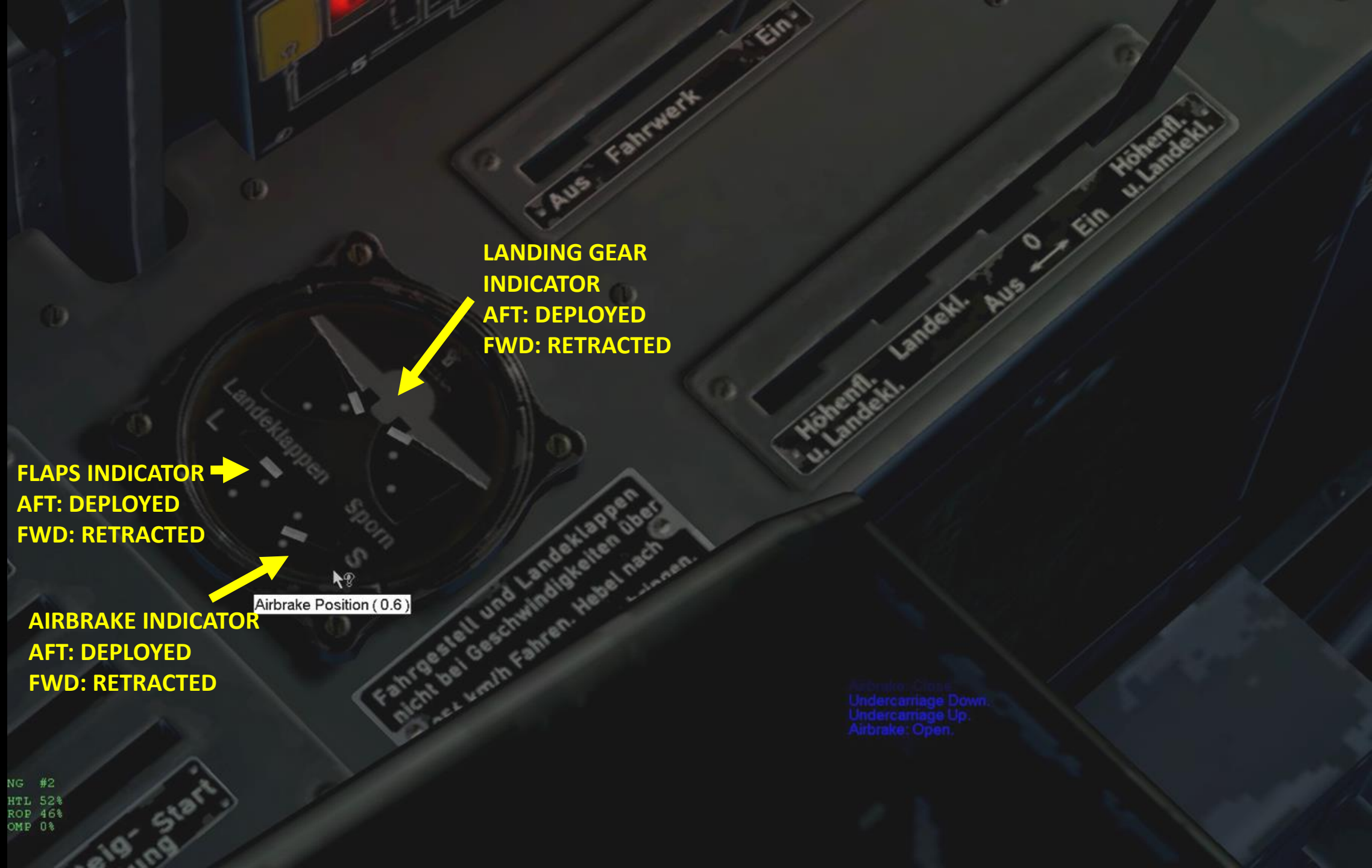
JU-88 A-1

PILOT

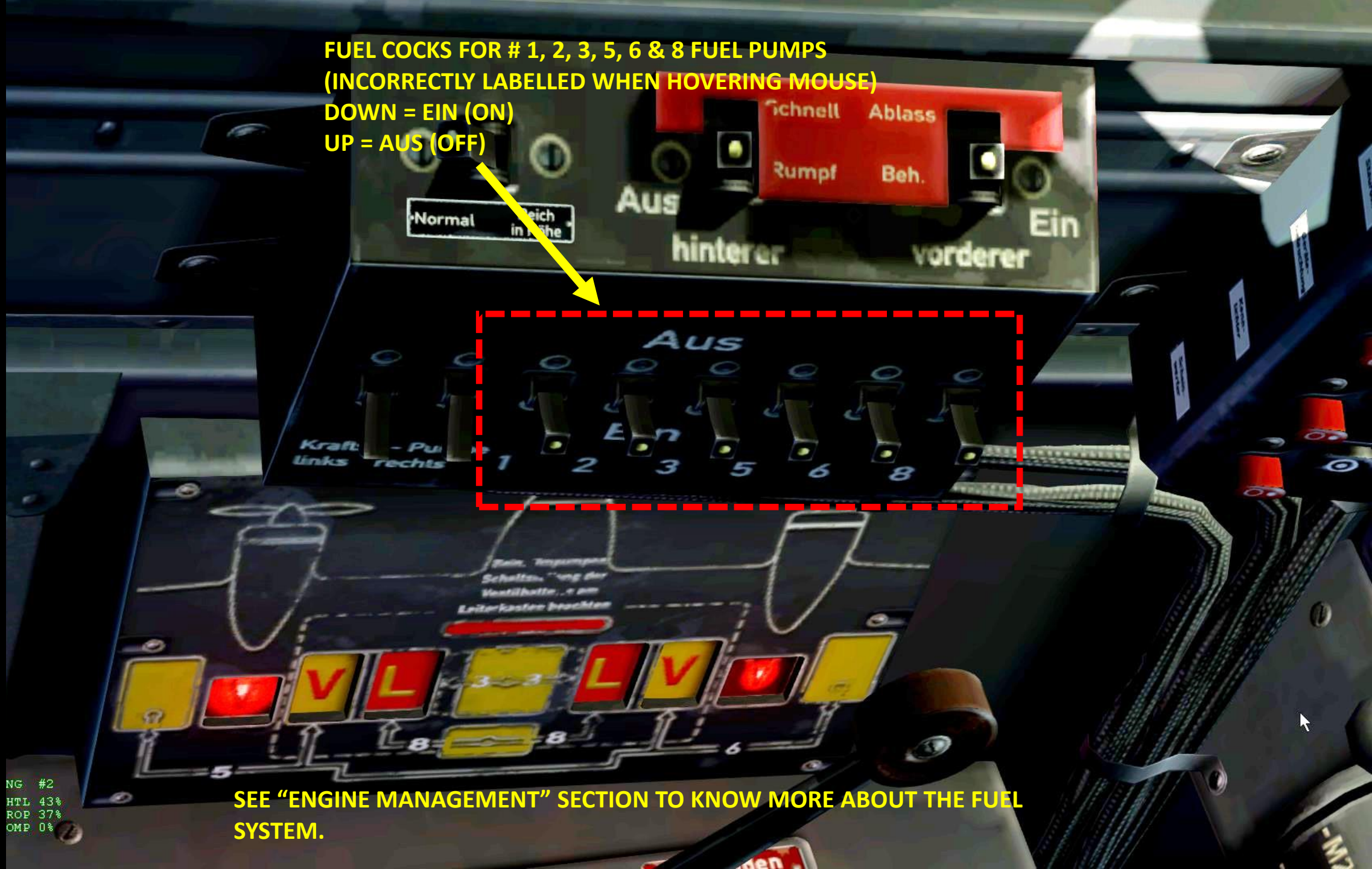
NOTE: FLAPS USE HYDRAULIC POWER. YOU HAVE THREE SETTINGS: UP, NEUTRAL AND DOWN. IN REAL LIFE, YOU WOULD OPERATE FLAPS BY HOLDING THE LEVER IN THE UP OR DOWN POSITION, AND RETURN THE LEVER IN THE "NEUTRAL" POSITION ONCE THE FLAPS ARE IN THE DESIRED POSITION. OBVIOUSLY, YOU WILL SIMPLY WEAR DOWN YOUR HYDRAULIC PUMPS IF YOU KEEP YOUR FLAPS IN THE "UP" POSITION INSTEAD OF THE CORRECT "NEUTRAL" POSITION.



PART 3: AIRCRAFT & COCKPIT FAMILIARIZATION



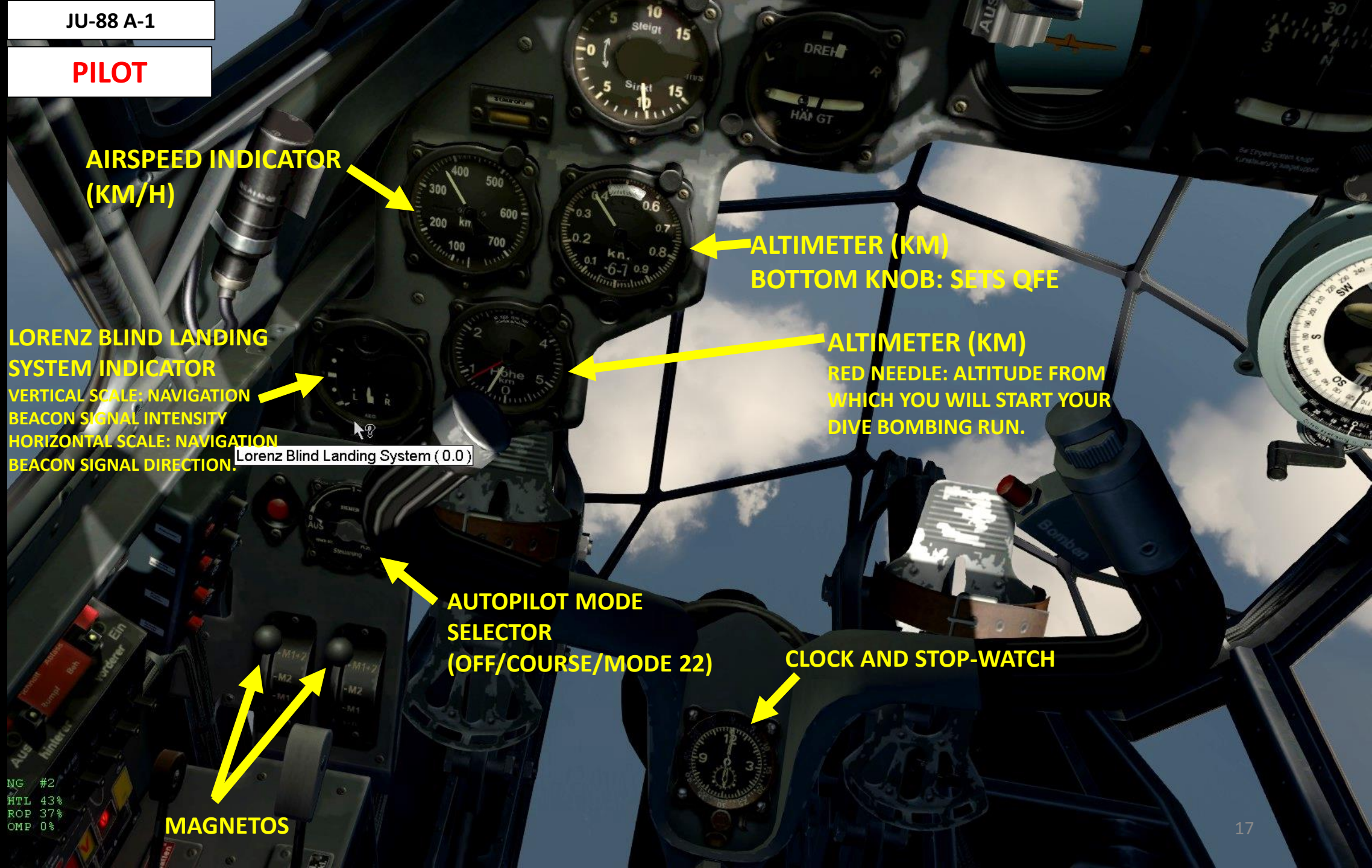
PART 3: AIRCRAFT & COCKPIT FAMILIARIZATION



PART 3: AIRCRAFT & COCKPIT FAMILIARIZATION

JU-88 A-1

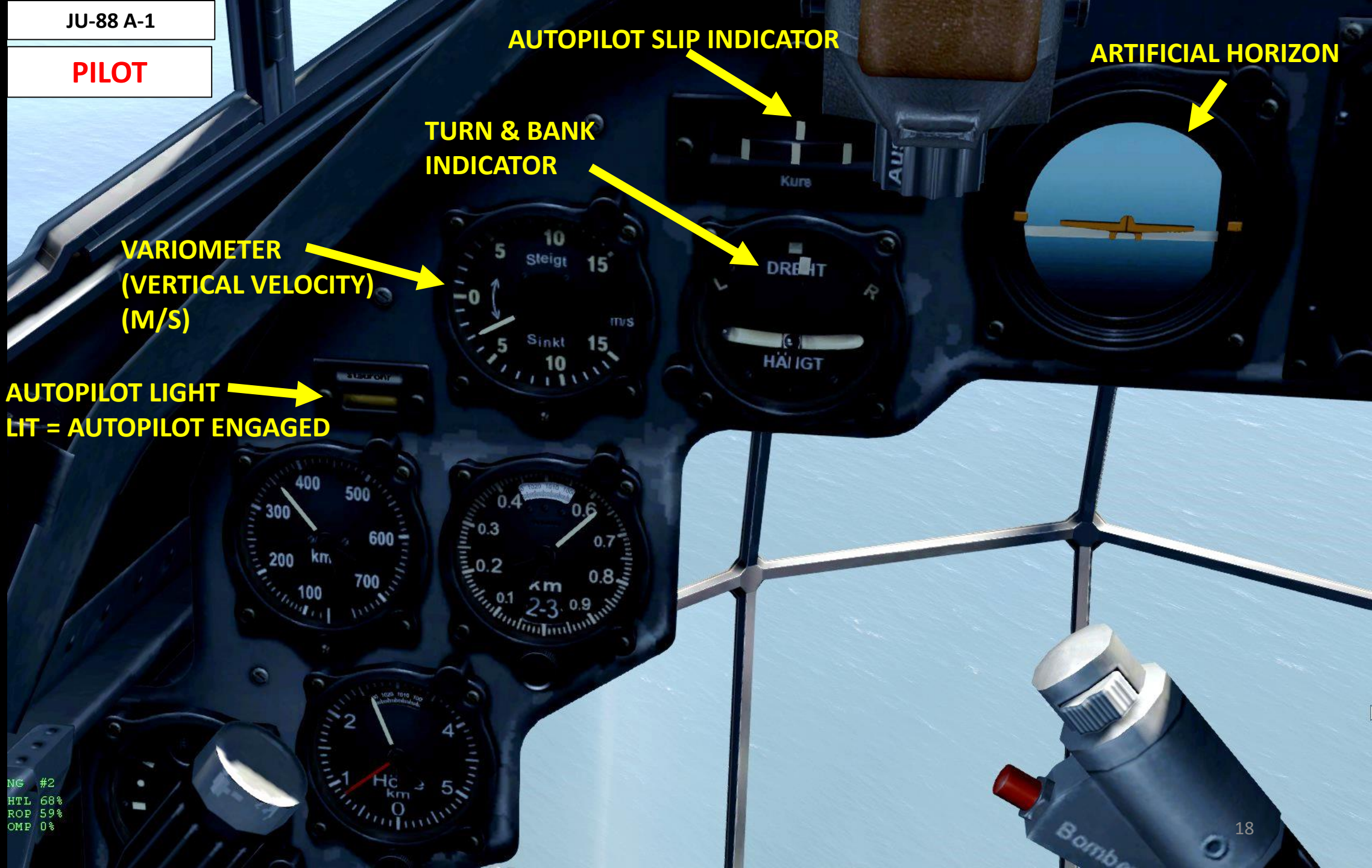
PILOT



PART 3: AIRCRAFT & COCKPIT FAMILIARIZATION

JU-88 A-1

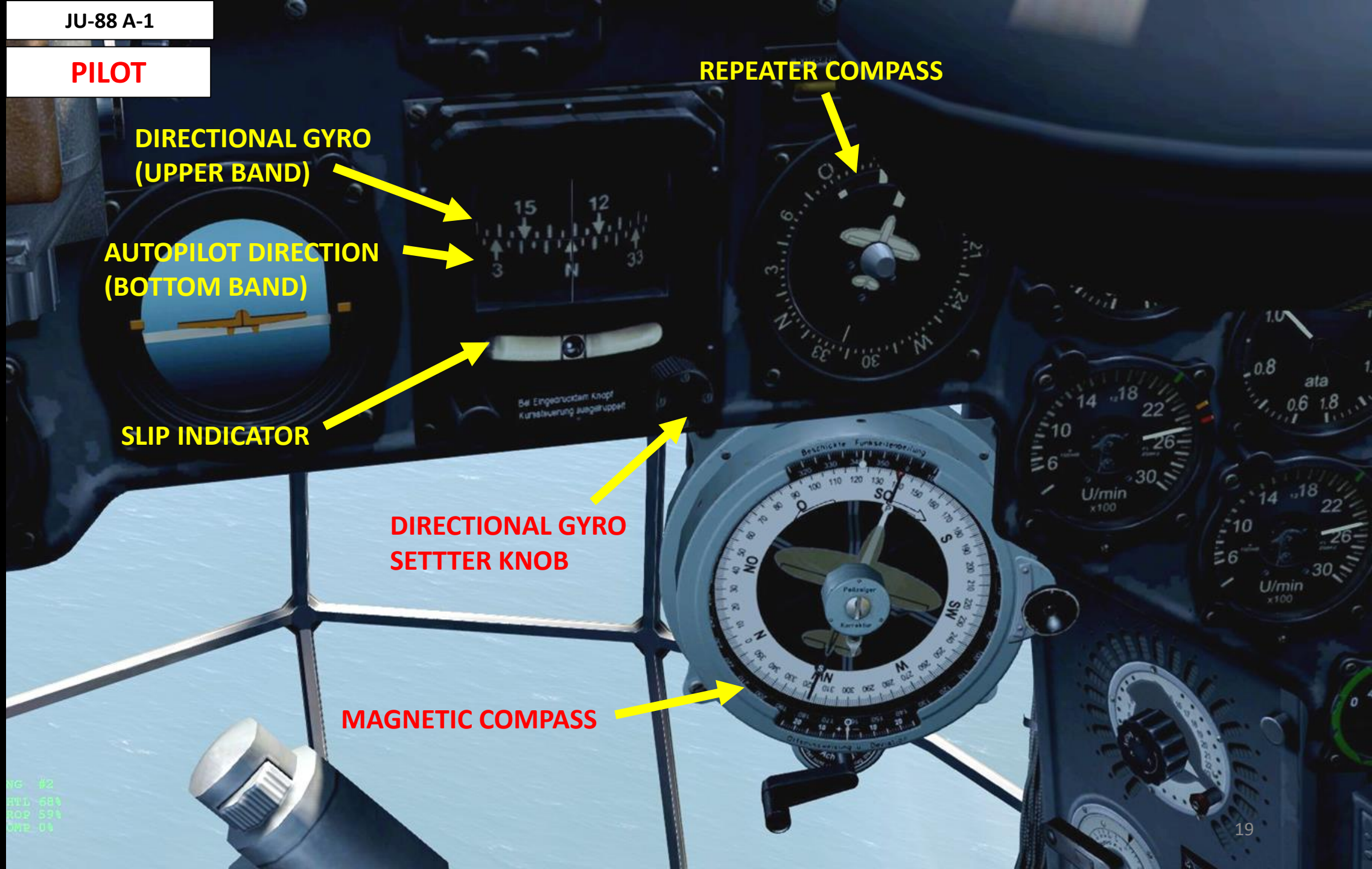
PILOT



PART 3: AIRCRAFT & COCKPIT FAMILIARIZATION

JU-88 A-1

PILOT



PART 3: AIRCRAFT & COCKPIT FAMILIARIZATION

JU-88 A-1

BOMBARDIER NOSE GUNNER

NOSE GUNNER CONTROLS

-LEAN TO GUNSIGHT: **CUSTOM KEY**
-FIRE WEAPON: **LEFT MOUSE BUTTON**
-SWITCH GUNNER/BOMBARDIER POSITION: **C**
-CHANGE MANNED POSITION: **L_SHIFT_C**
-GIVE GUNNER CONTROL TO AI: **L_ALT+F2**
-TAKE CONTROL OF GUN (TOGGLE INDEPENDENT MODE): **F10**

PART 3: AIRCRAFT & COCKPIT FAMILIARIZATION

JU-88 A-1

BOMBARDIER
NOSE GUNNER

GREEN INDEX: SETTING FOR INFINITE OPERATION
YELLOW INDEX: 30 MINUTES MAX OPERATION LIMIT
RED INDEX: 1 MINUTE MAX OPERATION LIMIT

SUPERCHARGER PRESSURE GAUGE (ATA)
SIMILAR FUNCTION TO BOOST OR MANIFOLD PRESSURE (THROTTLE)

RPM (U/min)

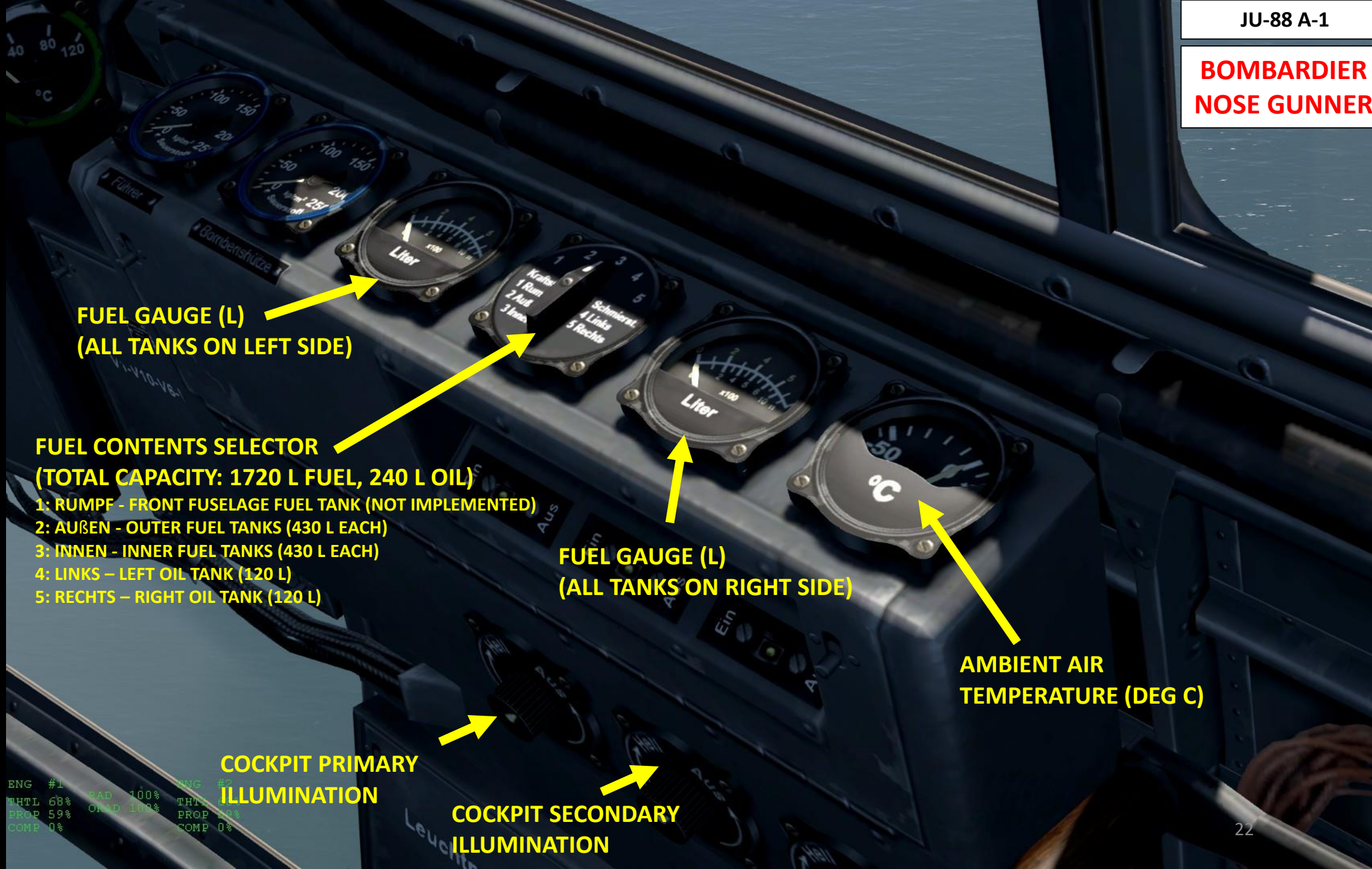
FUEL PRESSURE (KG/CM2)
UP: OIL PRESSURE
DOWN: FUEL PRESSURE

WATER RADIATOR TEMPERATURE (DEG C)

PART 3: AIRCRAFT & COCKPIT FAMILIARIZATION

JU-88 A-1

BOMBARDIER
NOSE GUNNER



PART 3: AIRCRAFT & COCKPIT FAMILIARIZATION

JU-88 A-1

BOMBARDIER NOSE GUNNER

PART 3: AIRCRAFT & COCKPIT FAMILIARIZATION

JU-88 A-1

BOMBARDIER NOSE GUNNER

PART 3: AIRCRAFT & COCKPIT FAMILIARIZATION

JU-88 A-1

VENTRAL GUNNER

VENTRAL GUNNER CONTROLS

-LEAN TO GUNSIGHT: **CUSTOM KEY**
-FIRE WEAPON: **LEFT MOUSE BUTTON**
-SWITCH GUNNER/BOMBARDIER POSITION: **C**
-CHANGE MANNED POSITION: **L_SHIFT_C**
-GIVE GUNNER CONTROL TO AI: **L_ALT+F2**
-TAKE CONTROL OF GUN (TOGGLE INDEPENDENT MODE): **F10**

PART 3: AIRCRAFT & COCKPIT FAMILIARIZATION

JU-88 A-1

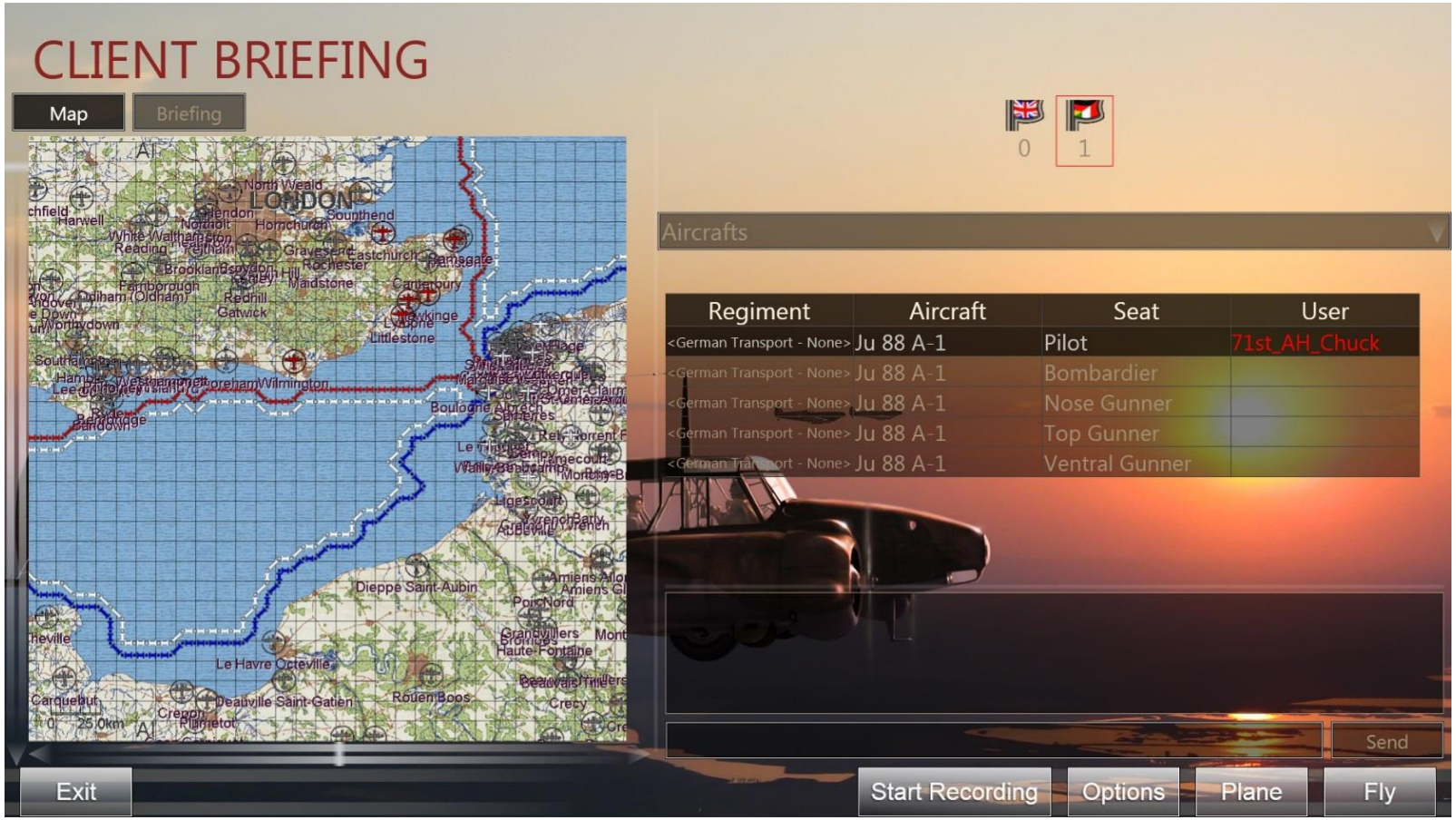
DORSAL GUNNER

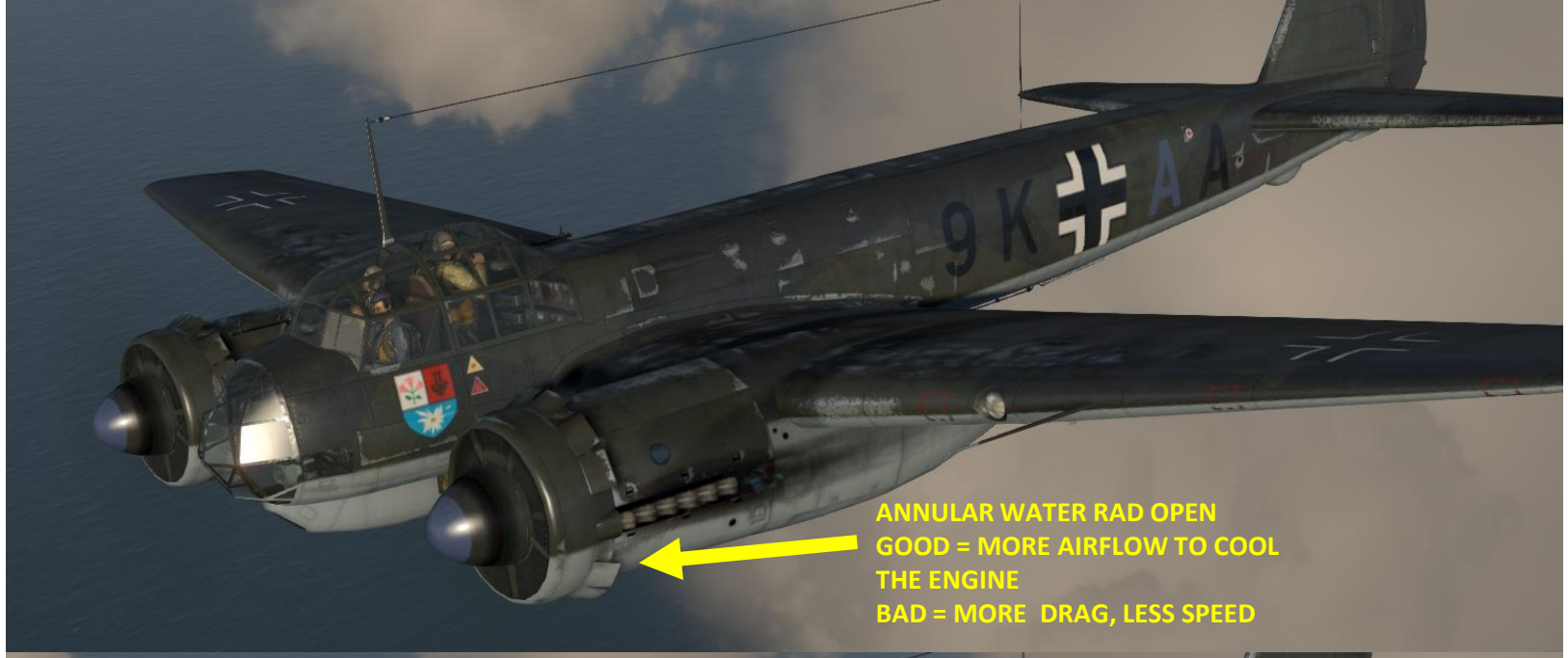
DORSAL GUNNER CONTROLS

-LEAN TO GUNSIGHT: **CUSTOM KEY**
-FIRE WEAPON: **LEFT MOUSE BUTTON**
-SWITCH GUNNER/BOMBARDIER POSITION: **C**
-CHANGE MANNED POSITION: **L_SHIFT_C**
-GIVE GUNNER CONTROL TO AI: **L_ALT+F2**
-TAKE CONTROL OF GUN (TOGGLE INDEPENDENT MODE): **F10**

NOTES

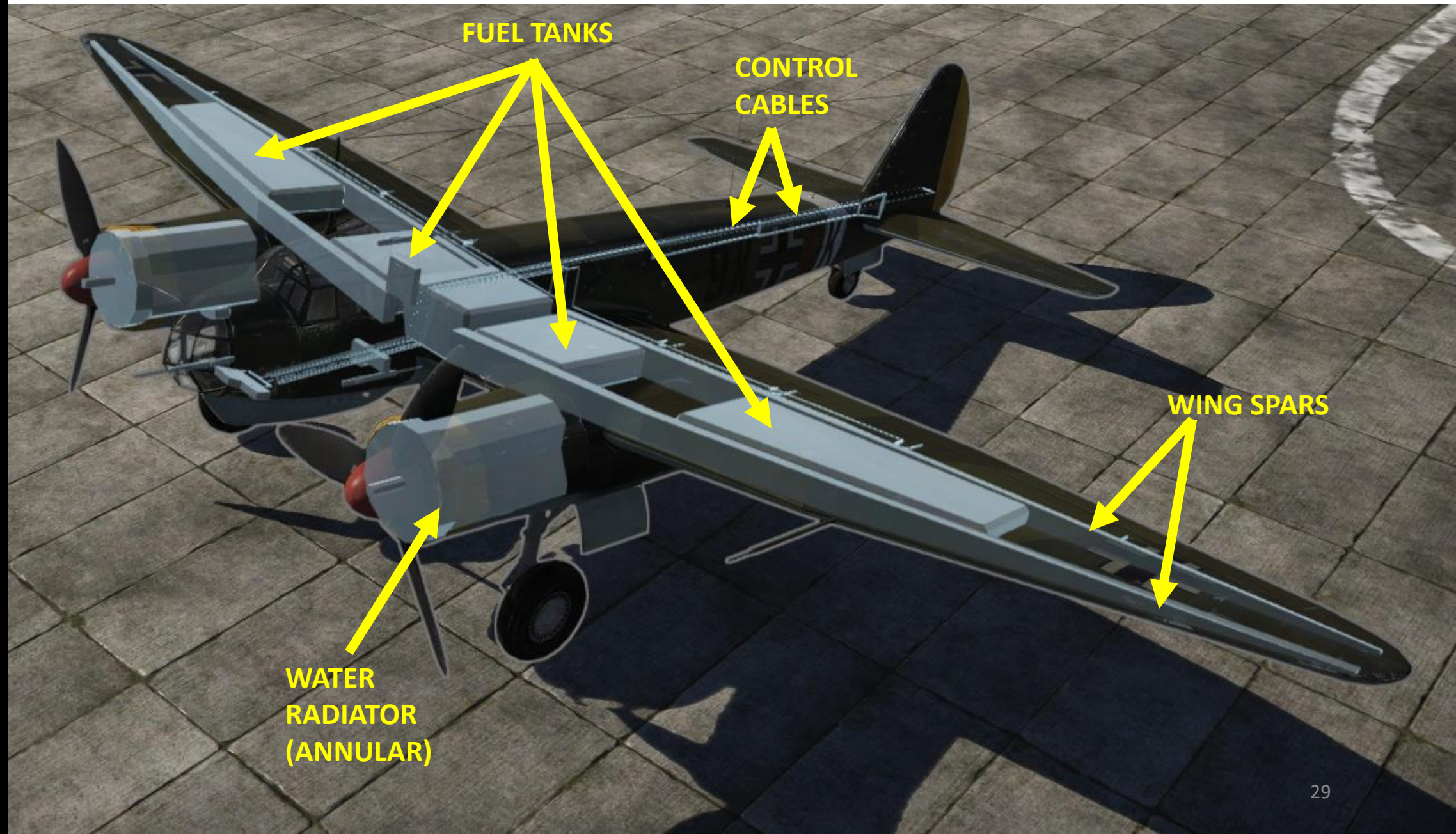
- Your gunner can call out fighters if you have your in-game chat info window enabled. However, if you switcher to your gunner position and switched back to your pilot seat, it is possible that the AI gunner will not take control of the gun. In other words, your gunner will not fire unless the AI takes control of it. To give back the AI control of your turret, you should use the “L_ALT+F2”.
- Any turret or other air crew position (like the bombardier) can be manned by other players in multiplayer. They just need to **double-click on the available slot in multiplayer** once they clicked on the “flag”.




ANNULAR WATER RAD OPEN
GOOD = MORE AIRFLOW TO COOL THE ENGINE
BAD = MORE DRAG, LESS SPEED


ANNULAR WATER RAD CLOSED
GOOD = LESS DRAG, MORE SPEED
BAD = LESS AIRFLOW TO COOL THE ENGINE, HIGH RISK OF ENGINE OVERHEAT

CRITICAL COMPONENTS



HOW TO RECOGNIZE A TAIL NUMBER

LUFTWAFFE

The tactical markings system for the Luftwaffe in WWII must have been designed by a mad genius. Comparative simplicity of the systems used by Italy and the British is a further testament to the fact.

The system will seem extremely convoluted to most everyone who reads this guide; imagine programming all that into the sim!

Serial Number or Werknummer: usually a four-digit number.

Some Examples (symbols in **bold** can be set by the player, symbols in *italics* are automatically set by Cliffs of Dover)

Plane	Squadron	Tactical #	Serial #
Bf-109E-3	II./JG26	<<+-	**1542**
Bf-109E-3	7./JG26	**7**+|	**1195**
Bf-110	5./ZG1	*G9*+**I***N*	**4277**
Bf-110	Stab II./ZG76	*M8*+**K***C*	**3863**
He-111	Stab./KG55	*G1*+**F***A*	**1582**
Ju-87	III./StG51	*6G*+**A***D*	**5338**

Tail Number. Two completely different systems were used for bomber and fighter aircraft.

Fighters: Squadron designated by squadron badge. Tactical number either consists of a one- or two-digit number, or a special symbol such as double chevron for a group commander. See below for all symbols supported by Cliffs of Dover.

Colour of the tactical number determines the Staffel within the squadron the aircraft belongs to. Some Gruppen are also marked with another special symbol aft of the fuselage cross, such as a horizontal line for II. Gruppe or a curvy line for the III. Gruppe.

Bombers: a four character string, in which the first two symbols are the squadron code, usually a number and a letter. The next symbol is the individual aircraft letter, and the final is the letter that identifies which Gruppe and Staffel the aircraft belongs to. The final letter also determines the colour of the individual aircraft letter.

Luftwaffe Fighter Symbols

Note that there are multiple variants for some positions, which give similar but distinct markings. For example both <|- and <I mean Geschwader Adjutant, but display different graphics on the aircraft. These variations were generally created and used by individual squadrons.

Symbol	Deciphered	Meaning
<|-	[less than] [vert line] [dash]	Geschwader Adjutant
<|	[less than] [vert line]	Geschwader Adjutant
<I	[less than] [capital I]	Geschwader Adjutant
--	[dash] [dash]	Geschwader Adjutant
-o	[dash] [lower case o]	Geschwader Adjutant
<--	[less than] [dash] [dash]	Geschwader Commodore
<_1	[less than] [underscore] [number 1]	Geschwader Commodore
<-	[less than] [dash]	Geschwader Commodore
<.-	[less than] [period] [dash]	Geschwader Commodore
<<-	[less than] [less than] [dash]	Geschwader Commodore
<<<4	[less than] [less than] [less than]	Geschwader Commodore
K<<	[less than] [less than]	Geschwader Commodore Kuban
<||	[less than] [vert line] [vert line]	Geschwader Major Beim Stab
<o-	[less than] [lower case o] [dash]	Geschwader Technical Officer
<O-	[less than] [capital O] [dash]	Geschwader Technical Officer
<|o	[less than] [vert line] [lower case o]	Geschwader Technical Officer
<Io	[less than] [capital I] [lower case o]	Geschwader Technical Officer
<|O	[less than] [vert line] [capital O]	Geschwader Technical Officer
<IO	[less than] [capital I] [capital O]	Geschwader Technical Officer
<	[less than]	Gruppen Adjutant
_<	[underscore] [less than]	Gruppen Adjutant
<1	[less than] [one]	Gruppen Beim Stab
<.	[less than] [period]	Gruppen Kommandeur
_<.	[underscore] [less than] [period]	Gruppen Kommandeur
<<	[less than] [less than]	Gruppen Kommandeur
I<<	[capital I] [less than] [less than]	Gruppen Kommandeur
<o	[less than] [lower case o]	Gruppen Technical Officer
<O	[less than] [capital O]	Gruppen Technical Officer
T	[capital T]	Gruppen Technical Officer
<*	[less than] [asterisk]	Gruppen Technical Officer
<t	[less than] [lower case T]	Kommodore
<0	[less than] [zero]	Kuban
-A-	[dash] [capital A] [dash]	Stab.
I_	[capital I] [underscore]	Stab.

NOTE: Many of these symbols were historically meant for Stab aircraft only; however you can still assign them to other Staffeln, which may colour these symbols in non-historical Staffel colours.

PART 4: CONTROLS

JUNKERS JU-88 A-1		
DESCRIPTION	MAPPED TO	ESSENTIAL / NON-ESSENTIAL
Wheel Chocks		ESSENTIAL
toggle primary cockpit illumination		CLICKABLE IN COCKPIT
toggle secondary cockpit illumination		CLICKABLE IN COCKPIT
Drop ordnance (bombs)	B	ESSENTIAL
Fuel Cock Toggle #1 #2		ESSENTIAL (NOT CLICKABLE!)
Fuel Cock Toggle #6 #7		CLICKABLE IN COCKPIT
toggle selected engine (ignition)	“I” by default	ESSENTIAL
directional controls (ailerons, elevators, and rudder)	Joystick & Rudder Pedal axes	ESSENTIAL
Trim controls (elevator/rudder)	Joystick hat switch	ESSENTIAL
Field of View + (allows you to zoom out)		ESSENTIAL
Field of View – (allows you to zoom in)		ESSENTIAL
engine #1 select	L_SHIFT+1	ESSENTIAL
engine #2 select	L_SHIFT+2	ESSENTIAL
all engines select	L_SHIFT+3 (CUSTOM)	ESSENTIAL
Retract Airbrakes		ESSENTIAL
Extend Airbrakes		ESSENTIAL
Open / Close Bomb Bay Doors	N / LCTRL+N (CUSTOM)	ESSENTIAL

PART 4: CONTROLS

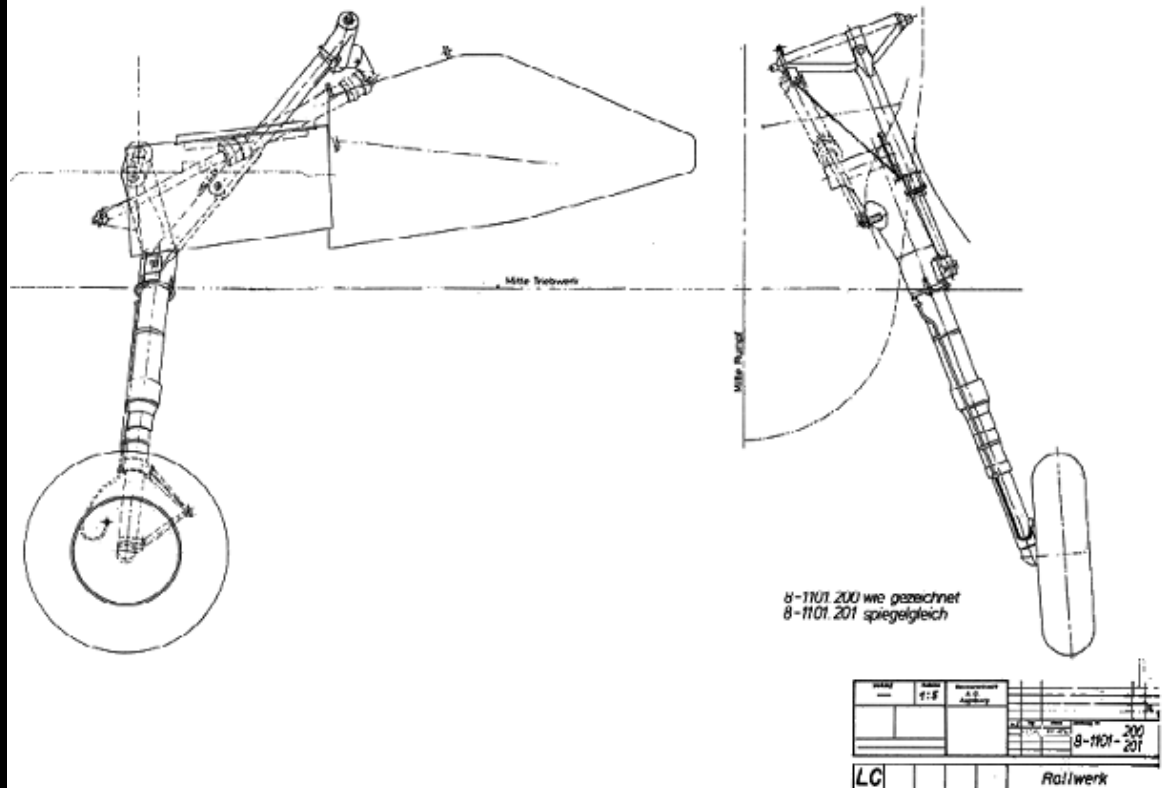
JUNKERS JU-88 A-1		
DESCRIPTION	MAPPED TO	ESSENTIAL / NON-ESSENTIAL
lean to gunsight		ESSENTIAL
throttle	Throttle axis	ESSENTIAL
toggle canopy/hatch		ESSENTIAL
Jettison canopy		ESSENTIAL
Open oil radiator	Right Arrow keyboard	ESSENTIAL
close oil radiator	Left Arrow keyboard	ESSENTIAL
open radiator	Up Arrow keyboard	ESSENTIAL
close radiator	Down Arrow keyboard	ESSENTIAL
increase propeller pitch	Usually set to Axis for second throttle. Set to keyboard otherwise.	ESSENTIAL
decrease propeller pitch		ESSENTIAL
Toggle undercarriage (landing gear)		ESSENTIAL
Left / Right Wheel brake	Map in AXES if pedals	ESSENTIAL
bail out		ESSENTIAL
Toggle Independent Mode (allows you to use/hide mouse cursor)	F10	ESSENTIAL
External View (Give Turret Gunner Control to AI)	L_ALT+F2	ESSENTIAL
View-Position #1 (pilot)	L_ALT+1	ESSENTIAL
View-position #2 (bombardier)	L_ALT+2	ESSENTIAL
View-position #5 (ventral gunner)	L_ALT+3	ESSENTIAL
Next Manned Position (Cycles through air crew)	C	ESSENTIAL

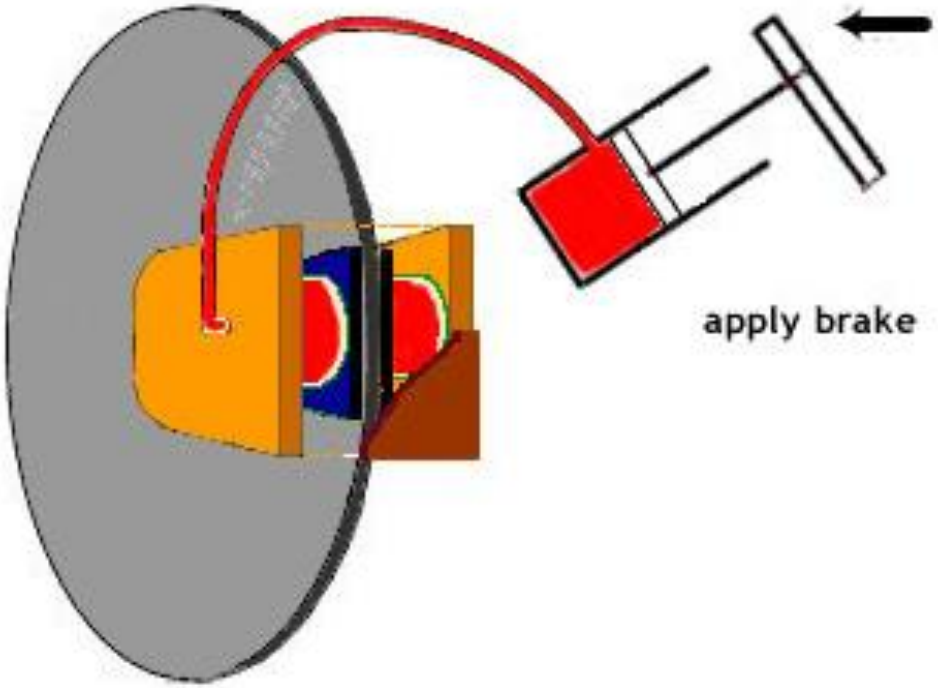
PART 4: CONTROLS

JUNKERS JU-88 A-1		
DESCRIPTION	MAPPED TO	ESSENTIAL / NON-ESSENTIAL
Course autopilot – Previous Mode	A	ESSENTIAL
Course autopilot – Next Mode	S	ESSENTIAL
course setter – increase	NUMPAD + (CUSTOM)	ESSENTIAL
course setter – decrease	NUMPAD - (CUSTOM)	ESSENTIAL
directional gyro – increase	NUMPAD / (CUSTOM)	ESSENTIAL
directional gyro – decrease	NUMPAD * (CUSTOM)	ESSENTIAL
Autopilot left (aircraft turns left while in autopilot)	L_CTRL + A (CUSTOM)	ESSENTIAL
Autopilot right (aircraft turns right while in autopilot)	L_CTRL + S (CUSTOM)	ESSENTIAL
bomb mode selector – next / previous (salvo/series/single)	SEE BOMBER NUMPAD	ESSENTIAL
Increase/decrease bomb distributor salvo quantity	SEE BOMBER NUMPAD	ESSENTIAL
toggle bombs armed	SEE BOMBER NUMPAD	ESSENTIAL
toggle bomb short delay	SEE BOMBER NUMPAD	ESSENTIAL
Increase/decrease bomb distributor delay	SEE BOMBER NUMPAD	ESSENTIAL
Increase/decrease sight distance	SEE BOMBER NUMPAD	ESSENTIAL
Select bomb bay previous/Next	SEE BOMBER NUMPAD	ESSENTIAL
Bombsight altitude + / -	SEE BOMBER NUMPAD	CLICKABLE IN COCKPIT
Bombsight velocity + / -	SEE BOMBER NUMPAD	CLICKABLE IN COCKPIT
Toggle bombsight automation	SEE BOMBER NUMPAD	ESSENTIAL
Selected Supercharger – Previous Step	L_CTRL+Q (CUSTOM)	ESSENTIAL
Selected Supercharger – Next Step	Q (CUSTOM)	ESSENTIAL

PART 4: CONTROLS

- Most german aircraft, unlike the majority of British and Russian planes, has a “toe brake” or “heel brake” system, which is linked to each individual wheel of your landing gear.
- In order to brake, you need to hold either your left or right wheel toe brake key to steer your aircraft. Applying rudder will also help you turn tighter.
- The main landing wheel brake system employs hydraulically actuated disc-type brakes. Each brake is operated by individual master brake cylinders located directly forward of the instrument panel. The brakes are selectively controlled by means of toe pedals incorporated into the rudder pedal assembly.
- Be careful: your “wheel brake” command used for Differential braking aircraft will lock both your brakes in a german plane. You can map “left/right wheel brake” axes if you have rudder pedals.





Recommended Gunner Machine-Gun Belt Loadouts – **Rheinmetall-Borsig MG 15 (7.92 mm)**

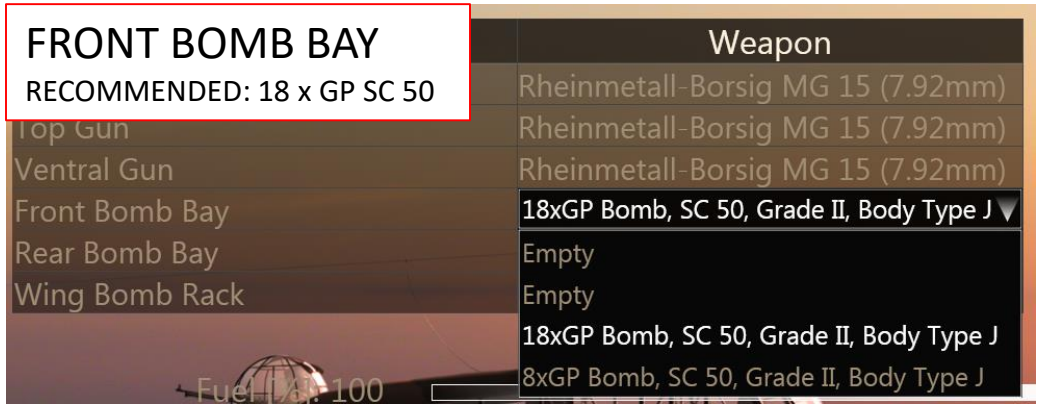
1. 7.92×57, S.m.K.H. - Spitzgeschoss mit Kern, Hart- Improved AP round with tungsten core. Highly recommended if you want a straight AP. However, the S.m.K.H. **in-game is in fact a duplicate of the S.m.K**., because the S.m.K.H. was never used on a fighter aircraft. Tungsten is a precious and expensive metal that was much needed elsewhere for the german war effort.
2. 7.92×57, P.m.K. - Phosphor mit Stahlkern- Standard AP with an incendiary composition. A great round, can still pierce armor and set fires
3. 7.92×57, S.m.K. L'spur (gelb) OR 7.92×57, S.m.K. L'spur (Weiss)- Standard AP with yellow (gelb) or white (Weiss) tracers. Good for aiming.

PART 5: WEAPONS AND ARMAMENT

TWO	LUFTWAFFE WEAPON DATA						TWO
Luftwaffe Machinegun and Cannon Ammunition							
Weapon	**Nomen**	**Type**	**Fill**	**Burnout**	**Tracer Color**	**Smoke Trail**	**Notes**
MG 17 7.92mm	SmK v	AP					Steel Core
	SmK (H) v	AP (Super)					WC Core
	SmK L'Spur v	AP-T		900 m	Yellow		
	SmK L'Spur v	AP-T		900 m	White		
	SmK Ub m Zer	SAPHE w SD					Flash
	PmK v	API	Ph			Yes	Burns
	B Patr v	HEI	Ba				Flash
MG FF 20mm	Brsprgr L'Spur	HEI-T / SD	PETN, Mg/Thm	1100 m			750m SD
	Brgr L'Spur	Incend -T / SD		1100 m		Yes	750m SD, Burns
	Pzbrgr	API / SD					750m SD
	PzBrgr (Elek)	API / SD	Mg				750m SD
	Pzbrgr (Phos)	API / SD	Ph				750m SD
MG FFM	M'gesch.	HE	RDX / Al				750m SD
German Ammunition Types	**SmK - Spitzgeschoss mit Stahlkern** = Pointed bullet with Steel Core						
	v - Verbesserte = Improved - increased propellant for increased muzzle velocity. Aircraft use only						
	L'Spur - Leuchtspur = Tracer						
	Ub. - Ubung = Training Ammo containing a small bursting charge						
	m. Zerl - mit Zerleger = with Burster = SD = Self Destruct Mechanism						
	PmK - Phospor mit Stahlkern = Phosphorus with Steel Core						
	B Patr - Beobachtung Patrone = Observation Cartridge						
	Brsprgr - Brandsprenggranate = Incendiary Explosive Grenade						
	Brgr - Brandgranate = Incendiary Grenade						
	Pzbrgr - Panzerbrandgranate = Armor peircing Incendiary Grenade						
	M'gesch. - Minengeschoß = Mine Projectile - High Capacity HE						
Notes	**Fill**: Ph (Phosph.), Mg (Magnes.), Al (Alum.), Ba (Barium), WC (Tunsten Carbide), Thm (Thermite)						
	Burns = Incendiary Composition (usually Phosphorus) is ignited on firing and burns during flight						
	Flash = Incendiary Ignition or small HE Burst on impact with target						
	Slow Tracer = Delayed tracer ignition for Night use						

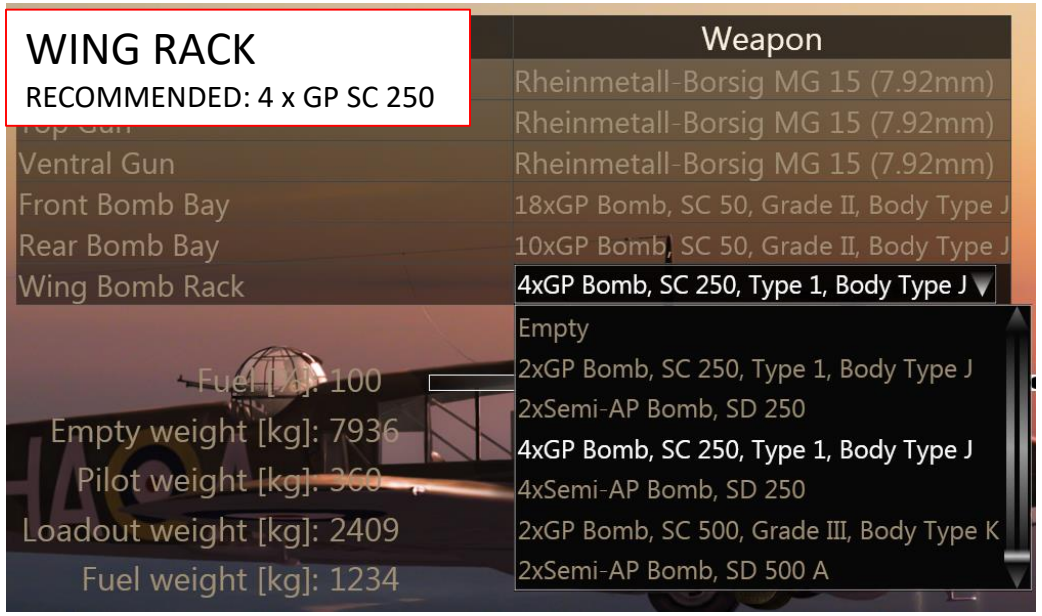
PART 5: WEAPONS AND ARMAMENT

FRONT BOMB BAY
RECOMMENDED: 18 x GP SC 50

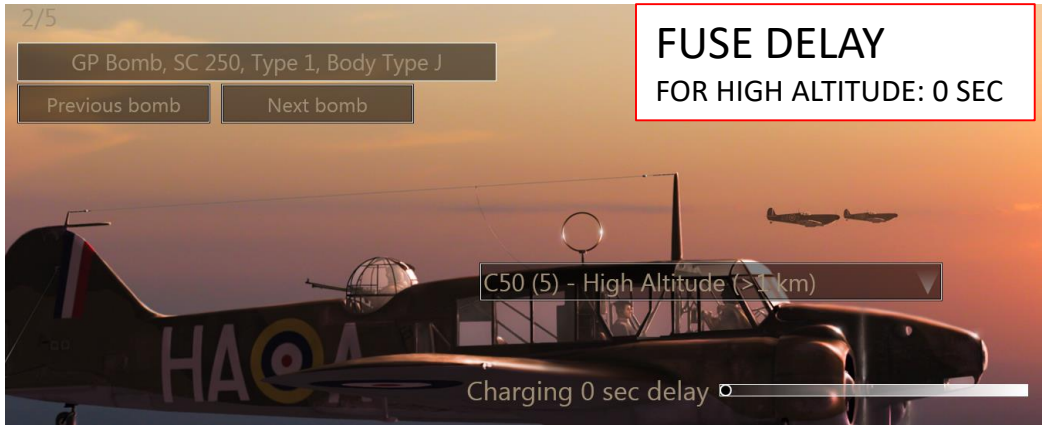


REAR BOMB BAY
RECOMMENDED: 10 x GP SC 50

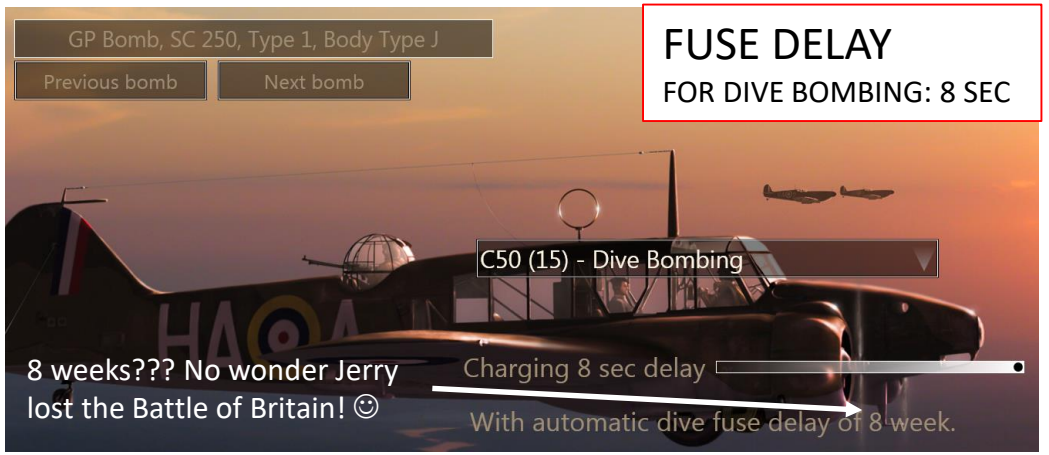
WING RACK
RECOMMENDED: 4 x GP SC 250



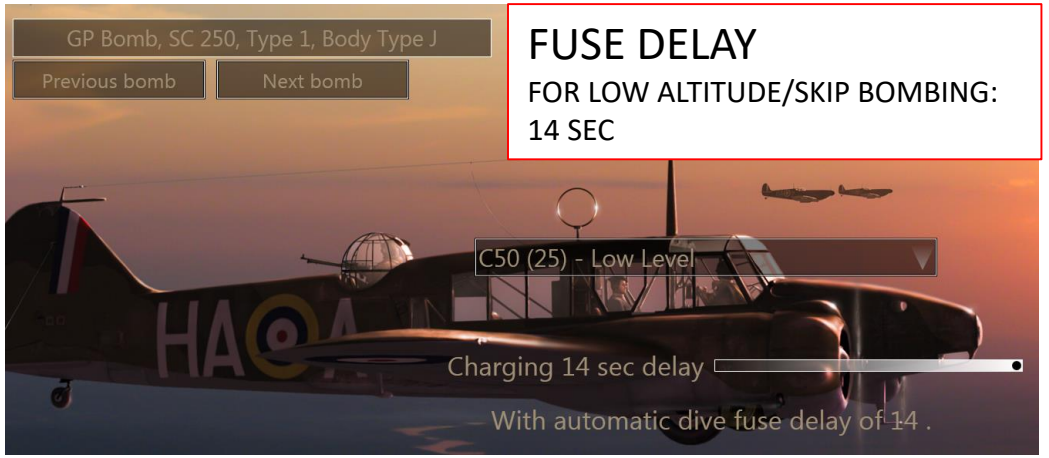
FUSE DELAY
FOR HIGH ALTITUDE: 0 SEC



FUSE DELAY
FOR DIVE BOMBING: 8 SEC



FUSE DELAY
FOR LOW ALTITUDE/SKIP BOMBING: 14 SEC



PART 5: WEAPONS AND ARMAMENT

Bombs					
Country	**Nomen**	**Type**	**WT (lbs/kg)**	**Fuze**	**Aircraft**
Luftwaffe	SC 50	GP	110 / 50	5, 25B	Ju87B, Ju88, Me109, He111
	SC 250	GP	551 / 250	5, 15, 25B	Ju87B, Ju88, Me109, Me110, He111
	SD 250	Semi-AP Frag	551 / 250	5	Ju87B, Ju88, Me110, He111
	SC 500	GP	1102 / 500	25B	Ju87B, Ju88
	SD 500	Semi-AP Frag	1102 / 500	5	Ju87B, Ju88
Notes	**SC - Sprengcylindrische** = Cylindrical Explosive: GP - General Pupose HE				
	SD - Spreng Dickenwand = Thick wall Explosive: Semi AP Frag - Thick walled case HE				

Pistols					
Weapon	**Nomen**	**Type**		**Settings (oV, mV, Vz)**	**Bomb Type**
Luftwaffe Fuzes	5	High Alt		0, .8sD	SC50, SC250, SD500
	15	Dive		0, .05sD, 8sD	SC250
	25B	Low Alt		0, .8sD, 14sD	SC50, SC250, SC500
Notes	**Settings:** 0 = Instantaneous; 8sD = 8 second Delay; etc				
	LW High Alt = High Altitude Release - Greater Than 1km				
	LW Low Alt = Low Altitude Release - Less Than 1km				
	LW Dive = Automatic Delay in Dive Release of 14 seconds				
TWO					**TWO**

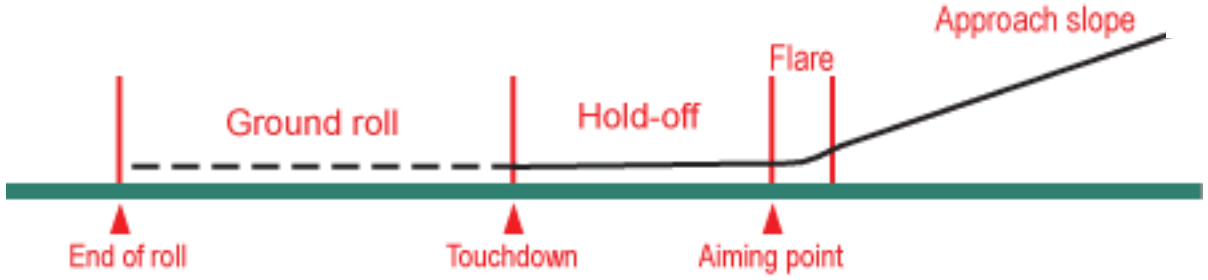
PART 6: TAKEOFF

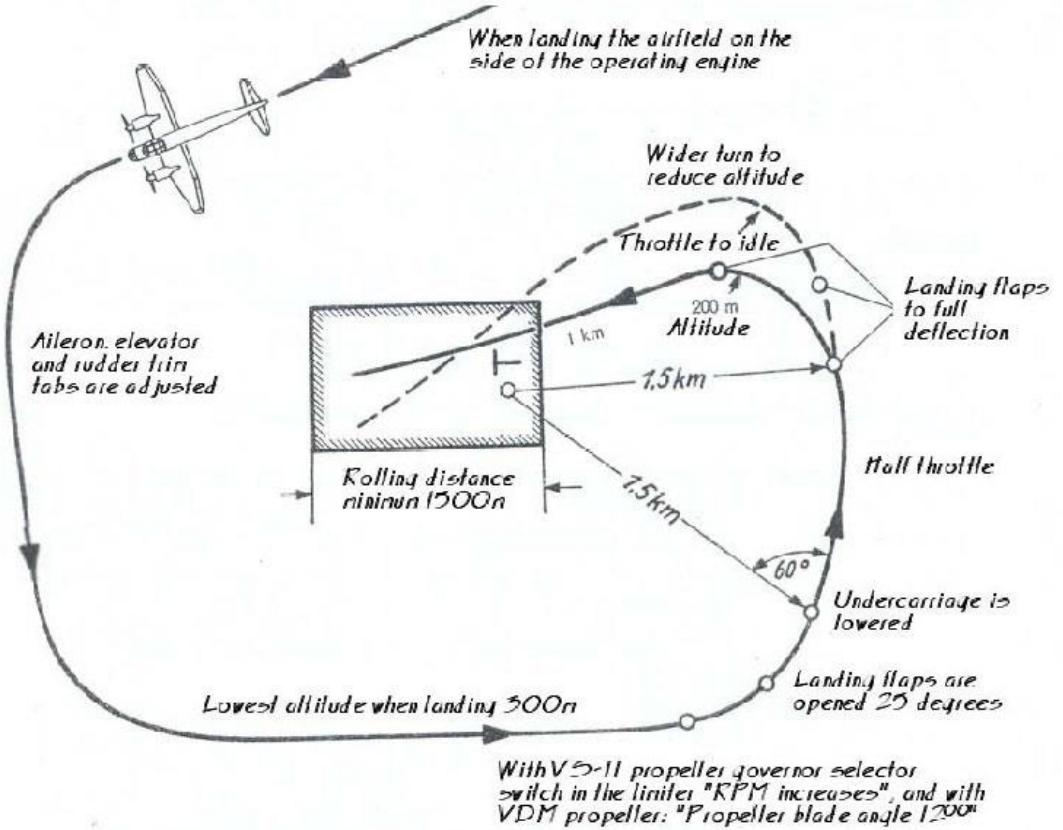
NOTE: This procedure is NOT the real-life start-up procedure, it has been simplified in the sim.

1. Fuel cocks for both engines set to BOTH (not visible in cockpit, use key bindings. Mine are LCTRL+1 and LCTRL+2 for fuel cock # 1 and # 2 toggle). Make sure that your engine fuel tanks are filled by selecting inner tanks with the Fuel Contents Gauge Selector (3 – inner main fuel tanks).
2. Select Engine # 1 (L_Shift + 1).
3. Oil rad and water rad fully open (100 %)
4. Prop pitch full fine (RPM @ 100 %).
5. Crack throttle about an inch
6. Switch Magnetos to M1+M2
7. Make sure your propeller is clear (“Clear prop!”)
8. Engine ignition! (press “I” by default)
9. Select Engine # 2 (L_Shift + 2) and repeat steps 3 to 8.
10. Select both engines (L_Shift + 3).
11. Wait for oil temperature to reach at least 40 deg C and water rad temperature to reach at least 40 deg C.
12. Taxi to the runway.
13. Make sure you are facing yellow panels on the runway. This means you are facing the right direction for takeoff.
14. Perform last takeoff checks: Canopy Closed, Water & Oil Rads fully open, Full Fine prop pitch (100 %), good oil & water rad temperatures.
15. Gradually throttle up. Compensate for engine torque and wind using rudder pedals and small brake input to keep the aircraft straight. Slightly push the yoke forward to lift the tail, which should lift off by itself naturally.
16. Rotation is at 185 km/h. Be very careful as your tyres will burst at around 200 km/h.
17. Raise landing gear and flaps and throttle back to approx. 1.15 ATA (orange line). Lower prop pitch until engine is operating at 2300 RPM while you are beginning your climb. Your best climb rate is at 250 km/h.

PART 7: LANDING

1. Start your approach at 200 km/h @ approx. 800 m (1500 ft AGL).
2. Water and oil rads fully open (100 %) and set prop pitch to full fine (100 %).
3. Deploy flaps (fully down) and landing gear.
4. Cut throttle and try to keep your nose pointed to the end of the runway.
5. Touchdown at 180 km/h in a 3-point landing.
6. Yoke fully back.
7. Tap your brakes until you come to a full stop. Be careful not to overheat your brakes or force your aircraft to nose over into a prop strike.

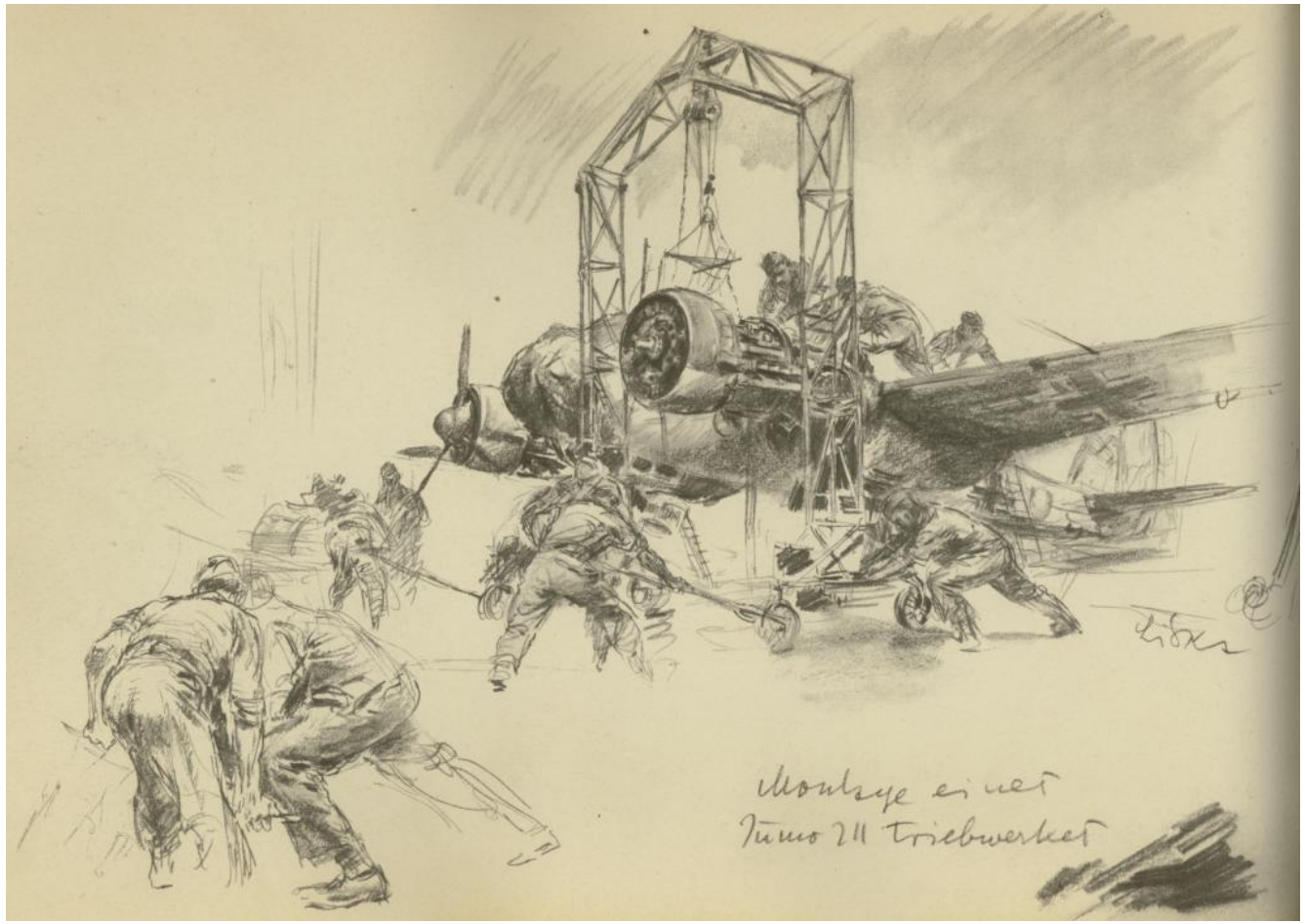




PART 8: ENGINE MANAGEMENT

The **Jumo 211** was an inverted V-12 aircraft engine, Junkers Motoren's primary aircraft engine of World War II. It was the direct competitor to the famous Daimler-Benz DB 601 and closely paralleled its development. While the Daimler-Benz engine was mostly used in single-engined and twin-engined fighters, the Jumo engine was primarily used in bombers such as Junkers' own Ju 87 and Ju 88, and Heinkel's H-series examples of the Heinkel He 111 medium bomber. It was the most-produced German aero engine of the war, with almost 70,000 examples completed.

PART 8: ENGINE MANAGEMENT



The Jumo 211 was developed by Dr. Franz Josef Neugebauer as scaled-up successor to the earlier Jumo 210. In 1934, even before the new Jumo 210 had completed its acceptance tests, the RLM sent out a request for a new 1,000 PS-class engine of about 500 kg weight. Both Jumo and Daimler-Benz responded, and in order to reach service before the new Daimler-Benz DB 600, the Jumo team decided to make their new design as similar as possible to their 210H model, currently in testing. The resulting Jumo 211 was first prototyped at Jumo's Dessau plant in 1935 and started testing in April 1936. Like the 210H, it featured a mechanical direct fuel injection system using small pistons driven off the crankshaft, three valves per cylinder, and an inverted V layout. It also had an open-cycle cooling system, not pressurized.

PART 8: ENGINE MANAGEMENT

Development of the 211 continued with the 211B being released in 1938, with a slightly increased maximum RPM of 2,400 which boosted power to 1,200 PS (1,200 hp; 880 kW). The later 211C and 211D differed primarily in the propeller gear ratios and other features.

A major upgrade was started in 1940 in order to better compete with the 601, following in its footsteps with a pressurized cooling system. The resulting 211E proved to be able to run at much higher power settings without overheating, so it was quickly followed by the 211F which included a strengthened crankshaft and a more efficient supercharger.

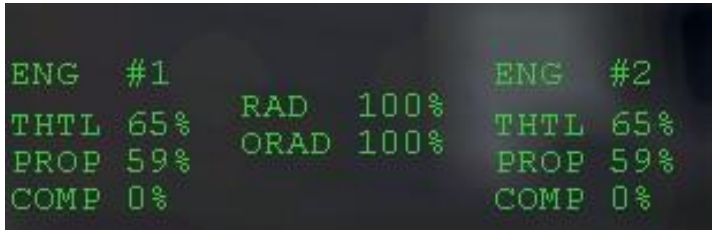
The Jumo 211 became the major bomber engine of the war, in no small part due to Junkers also building a majority of the bombers then in use. Of course, since it was the Luftwaffe that selected the final engine to be used after competitive testing on prototypes (such as the Dornier Do 217), there is certainly more to it. Limited production capacity for each type, and the fact that the Jumo was perfectly capable (if not superior) in a bomber installation meant that it made sense to use both major types to the fullest; since the Daimler had a slight edge in a lightweight, single-engine application, that left the Jumo to fill in the remaining roles as a bomber engine. Even this wasn't enough in the end, and radial engines like the BMW 801 were increasingly put into service alongside the Jumo and DB series, most often in multi-engine installations like the Jumo.

PART 8: ENGINE MANAGEMENT

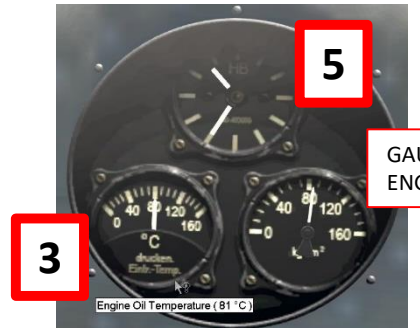
FOUR	ENGINES IN CLIFFS OF DOVER	FOUR
Mixture Control		
Engine	**Operation**	
Gypsy Major	Mixture Lever in rear cockpit has 2 operating positions only: RICH and WEAK. The mixture should be set to RICH at all times under 5000 feet. Above 5000 feet, mixture ajustment should not cause a drop in RPM.	
Merlin II - XII	Mixture Lever has 2 operating positions only: RICH (NORMAL) and WEAK. An interlocking arrangement returns the mixture control to RICH when the throttle is closed. **Note: Mixture Control moves AFT for RICH and FORWARD for WEAK.**	
Mercury XV	Mixture Lever has 2 operating positions only: RICH (NORMAL) and WEAK. An interlocking arrangement returns the mixture control to RICH when the throttle is closed. **Note: Mixture Control moves AFT for RICH and FORWARD for WEAK.**	
DB 601 A - A1	The DB 601 Series engines are Direct Fuel Injection engines and do not have a pilot selectable mixture control.	
Jumo 211 B/D	The Jumo 211 B/D Series engines are Direct Fuel Injection engines and do not have a pilot selectable mixture control.	

PART 8: ENGINE MANAGEMENT

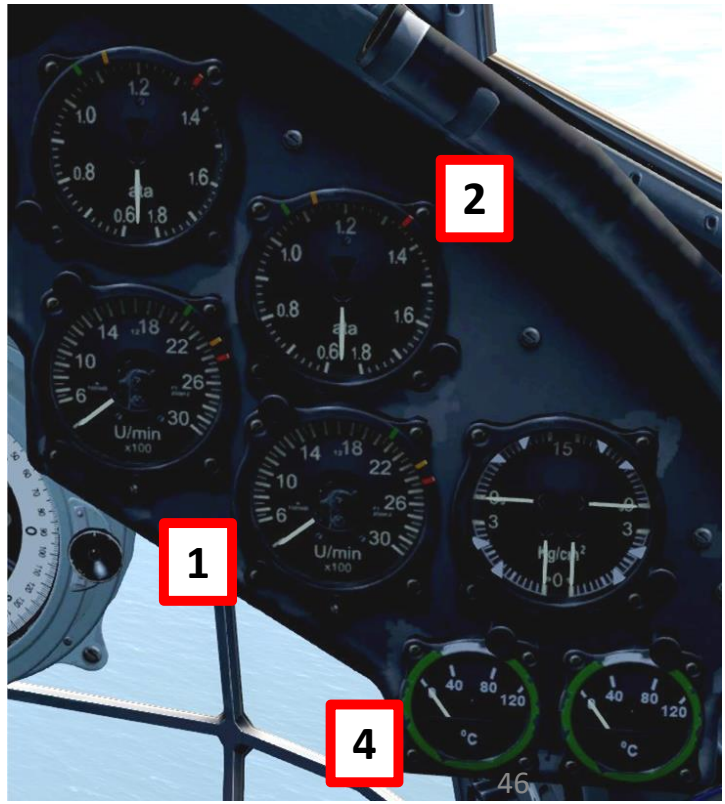
During a mission, the flight lead usually calls out his engine settings once in a while for the pilots to know what settings they should use. You can read your engine settings from the gauges in the cockpit or from an info window.



- The RPM indicator (1) and the manifold pressure (2) are what you should check every minute. The green, orange and red indexes are visual markers to remind you of the limits for 1 min operation (red), 30 min operation (orange) and infinite operation (green). The oil (3) and water (4) radiators can be approximated from the crank position or read from the info window in % (only the oil radiator can be read though as the water rad info window will only tell you if you are opening or closing them). Note: 100 % = fully open
- The resulting RPM is affected by both manifold pressure and prop pitch (5).
- Radiator settings:
  - 75% WATER / 50 % OIL during **normal operation**
  - 75 % WATER / 75 % OIL during **takeoff & climb**
  - 100 % WATER / 100 % OIL during **landing**



GAUGE IS ON THE ENGINE ITSELF!



	(Unit)	JU-88 A-1
TEMPERATURES		
Water Rad Min	Deg C	40
Max		90
Oil Rad (OUTBOUND) Min	Deg C	40
Max		80

PART 8: ENGINE MANAGEMENT

SUPERCHARGER OPERATION

- There are a lot of misconceptions and rumours about the use of superchargers. Time to reveal the truth!
- A **supercharger is an engine-driven air pump or compressor that provides compressed air to the engine to provide additional pressure to the induction air so the engine can produce additional power.** It increases manifold pressure and forces the fuel/air mixture into the cylinders. The higher the manifold pressure, the more dense the fuel/air mixture, and the more power an engine can produce.
- With a normally aspirated engine, it is not possible to have manifold pressure higher than the existing atmospheric pressure. A supercharger is capable of boosting manifold pressure above 30 "Hg (for german planes it would be an ATA value). For example, at 8,000 feet a typical engine may be able to produce 75 percent of the power it could produce at mean sea level (MSL) because **the air is less dense at the higher altitude**. The supercharger compresses the air to a higher density allowing a supercharged engine to produce the same manifold pressure at higher altitudes as it could produce at sea level.
- Thus, an engine at 8,000 feet MSL could still produce 25 "Hg of manifold pressure whereas without a supercharger it could produce only 22 "Hg. Superchargers are especially valuable at high altitudes (such as 18,000 feet) where the air density is 50 percent that of sea level. The use of a supercharger in many cases will supply air to the engine at the same density it did at sea level. With a normally aspirated engine, it is not possible to have manifold pressure higher than the existing atmospheric pressure.

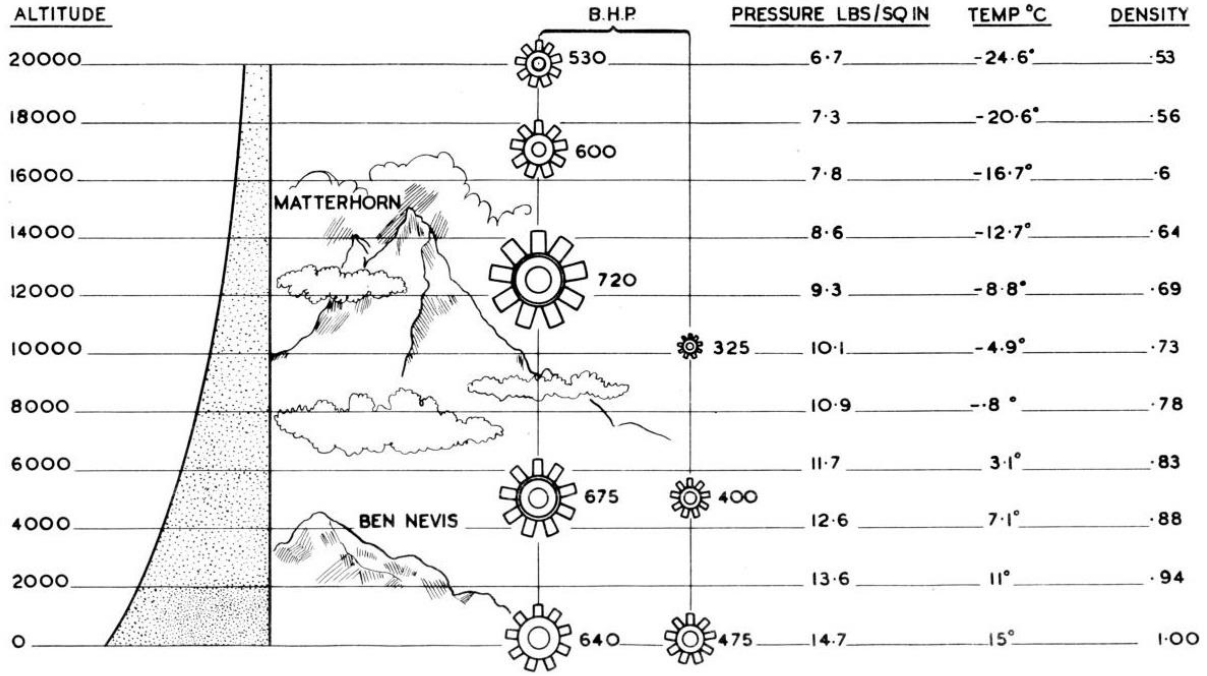
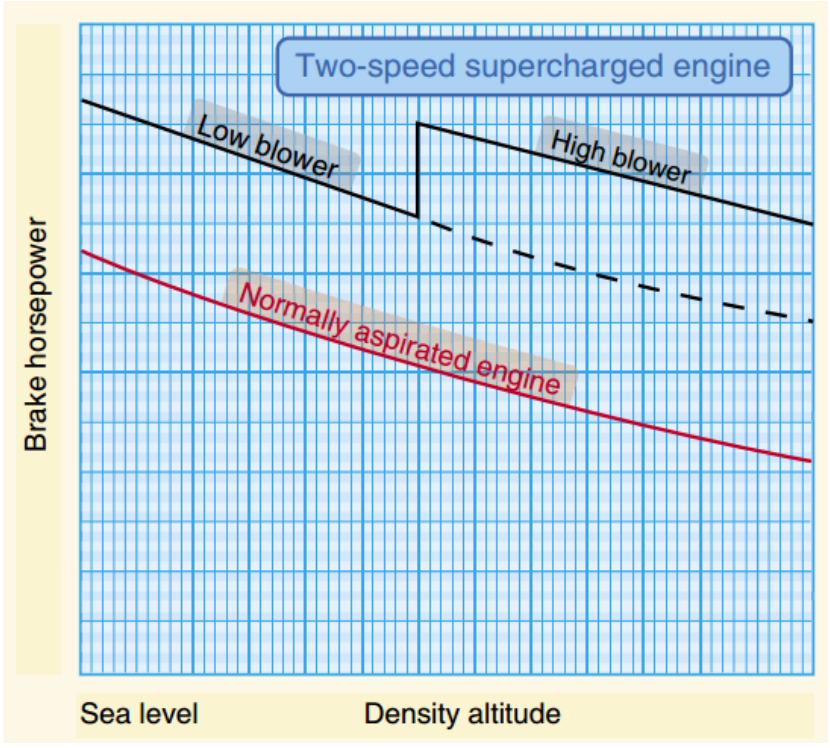


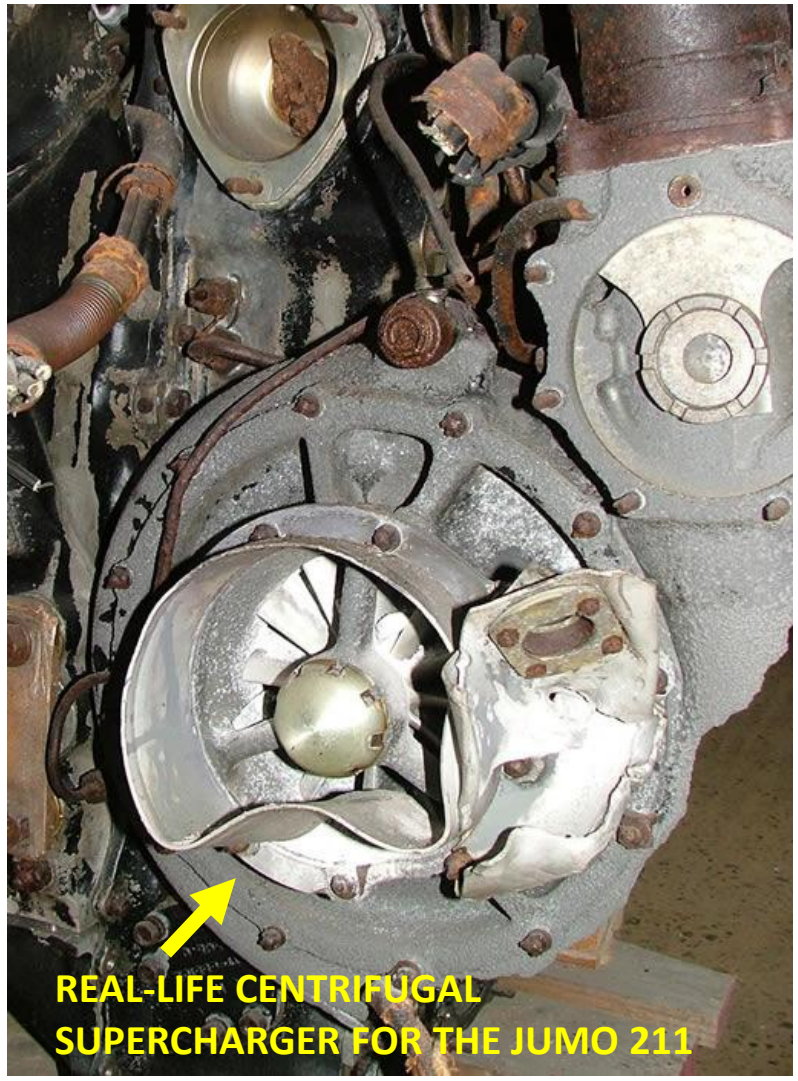
DIAGRAM SHOWING ATMOSPHERIC AND POWER VARIATIONS

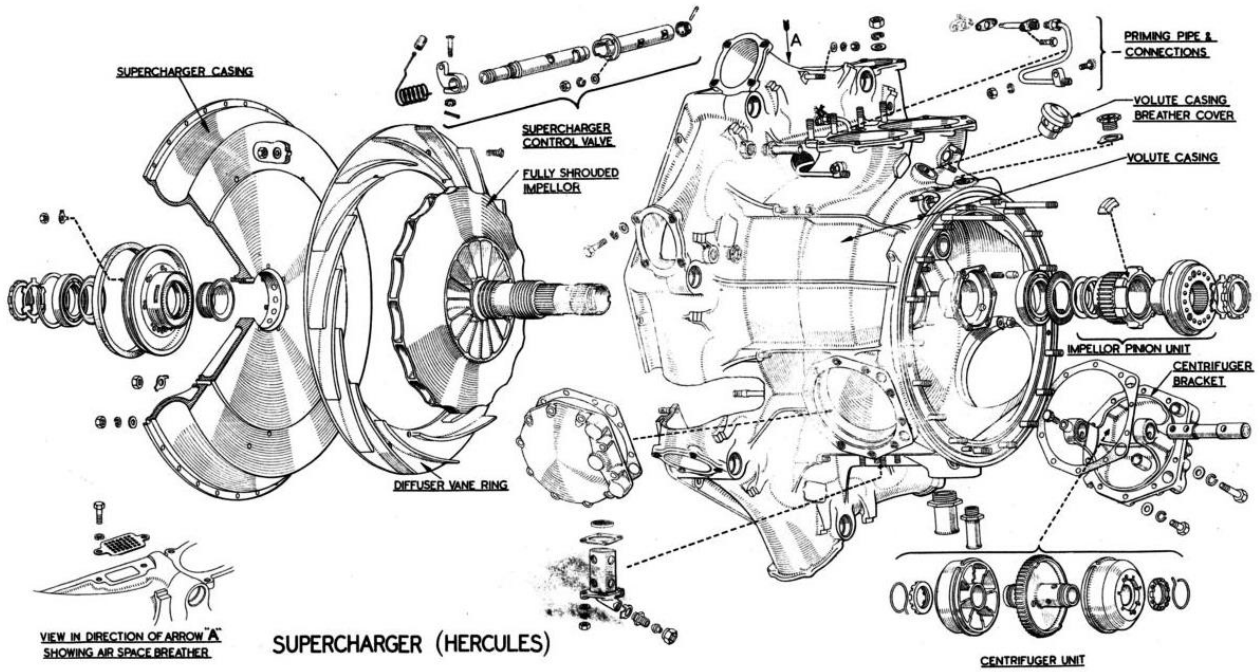


PART 8: ENGINE MANAGEMENT

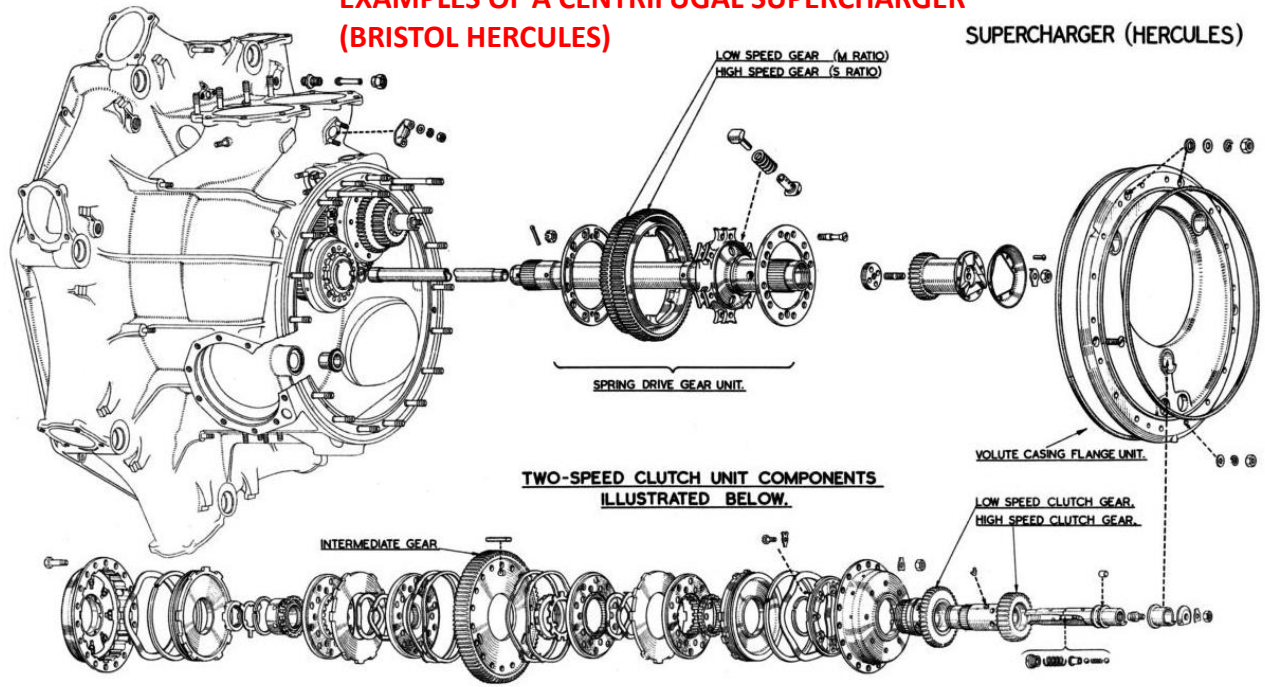
SUPERCHARGER OPERATION

- This is what a two-speed centrifugal supercharger looks like.





EXAMPLES OF A CENTRIFUGAL SUPERCHARGER (BRISTOL HERCULES)



PART 8: ENGINE MANAGEMENT

SUPERCHARGER OPERATION

- Some of the large radial engines developed during World War II have a single-stage, two-speed supercharger. This is what we have on the Jumo 211. With this type of supercharger, a single impeller may be operated at two speeds.
- The low impeller speed is often referred to as the low blower setting, while the high impeller speed is called the high blower setting. On engines equipped with a two-speed supercharger, a lever or switch in the flight deck activates an oil-operated clutch that switches from one speed to the other.

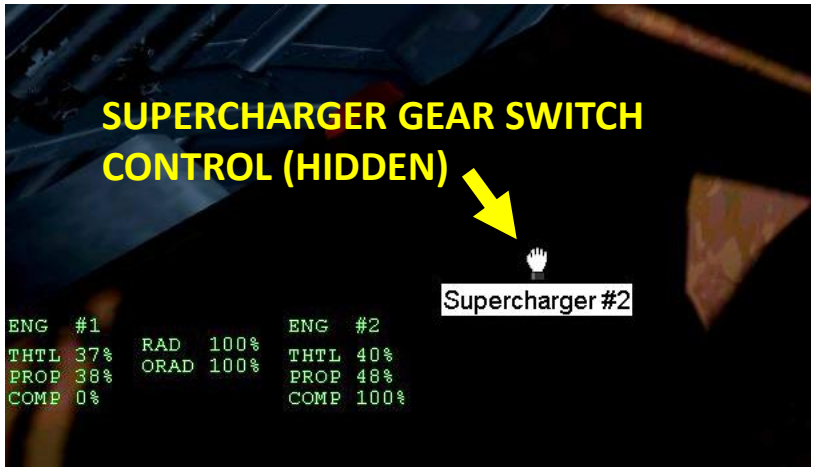
Supercharger vs Turbosupercharger (or Turbocharger)

- While there is no turbocharger installed on the Jumo 211, it is interesting to explain the differences between a turbocharger (installed on the P-47 Thunderbolt for example) and a supercharger. Why? Simply because people often confuse them.
- The most efficient method of increasing horsepower in an engine is by use of a turbosupercharger or turbocharger. Installed on an engine, this booster **uses the engine's exhaust gases to drive an air compressor to increase the pressure of the air** going into the engine through the carburetor or fuel injection system to boost power at higher altitude.
- The major disadvantage of the gear-driven supercharger – use of a large amount of the engine's power output for the amount of power increase produced – is avoided with a turbocharger, because turbochargers are powered by an engine's exhaust gases. This means a turbocharger recovers energy from hot exhaust gases that would otherwise be lost.
- A second advantage of turbochargers over superchargers is the ability to maintain control over an engine's rated sea level horsepower from sea level up to the engine's critical altitude. Critical altitude is the maximum altitude at which a turbocharged engine can produce its rated horsepower. Above the critical altitude, power output begins to decrease like it does for a normally aspirated engine.

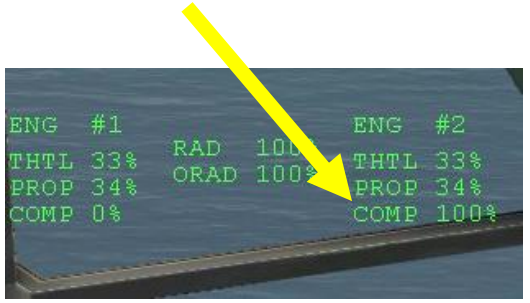
PART 8: ENGINE MANAGEMENT

SUPERCHARGER OPERATION TUTORIAL (PART 1)

- The supercharger on the Jumo 211 is a two-speed centrifugal type supercharger with automatic boost control
- You switch between first (low blower) and second (high blower) supercharger gears using the “Selected Supercharger – Previous / Next Step” controls.
- Do not use the “Selected Supercharger – Cycle” control. It is bugged and does not work.
- My key custom bindings are: “Selected Supercharger – Previous Step” mapped to “LCTRL+Q” and “Selected Supercharger – Next Step” mapped to “Q”.
- Supercharger has no effect at low altitudes (under 1200 m). You need to be above 1500 m to see a difference.
- “COMP” at 0 % means the supercharger is in first gear. “COMP” at 100 % means the supercharger is in second gear.



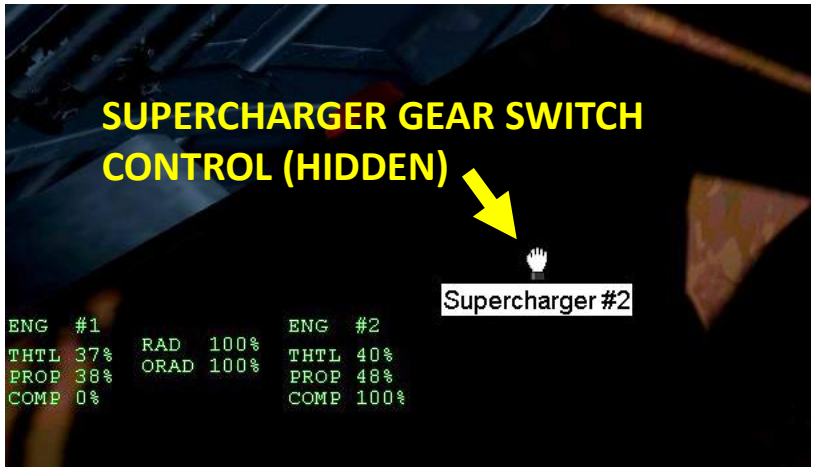
	(Unit)	JU-88 A-1
ALTITUDE		
Supercharger Stage 1 Operation Altitude	UK: ft GER: M	0 1220
Supercharger Stage 2 Operation Altitude	UK: ft GER: M ITA: M	1220+

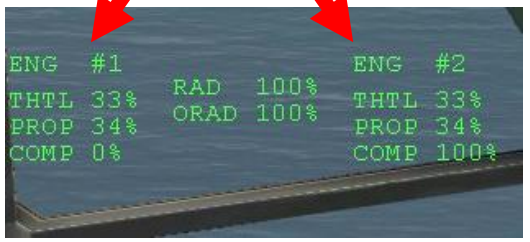


PART 8: ENGINE MANAGEMENT

SUPERCHARGER OPERATION TUTORIAL (PART 2)

- To switch gears, you need to do it individually for each engine:
  1. *Check your altitude. If you are under 1200 m, you need to have your supercharger in first gear. If you are over 1500 m, you need to have your supercharger in second gear.*
  2. *Select Engine # 1 (LSHIFT+1)*
  3. *Hit "Q" to switch to second gear (high blower) or hit "LCTRL+Q" to switch to first gear (low blower).*
  4. *If you switch to second gear, you will see an increase in manifold pressure (ATA) and RPM. Make sure to adjust throttle so your ATA and RPM are not over the orange index. If you ATA is too high, you can cook the engine.*
  5. *Select Engine # 2 (LSHIFT+2) and repeat steps 2 to 4.*
  6. *Select all engines (LSHIFT+3) and you're done!*
- In this example, I deliberately chose to fly high (4000+ m) and run the left engine on the first supercharger gear (low blower) and the right engine on the second supercharger gear (high blower) to show you the difference between supercharger gear behaviour.
- Left engine has an ATA of 0.85 and a RPM of 1800. (supercharger gear 1)
- Right engine has an ATA of 1.12 and a RPM of 2000. (supercharger gear 2)
- And yet, **both engines have their throttle & prop pitch at the same position**!





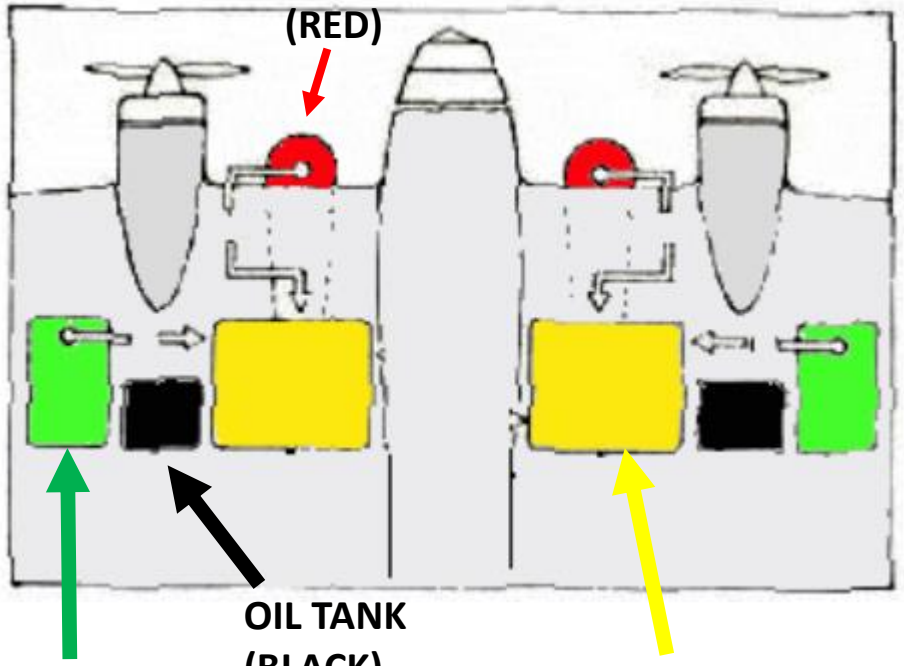
	(Unit)	JU-88 A-1
ALTITUDE		
Supercharger Stage 1 Operation Altitude	UK: ft GER: M	0 1220
Supercharger Stage 2 Operation Altitude	UK: ft GER: M ITA: M	1220+ (AUTO/MAN MODES)

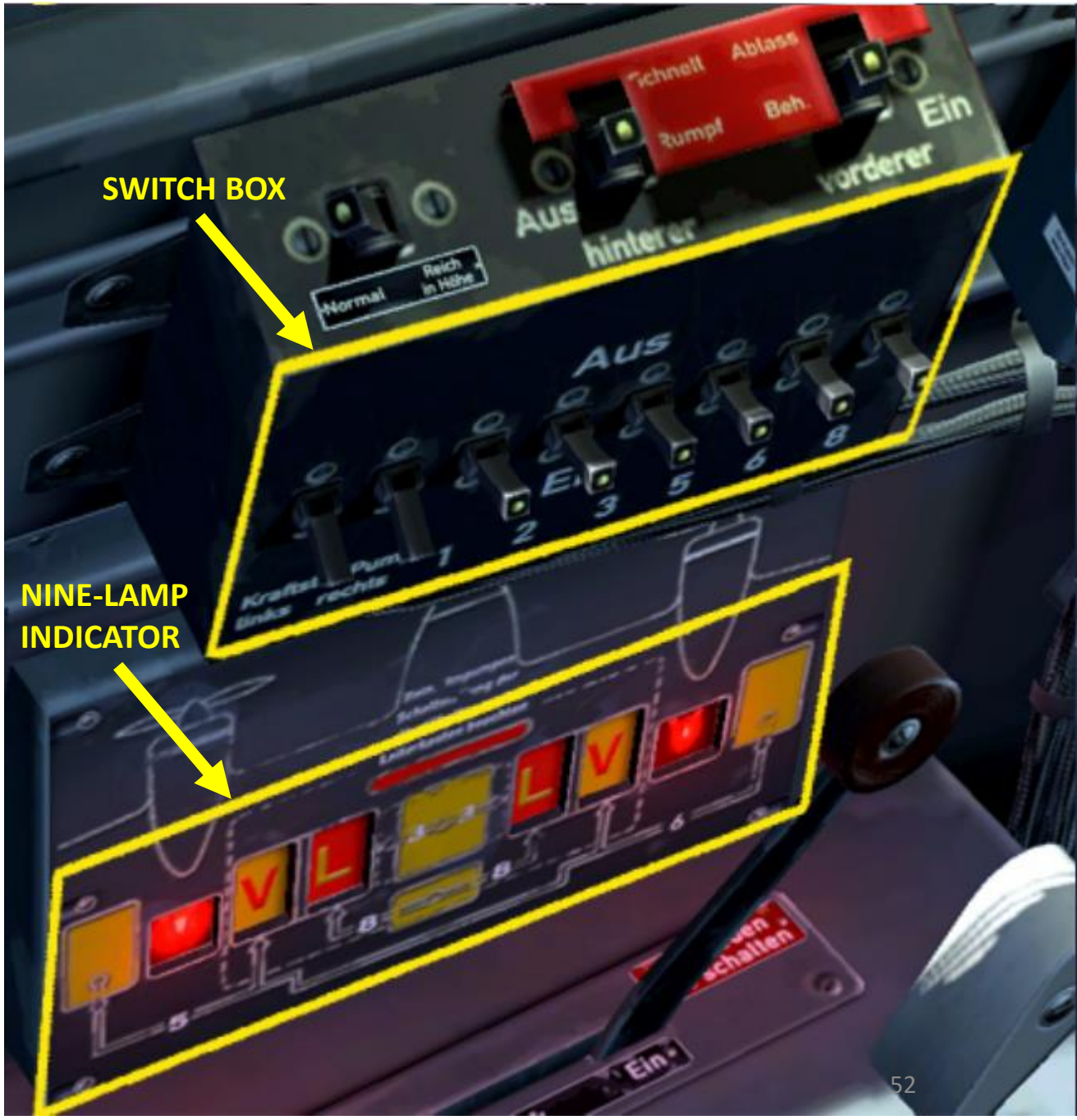
PART 8: ENGINE MANAGEMENT

FUEL MANAGEMENT SYSTEM

- The **switch box** is used to control fuel transfer pumps.
  - "Aus" (UP) is OFF.
  - "Ein" (DOWN) is ON.
- The **nine-lamp indicator** is used as a "pumping diagram". This basically tells you what is going on with each fuel tank.
- You can see the fuel diagram below:

EXTERNAL DROP TANK (NOT IN GAME)



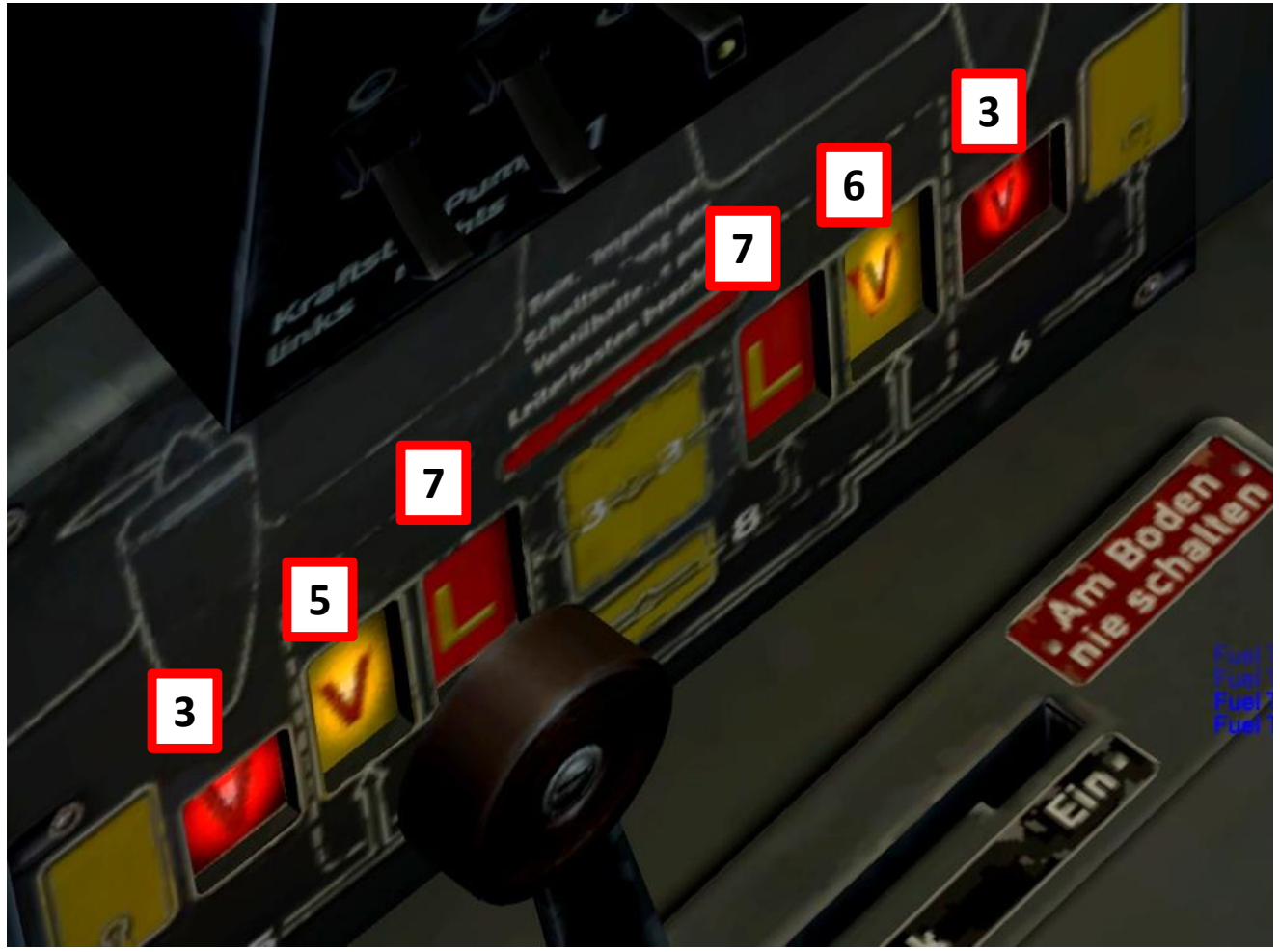


PART 8: ENGINE MANAGEMENT

FUEL MANAGEMENT SYSTEM

NOTE: Your engines only take fuel from the inner (main) tanks… NOT from the outer (reserve) tanks.

1. There are six fuel lamps on the panel on the left of the pilot seat. You can read letters in them: V-V-L-L-V-V.
2. The "V" indicates filling/pumping and the "L" indicates emptying.
3. The outer lamps with the red “V” are the fuel pumps of your engines. They should be lit at all times.
4. The inner lamps with yellow “V” are the fuel pumps that transfer fuel from BOTH outer tanks to either the left inner tank (left V lit) or the right inner tank (right V lit).
5. Left yellow V lit = fuel transfer pump is sending fuel from BOTH outer reserve tanks to left inner main tank only.
6. Right yellow V lit = fuel transfer pump is sending fuel from BOTH outer reserve tanks to right inner main tank only.
7. Inner red L lamps are lit when either left or right inner main tanks are under 50 %. It is basically a reminder to let you know “hey dude, start transferring fuel from reserve tanks to main tanks!”



OVERALL, just remember that when you have a red L lit up, it’s time to take fuel from your outer reserve tanks to your inner main tanks (see next slide).

PART 8: ENGINE MANAGEMENT

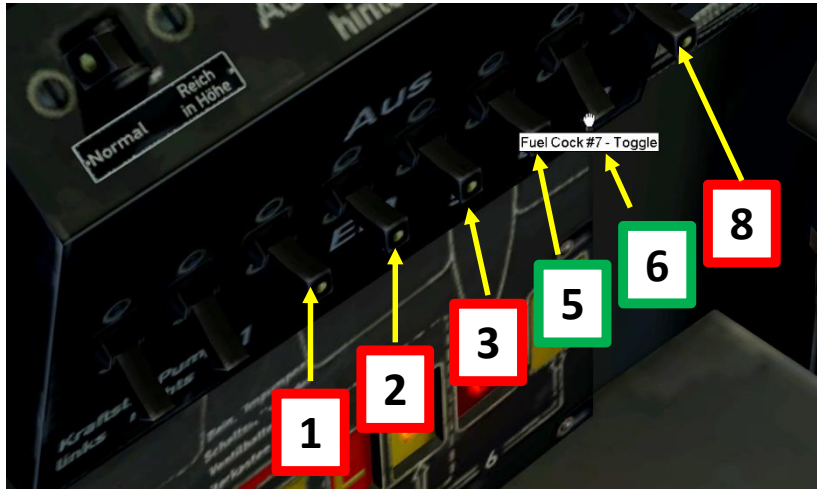
FUEL MANAGEMENT SYSTEM

These switches are pretty… but what do they do?

Visible switch label	In-Game Label	Action
Kraftst.Pump.links	--	(always on)
Kraftst.Pump.rechts	--	(always on)
1 **1**	Fuel cock #3	EIN: ON / AUS: OFF Pump fuel from left drop tank to the left inner tank only. Left yellow V should be lit. (FUNCTIONAL, BUT USELESS SINCE WE DON'T HAVE EXTERNAL FUEL TANKS)
2 **2**	Fuel cock #4	EIN: ON / AUS: OFF Pump fuel from right drop tank to the right inner tank only. Right yellow V should be lit. (FUNCTIONAL, BUT USELESS SINCE WE DON'T HAVE EXTERNAL FUEL TANKS)
3 **3**	Fuel cock #5	EIN: ON / AUS: OFF Pump fuel from forward fuselage tank to both inner tanks. Both yellow V should be lit. (FUNCTIONAL, BUT USELESS SINCE FWD AND REAR FUSELAGE TANKS ARE NOT IMPLEMENTED IN CLOD)
5 **5**	Fuel cock #6	**EIN: ON / AUS: OFF** **Pump fuel from LEFT outer tank to both inner tanks. Both yellow V should be lit.**
6 **6**	Fuel cock #7	**EIN: ON / AUS: OFF** **Pump fuel from RIGHT outer tank to both inner tanks. Both yellow V should be lit.**
8 **8**	Fuel cock #8	EIN: ON / AUS: OFF Pump fuel from rear fuselage tank to both inner tanks. Both yellow V should be lit. (FUNCTIONAL, BUT USELESS SINCE FWD AND REAR FUSELAGE TANKS ARE NOT IMPLEMENTED IN CLOD)

In other words, items switches highlighted in **RED** are **useless junk** that you should forget. **GREEN** is what you **should remember**.

Just remember that switch 5 (fuel cock # 6) transfers fuel from the outer left tank to both inner tanks, and that switch 6 (fuel cock # 7) transfers fuel from the outer right tank to both inner tanks.



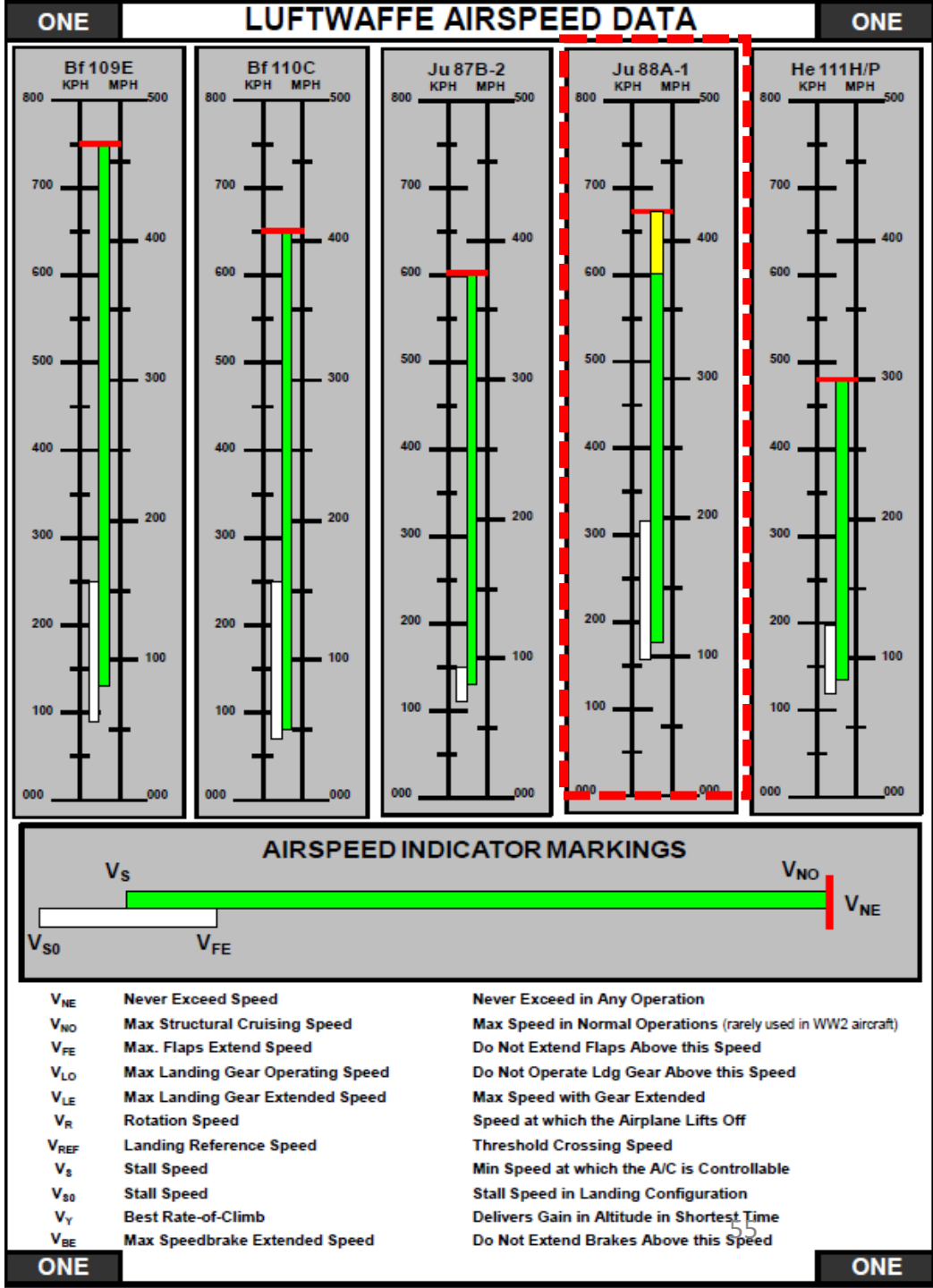
PART 9: AIRCRAFT PERFORMANCE

AIRSPEEDS

Takeoff – Rotation	UK: mph GER/ITA: km/h	185
Max Dive Speed		675
Optimal Climb Speed		250
Landing – Approach		200
Landing – Touchdown		180

- Best airspeed for climb: 250 km/h
- In practice, lots of experienced pilots found out that a climb speed between 300 and 340 km/h allowed for a better climb rate.
- It For more information on either aircraft or engine performance, consult the **2nd Guards Composite Aviation Regiment** Operations Checklist. It is a fantastic resource (link below).

https://drive.google.com/open?id=0B-uSpZROuEd3NGN4c0JRNHJpYkk&authuser=0



PART 9: AIRCRAFT PERFORMANCE

ONE	Ju 88A		ONE
Aircraft Type	**Engine & Prop**	**Fuel**	**Reference**
Ju 88A-1	Jumo 211B-1	87 Oct	

AIRSPEED LIMITATIONS

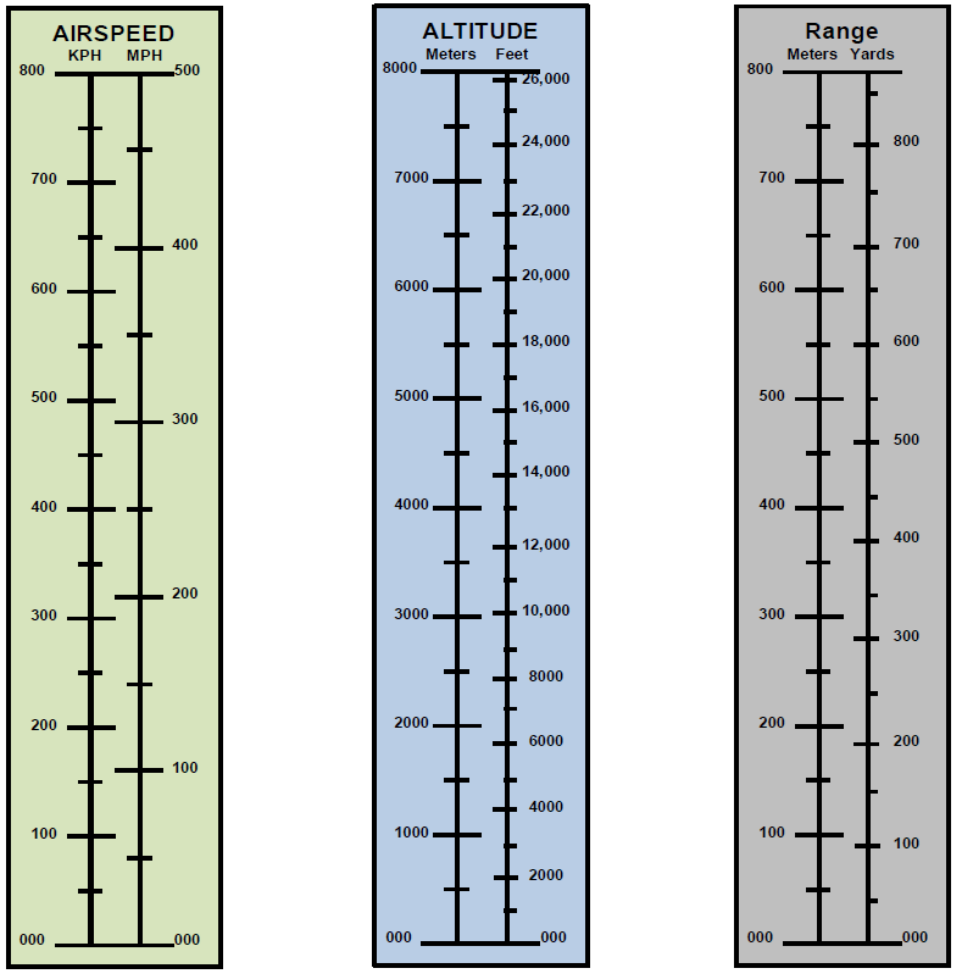
	Design Speeds	KPH	
V_{NE}	Never Exceed Speed (wo/w dive break)	675/575	Never Exceed in Any Operation
V_{FE}	Max. Flaps Extend Speed (25°/50°)	320/275	Do Not Extend Flaps Above this Speed
V_{LO}	Max Landing Gear Operating Speed	NA	Do Not Operate Ldg Gear Above this Speed
V_{LE}	Max Landing Gear Extended Speed	265	Max Speed with Gear Extended
V_R	Rotation Speed (13k/13.7k kg)	175/180	Speed at which the Airplane Lifts Off
V_{REF}	Landing Reference Speed	210	Threshold Crossing Speed
V_S	Stall Speed	180	Min Speed at which the A/C is Controllable
V_{S0}	Stall Speed	160	Stall Speed in Landing Configuration
V_Y	Best Rate-of-Climb	250	Delivers Gain in Altitude in Shortest Time
V_{BE}	Max Speedbrake Extended Speed	NA	Do Not Extend Brakes Above this Speed

AIRSPEED INDICATOR OPERATING RANGES

ASI MARKING	KPH Range	Description
White Arc	160 - 320 KPH	Full Flap Operating Range. Lower Limit is Max. Weight V_{S0} . Upper Limit Max Speed w/Flaps Extended.
Green Arc	180 - 600 KPH	Normal Operating Range. Lower Limit is Max. Weight V_S . Upper limit Is Max Structural Cruising Speed.
Yellow Arc	600 - 675 KPH	Operation must be above 2000m Altitude
Red Line	675 KPH	Maximum Speed for ALL operations.

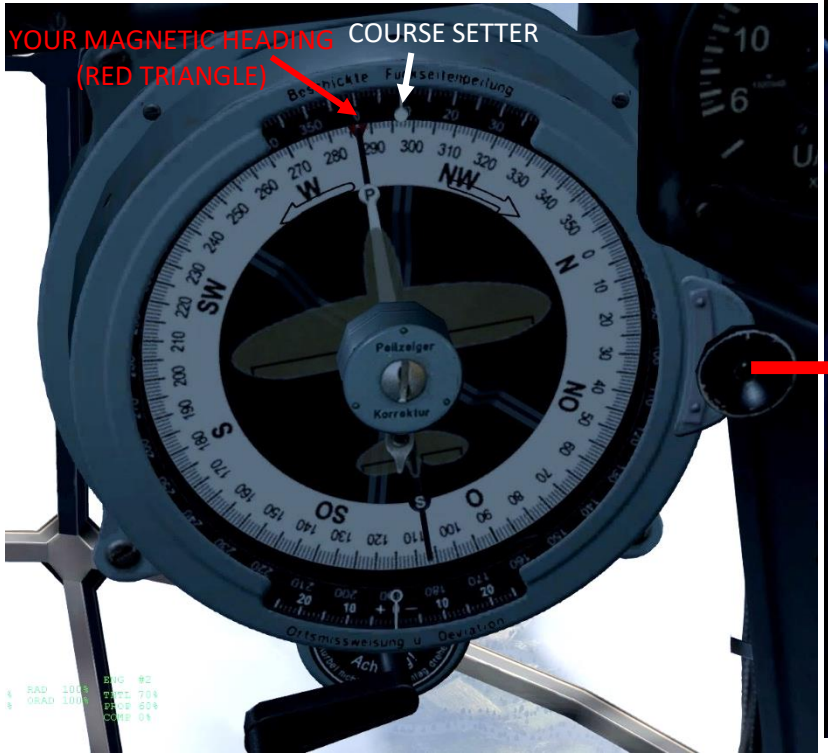
PART 9: AIRCRAFT PERFORMANCE

ONE **CONVERSION DATA** ONE



International Civil Aviation Organization International Standard Atmosphere							
Temperature		Altitude Above Sea Level		Atmospheric Pressure			Mach 1
°F	°C	feet	meters	inches Hg	mm Hg	psia	mph
59	15	SL	0	29.92	760	14.70	761
55	13	1000	305	28.86	733	14.17	758
52	11	2000	610	27.82	706	13.67	755
48	9	3000	914	26.82	681	13.17	752
45	7	4000	1219	25.84	656	12.69	750
41	5	5000	1524	24.90	632	12.23	748
38	3	6000	1829	23.98	609	11.78	745
34	1	7000	2134	23.09	586	11.34	742
31	-1	8000	2438	22.22	564	10.92	740
27	-3	9000	2743	21.39	543	10.51	736
23	-5	10000	3048	20.58	523	10.10	734
5	-15	15000	4572	16.89	429	8.29	720
-13	-25	20000	6096	13.75	349	6.75	706
-31	-35	25000	7620	11.10	282	5.45	693
ONE							ONE

PART 10: COMPASS TUTORIAL

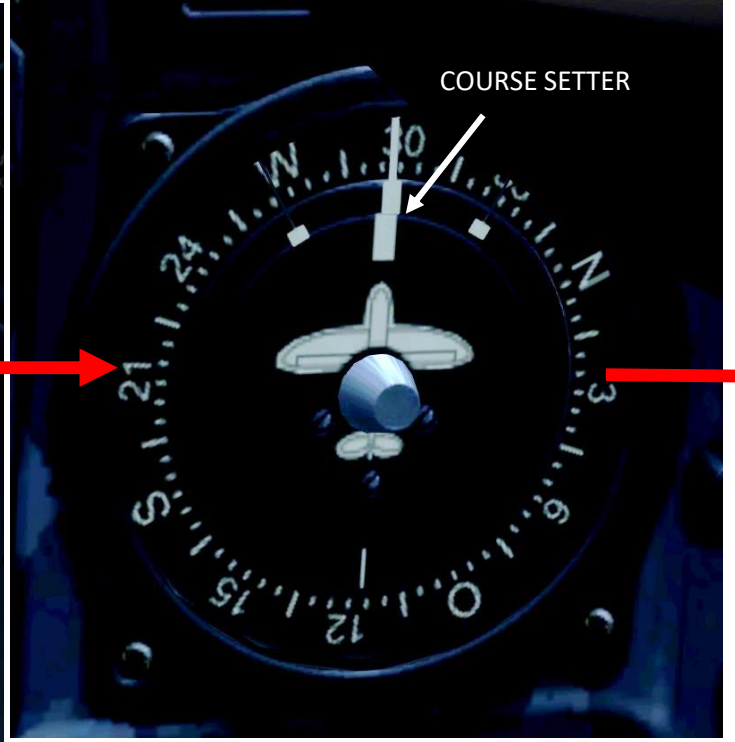


MAGNETIC COMPASS (MC)

GIVES YOU YOUR MAGNETIC HEADING. THE WHITE INDICATOR IS YOUR COURSE SETTER AND THE RED TRIANGLE IS YOUR ACTUAL HEADING.

WHEN YOU SET A COURSE WITH THE COURSE SETTER AND THE RED TRIANGLE AND THE WHITE INDICATOR ARE ALIGNED, IT MEANS THAT YOU ARE ON COURSE.

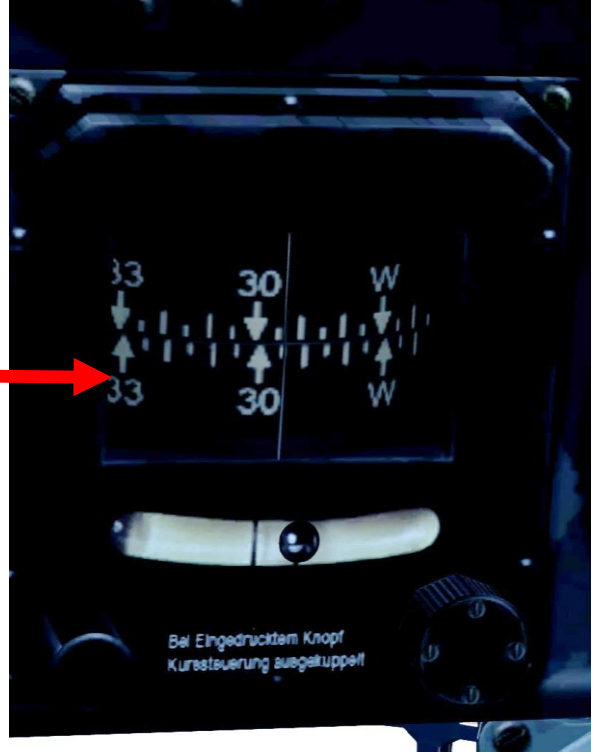
AS YOU CAN SEE IN THE PICTURE ABOVE, WE ARE ABOUT 8 DEGREES OFF-COURSE.



REPEATER COMPASS (RC) + COURSE SETTER (CS)

“REPEATS” WHAT THE MAGNETIC COMPASS IS SHOWING (SINCE YOU DON’T HAVE AN EXTRA SET OF EYES).

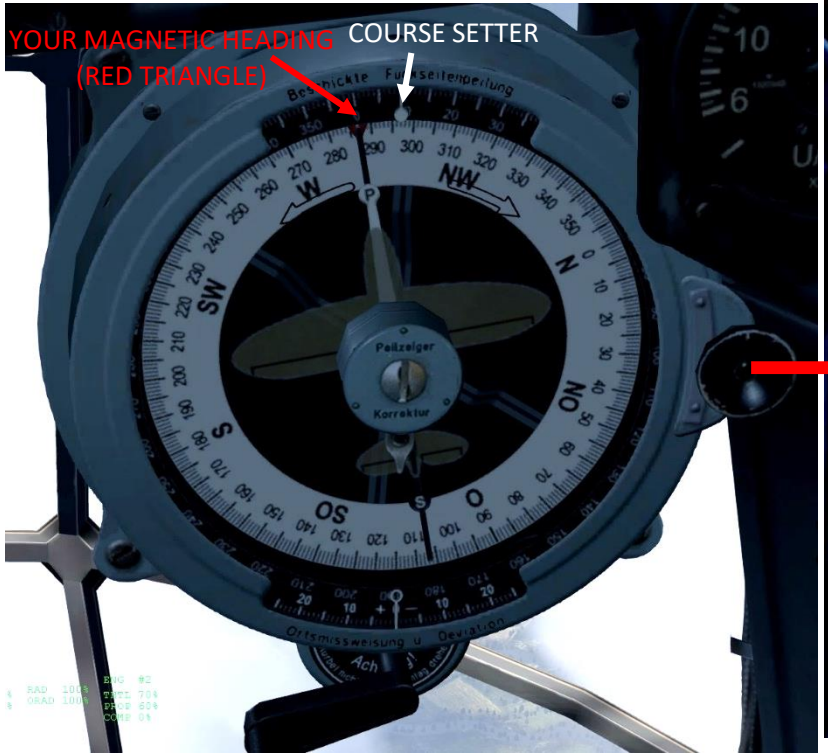
COURSE SETTER ALLOWS YOU TO CREATE A REFERENCE MARK ON THE COMPASS TO A HEADING OF YOUR CHOICE. THIS WAY, YOU JUST NEED TO STEER THE AIRCRAFT (AND MOVE THE REPEATER NEEDLE) TOWARDS THE “COURSE” SET ON THE COURSE SETTER.



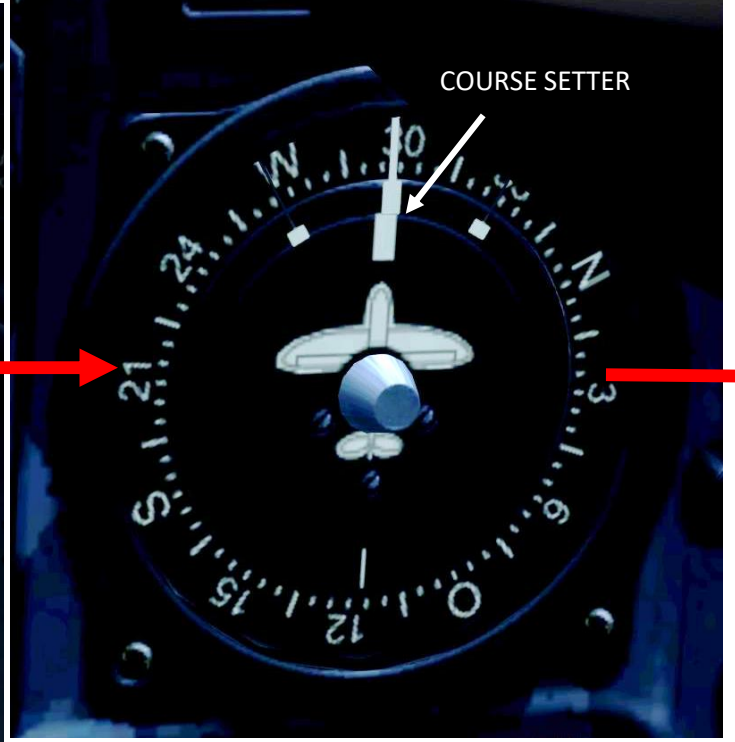
DIRECTIONAL GYRO (TOP BAND)
AUTO-PILOT SETTER (BOTTOM BAND)

DIRECTIONAL GYRO (DG) CAN BE SET TO ANY HEADING YOU WANT. IT IS RECOMMENDED FOR THE DG TO BE SET TO YOUR CURRENT HEADING SHOWN BY THE MAGNETIC COMPASS (AND REPEATER). THIS WAY, YOUR MG, RC AND DG ALL SHOW THE SAME HEADING, WHICH IS A MAGNETIC HEADING, NOT GEOGRAPHIC.
THE AUTO-PILOT “SETTER” MUST BE LINED UP WITH THE DIRECTIONAL GYRO. THE AUTO-PILOT WILL STEER THE AIRCRAFT TO LINE UP BOTH TOP AND BOTTOM BANDS.

PART 10: COMPASS TUTORIAL



MAGNETIC COMPASS (MC)



REPEATER COMPASS (RC) + COURSE SETTER (CS)

DIRECTIONAL GYRO (TOP BAND)
AUTO-PILOT SETTER (BOTTOM BAND)

There is no mechanical/electrical relationship between the directional gyro and the compasses. The autopilot could be set without any reference to the magnetic compass. However, it is good practice to align the compasses with the directional gyro. In practice, only the lead aircraft has the option of engaging the autopilot. The other planes in the formation fly manually due to the demands of formation flying. Having the magnetic/repeater compass setup gives the pilot a visual reference to the current course. In some cases the leader may prefer to fly using the magnetic/repeater compass rather than setting up the auto-pilot. The complexity of the mission plan (course), length of leg (etc.) will usually dictate the practicality of employing the auto-pilot.

PART 10: COMPASS TUTORIAL

HOW TO SET UP YOUR GYRO & COMPASS

1. Align your Course Setter with the heading you are facing. You can do that by either consulting the magnetic compass (red triangle) or the repeater compass. You will see a value in blue text pop up: that value is your current magnetic heading. Remember this value.

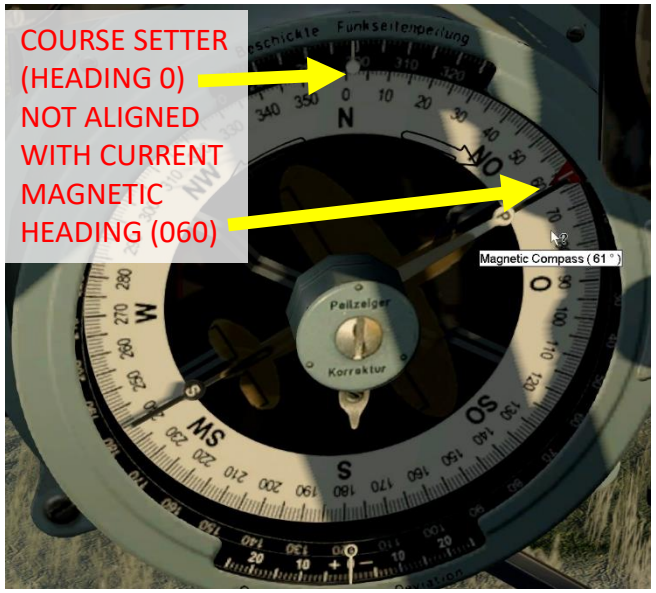
2. In our case, the number is a heading of 060. This heading is in reference to the magnetic north, NOT the geographic north.

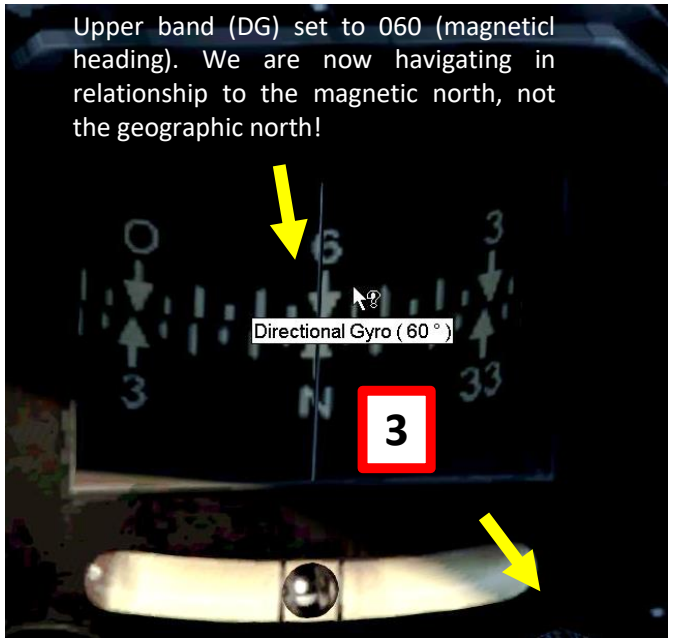
3. Set your directional **directional gyro compass** by clicking on the rotary knob to reflect the magnetic heading obtained on your magnetic compass. In our case, set the gyro to 060. This way, the directional gyro will give us a magnetic heading that is correct. You will see the blue numbers pop again. You can use them as a way to fine tune your gyro.

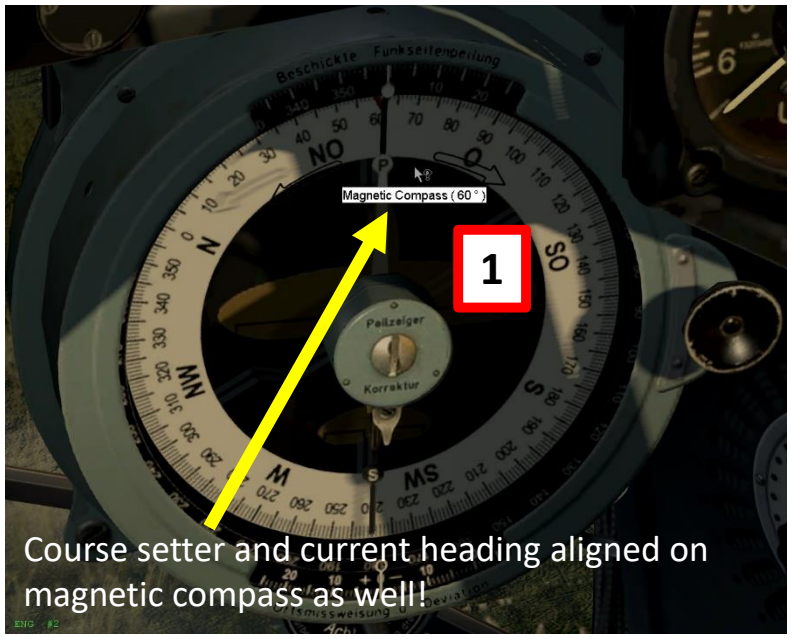
4. And that's it! You will now be able to use your directional gyro to orient yourself. If your gyro accumulates error after high-G manoeuvers, you can try to re-set it using steps 1 to 3.

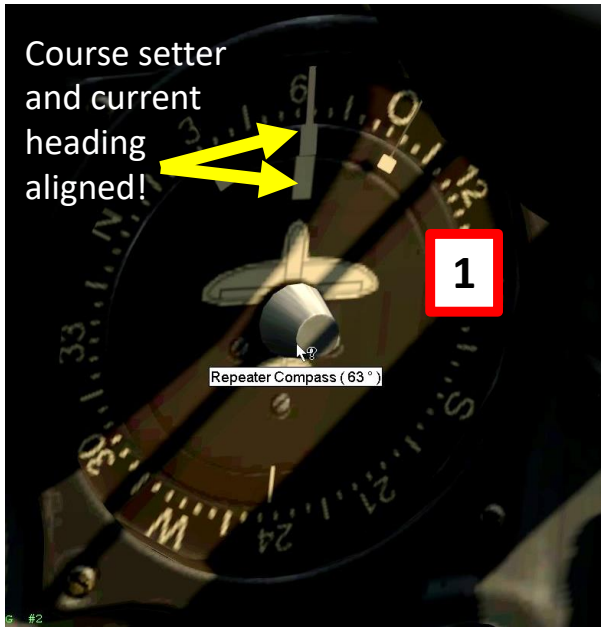
5. You could also set your directional gyro to 050 (060 minus 10 deg of magnetic declination) instead if you wanted to, which would give you your geographical heading instead of your magnetic one. But for simplicity's sake, we will use the DG, MC and RC all synchronized.

NOTE: To navigate from point A to point B, open the map, find a geographical heading to follow, add 10 degrees to this heading and it will give you the magnetic heading to follow on your MG, RC and DG (if they are all synchronized, of course).









PART 10: COMPASS TUTORIAL

COMPASS NAVIGATION TUTORIAL

- Using the magnetic compass and the directional gyro is quite useful to know where you are going.
- The directional gyro indicator itself does not indicate your heading. You need to set it manually in order to translate what the magnetic compass and the repeater compass are telling you.
- Typically, you set your compass and gyro on the ground. It is not the kind of stuff you want to do when you are flying 6,000 m over England.
- High-G manoeuvers can decalibrate your gyro and give you a wrong reading. Be aware that once you start a dogfight, your gyro can give you readings that don't make sense. It's normal: it is one of the real-life drawbacks of this navigation system. The same issue is also recurrent in today's civilian acrobatic prop planes.
- There is a difference between a **magnetic heading** and a **geographical heading**. If you follow a magnetic heading of 0 (which is what you read on your magnetic and repeater compasses), you will be following the magnetic North Pole, not the geographical one. Keep that in mind when you are navigating.
- If you consult your in-game map and want to go North, in fact you will have to take into account **magnetic declination**, which means that you will have to navigate to a magnetic heading of 0 + 10 deg = 010 deg.
- In other words, if you want to follow a specific heading, take that heading and add 10 degrees. This value is what you will have to follow on your magnetic and repeater compass.
- You can also look at it the other way: if you want to go North and you decide to follow your compass to "0" (magnetic North), you will in fact be 10 degrees off course. The next slide will explain why.

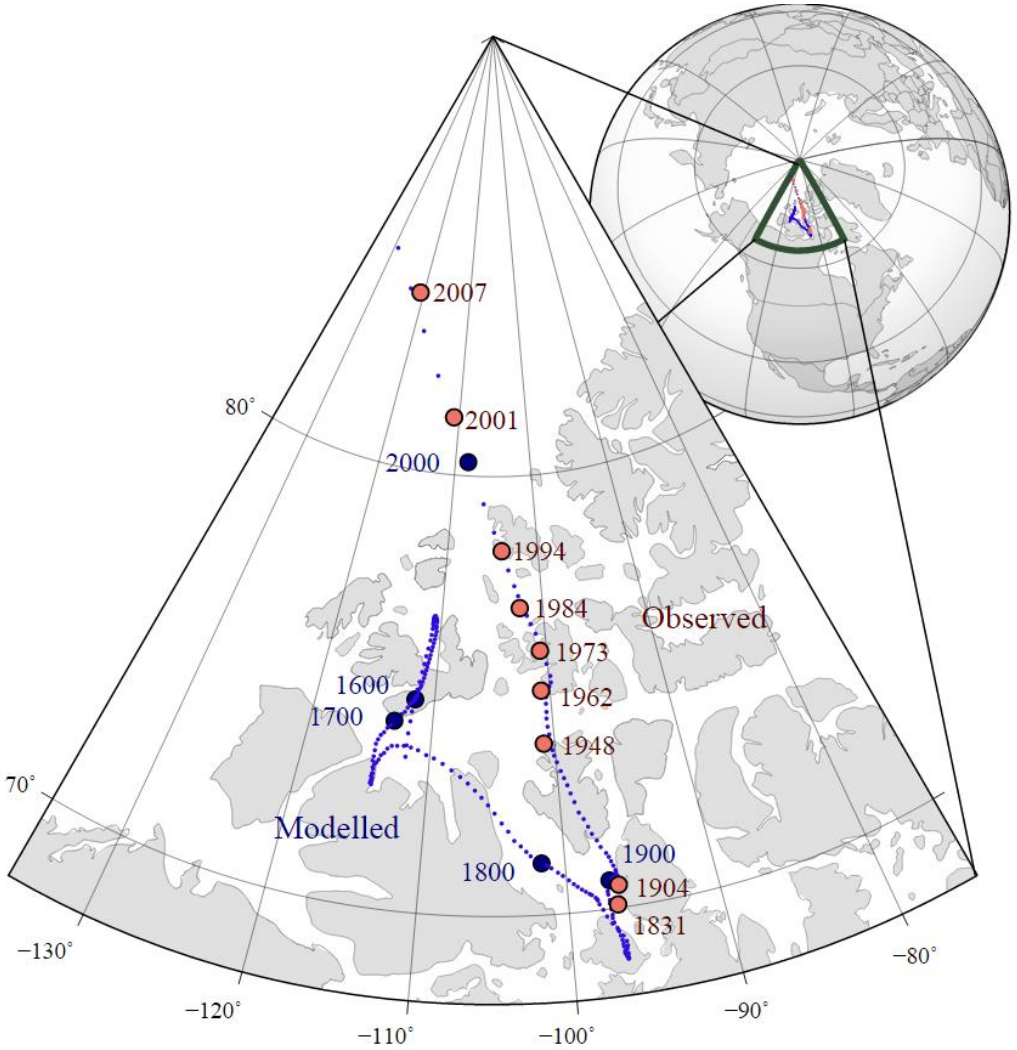
PART 10: COMPASS TUTORIAL

About Magnetic Declination

The direction in which a compass needle points is known as magnetic north. In general, this is not exactly the direction of the North Magnetic Pole (or of any other consistent location). Instead, the compass aligns itself to the local geomagnetic field, which varies in a complex manner over the Earth's surface, as well as over time. The local angular difference between magnetic north and true north is called the magnetic declination. Most map coordinate systems are based on true north, and magnetic declination is often shown on map legends so that the direction of true north can be determined from north as indicated by a compass.

This is the reason why in Cliffs of Dover, the magnetic compass needs to be “adjusted” to take into account this magnetic declination of the magnetic North pole (which is actually modelled in the sim, which is pretty neat).

In 1940, the magnetic declination required an adjustment of 10 degrees and 8 minutes. We round that to 10 deg.



The movement of Earth's north magnetic pole across the Canadian arctic, 1831–2007

PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL - INTRO

- Bombing is one of the most complex and rewarding features of flight simulators. The bomber pilot has a thankless job, yet bombing is an art form in itself.
- This tutorial will be for high-altitude bombing as it encompasses all aspects of bombing and navigation.
- Bombers should work as a team. Not only with other bombers, but with fighter escorts as well to keep them alive.
- The mind of a bomber pilot is a patient and organized one. If you fail to plan your mission properly, you certainly plan to fail and end up in a smoldering pile of ashes.

PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL - INTRO

- A bombing operation can be separated in 6 phases:
  1. Planning the mission
  2. Takeoff and assembly of bomber force
  3. Rendezvous with fighter escorts
  4. Fly to target
  5. Bombing run
  6. Return to Base
- We will explore phases 1, 4 and 5 together.

PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL – PHASE 1: PLANNING THE MISSION

- Before you even take off, you need to make sure you know the following:
  1. Where am I?
  2. Where am I going?
  3. How much fuel do I need?
  4. What am I doing?
  5. How am I doing it?
  6. What can help me?
  7. What can kill me?
  8. How do I get home?
- Once you have all that stuff figured out, THEN you can takeoff.
- The following example will show you a typical mission planning.

PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL – PHASE 1: PLANNING THE MISSION
WHERE AM I? WHERE AM I GOING?

- Reading the bomber objectives always helps to find a high-priority target.
- You can look at the bombing objectives in the mission briefing (can be accessed via aircraft selection menu or by right-clicking, opening the map, right-clicking on the map and choosing “Briefing”).
- **Hawkinge will be our target for today.**

Winds from the W @ 2 m/s.

4 Days ago England and her allies launched a raid into the city of Boulogne. Our ground forces have the city surrounded and the enemy shall soon suffer a total collapse. The Luftwaffe is supporting this effort, and plays a key role in throwing these "raiders' back to the sea. Aside from our regular duties with the bombing campaign against England, we will assist our army by taking out key bridges and artillery locations, as well as destroying the enemy re-supply ships in the channel.

Bombing orders:

=== 5 Enemy supply/troop ships inbound west of Boulogne
=== 2 Bridges in Boulogne centre (1 rail, 1 regular)
=== BA 19.1 Enemy artillery base east of Boulogne
=== AU 25.6 Faversham Railyard
=== AS 21.1 Battle Artillery Factory

Destroy the following RAF Airfeilds: (We believe Hawkinge and Littlestone are home to Spitfire IIa squadrons)

=== RAF Hawkinge
=== RAF Lympne
=== RAF Littlestone

JG. orders:

-Escort, patrol, and protect our troop staging area near Estree, and the railyard in Samer.
-Valuable fuel distribution and a munitions factory in the northern sectors must also be patrolled.
-Our frontline airfeilds are under threat! Cover them carefully, especially Campagne Les Guines, which is homebase to our E-1 Jabos and the 109 E-4N!
-Our troop trains may need air cover when called upon. One travelling from St Omer west to Samer, another travelling from Estree, to the coast, then north to Boulogne.

Grounded? Volunteer for the Army! Tank drivers and gunners are needed for the fight south of Boulogne. Fight your way in and destroy any artillery positions and even bridges (if you make it that far...)

(Please report any bugs/errors/suggestions on the ATAG Forums or PM ATAG_Freya)

Read bomber objectives and pick your targets.
For instance: the Faversham Railyard is located in grid AU25.6, which means it is located in the middle-right corner of the Alpha-Uniform 25 grid square. .6 is the location in the square based on the referential of a numpad for the designated grid square (1 is lower left, 5 is center, 6 is middle right, 9 is upper right, etc…)

However, Hawkinge seems like a juicier target. We’ll choose this one instead.

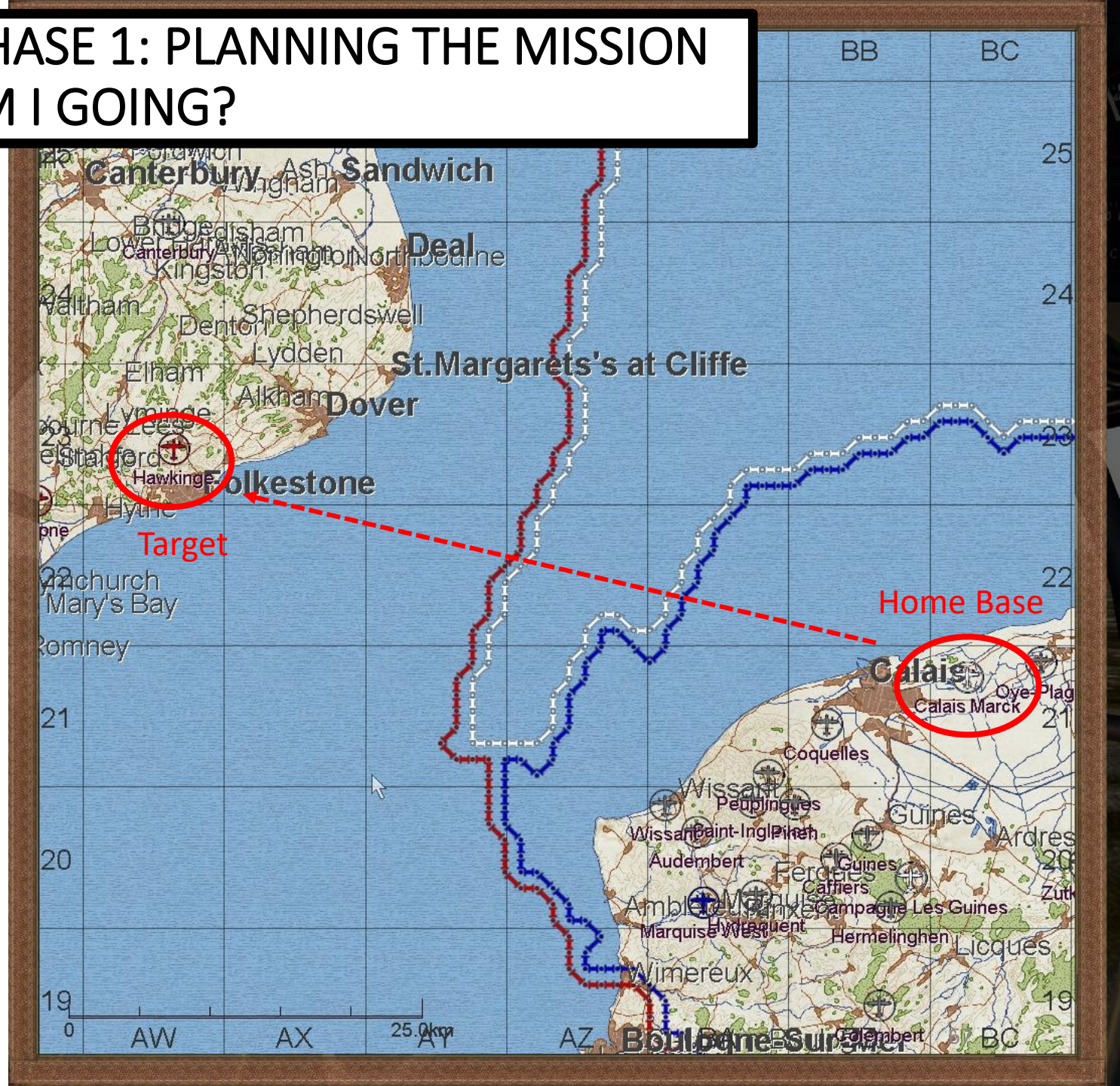
PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL – PHASE 1: PLANNING THE MISSION
WHERE AM I? WHERE AM I GOING?

- Good! We now have a target (Hawkinge airfield), and we decided that we would spawn at Calais-Marck.
- Now, it is time to figure out how we get there and drop them cabbage crates. We need a heading and a distance.
- Open your map and select (left click) your Protractor tool to obtain your heading to target.

While map is selected, open up your "Tools" menu (right click) and use your protractor to find the correct heading.

Left-Click on the protractor icon.

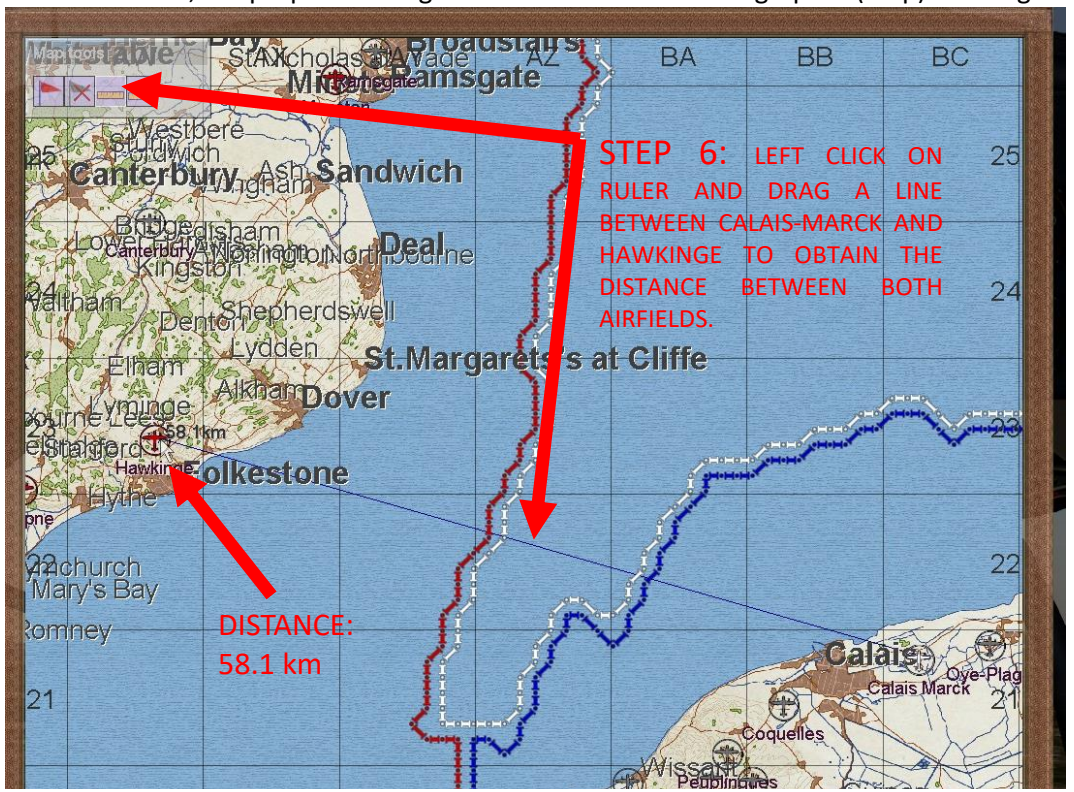


PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL – PHASE 1: PLANNING THE MISSION
WHERE AM I? WHERE AM I GOING?

1) Click and hold left mouse button on Calais-Marck and drag a vertical line. Once line is parallel with the North, release mouse button.
2) Click and hold left mouse button on Calais and drag a line to Hawkinge Airfield. Once line is crossing the center of the airfield icon, release mouse button.

3) A heading number should pop next to Calais. Remember this number. In our case, we get 074 degrees.
4) In case your target is West (to the left) to your home base, the number that pops up will not be your heading. The proper heading will be <u>360 minus the number that popped up</u>. In our case, the proper heading will be 360 – 74 = 286 Geographic (map) Heading.

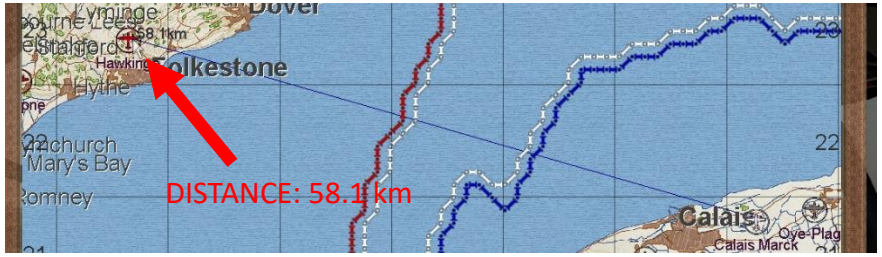


5) Since the heading we obtained on the map is geographic and not magnetic, the **magnetic course** we will need to follow on our compasses is **286 + 10 = 296 deg**. This is the heading we will follow on our compass, course setter, DG and repeater compass. We added 10 degrees to take into account magnetic declination as shown in previous compass navigation tutorial.
6) Obtain distance to target by clicking on the ruler and dragging a line from Calais to Hawkinge. In our case, we get a **distance of approx. 58 km**.

PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL – PHASE 1: PLANNING THE MISSION HOW MUCH FUEL DO I NEED?

- The heavier you are, the slower you are and the more vulnerable you are.
- Calculating your required fuel is easy.
- Based on in-game tests I performed, the Ju-88 consumes approximately 475 Liters of fuel per hour if we stay at engine settings for a max climb rate.
- If we fly at 350 km/h, based on fuel capacity, we can deduce that @ 100 % fuel we can fly around for 3.6 hours of flight time, which gives us a max flying distance of 1260 km (which is 2 times the max range).
- Use the "Map Tool Ruler" to get our target's range. Hawkinge is about 60 km away from Calais. Since we plan to return to base, we add another 60 km. We can add about 40 km for loitering time, assembly and rendezvous with fighters and another 40 km for reserve fuel in case we need to find a secondary airfield. We have a grand total of 200 km.
- To fly for 200 km at 2300 RPM at 350 km/h, we simply multiply our max takeoff fuel load (100 %) by the ratio of the distance we need to fly on the maximum distance @ max takeoff weight (1260 km):
- 100 % * 200 km / 1260 km = 16 % fuel approx. That is what we need.
- We can round that up to 20 % to be very conservative. So there we go, we need roughly 20 % fuel.
- Note: you could also takeoff with a full fuel load and full bomb load if you wanted to. The Ju-88 can still fly. This practice is simply to teach you how to plan your fuel for a real mission intelligently.



Left click and drag from point A to point B to get a distance.

PART 11: BOMBING TUTORIAL

IL2 STURMOVIK CLIFFS OF DOVER AIRFIELD ELEVATIONS

UK AIRFIELDS

Bembridge	13m	43ft	Manston	44m	14ft
Biggin Hill	179m	587ft	Netheravon	119m	390ft
Boscombe Down	127m	417ft	North Weald	80m	262ft
Canterbury	51m	167ft	Northolt	37m	121ft
Croydon	101m	331ft	Old Sarum	79m	259ft
Eastchurch	7m	23ft	Portsmouth	1m	3ft
Farnborough	77m	253ft	Ramsgate	47m	154ft
Ford	1m	3ft	Reading	46m	151ft
Gatwick	60m	197ft	Redhill	24m	79ft
Gosport	1m	3ft	Rochester	130m	426ft
Gravesend	63m	207ft	Rochford	10m	33ft
Hamble	20m	66ft	Ryde	52m	171ft
Harewell	120m	394ft	Salisbury	131m	430ft
Hawkinge	158m	518ft	Sandown	21m	69ft
Heathrow	23m	75ft	Southhampton	9m	30ft
Hendon	50m	163ft	Tangmere	12m	40ft
Heston	30m	98ft	Thorney Island	1m	3ft
Hornchurch	10m	33ft	Upavon	147m	482ft
Kenley	174m	571ft	Watchfield	100m	328ft
Larkhill	114m	374ft	West Hampnett	21m	69ft
Lee On Solent	10m	33ft	White Waltham	36m	118ft
Littlestone	22m	72ft	Willimington	22m	72ft
Lympne	100m	328ft	Yatesbury	170m	558ft
Maidstone	84m	275ft			

IL2 STURMOVIK CLIFFS OF DOVER AIRFIELD ELEVATIONS

FRENCH AIRFIELDS

Abbeville	61m	200ft	Guines	46m	151ft
Achiet Grevillers	127m	417ft	Haute Fontaine	180m	590ft
Amiens Allonville	89m	292ft	Horm Elingen	161m	528ft
Amiens Glisy	59m	194ft	Hydrequent	78m	256ft
Aras St Liger	109m	358ft	Le Havre Octeville	96m	314ft
Arras	98m	321ft	Le Touquet	1m	3ft
Audembert	42m	138ft	Licescourt	70m	230ft
Barly	122m	400ft	Marquise West	24m	79ft
Barly	112m	367ft	Merville calonne	9m	30ft
Beamont Le Roger	139m	456ft	Monchy Briton	150m	492ft
Beauvais Nivllers	120m	394ft	Montdidier	108m	354ft
Beauvais Tille	99m	325ft	Oye- Plage	2m	7ft
Berk	1m	3ft	Persan Beaumont	42m	138ft
Bernay St Martin	161m	528ft	Peuplinguess	101m	331ft
Bolsjean Ecuires	57m	187ft	Pihen	96m	315ft
Brias	150m	492ft	Plumetot	40m	131ft
Brombos	191m	627ft	Poiy Nord	171m	561ft
Bulougne Alperch	69m	226ft	Querqueville	1m	3ft
Caen Carpiquet	61m	200ft	Rezy Norrent fontes	94m	308ft
Caffiers	112m	367ft	Rosieres En Santifer	82m	269ft
Calais Marck	2m	7ft	Rouen Boos	140m	459ft
Carquebut	20m	197ft	Roye Amy	83m	272ft
Champ Les Guines	75m	246ft	Samer	61m	200ft
Colembert	198m	649ft	Sempy	120m	394ft
Coquelles	13m	43ft	St Inglewert	129m	423ft
Cramont Yurtench	121m	397ft	St Omer Arques	29m	95ft
Crecy	141m	462ft	St Omer Clairmarrias	9m	29ft
Creil	101m	331ft	St Omer Wizennes	78m	256ft
Crepon	59m	194ft	Theville	135m	443ft
Deanville St Gatien	140m	459ft	Tramecourt	126m	413ft
Desures	200m	656ft	Wailly Beauchamp	51m	167ft
Dieppe	101m	331ft	Wissant	21m	69ft
Estree	80m	262ft	Yvrench	110m	361ft
Grandvilliers	180m	590ft	Zuterque	36m	118ft

NOTES

To determine Map QNH. Park on the airfield. Set Altimeter to read the values above. Pressure sub scale is now set to correct QNH for the map.

SC/JG_Ivank Oct 2012

PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL – PHASE 1: PLANNING THE MISSION WHERE AM I? WHERE AM I GOING?

- We now know our target: Hawkinge. We must know how high it is to take into account target elevation when we will be bombing.
- You can use the LOFTE tool available on ATAG: theairtacticalassaultgroup.com/utils/lotfe7.html
- A tutorial on how to use this tool is available in Chuck's Blenheim High Altitude Bomber Guide 2.0 available here: https://drive.google.com/open?id=0B-uSpZROuEd3MDEwaDZXdmNSdnM&authuser=0
- One quicker way to do it is to get the airfield's altitude directly from the list on the next page made by Ivank.
- LOFTE's values tend to vary from point to point: values you get from this tool are an approximation that must sometimes be taken with a grain of salt.
- Hawkinge's altitude in the table is 158 m (518 ft).

PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL – PHASE 1: PLANNING THE MISSION WHAT AM I DOING?

- Now that we know where we are and where we are going and how much fuel we need, we need to know what we will be doing.
- We will load up
  - FRONT BOMB BAY: 1**8 X SC 50 GP bombs with a C-50 fuse (high altitude) with a 0 sec fuse delay**.
  - REAR BOMB BAY: **10 X SC 50 GP bombs with a C-50 fuse (high altitude) with a 0 sec fuse delay**.
  - WING RACK: **4 X SC 250 GP bombs with a C-50 fuse (high altitude) with a 0 sec fuse delay.**
  - See the Weapons and Armament section to know more.
- Our bombing altitude will be 6,000 m. We could go as high as 8,000 if we wanted to.
- Why do we ask ourselves this question? Simply because the challenge of a bomber pilot is the sheer workload behind it. You are doing by yourself the task that took two dedicated guys or more to do. Therefore, our goal is to reduce the workload as much as possible by doing as much as we can on the ground so we can concentrate on what's going on during the flight rather than prepare our instruments in a hurry.
- In a bomber flight, generally half the guys do not know how to use a bomb sight: they simply drop their bombs on the bomber lead's command. Keep in mind that having a bomber lead is not enough to have a proper mission: fighter interceptors always go for the bomber lead because odds are that he is the most experienced bomber pilot. Good bomber operations generally have a second or a third leader to take No. 1's place in case he gets shot down or runs into engine trouble.
- If you have 9 guys flying for an hour to get to a target that are waiting on your command to drop their bombs, you better make sure that you know where you're aiming…
- Therefore, it is important to know at what speed and what altitude you plan to do your bomb run so you can set up your bombsight in advance. I usually set my bombsight when I am on the ground. This way, you just need to make small adjustments when you get to target rather than set everything up in a hurry.
- You will need your target elevation to set up your bombsight properly.

PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL – PHASE 1: PLANNING THE MISSION HOW AM I DOING?

- Here is why you need to take into account target elevation in your bombsight:
- Pressure altitude and Height are related to one another, but keep in mind that they are two completely different things.
- Height is the vertical physical distance between your aircraft and the ground. Pilots often refer to height as “AGL” (Above Ground Level).
- Pressure altitude is the altitude measured using a pressure datum reference. Pilots often refer to altitude as “AMSL” (Above Mean Sea Level). Pressure Altitude reading can vary based on meteorological conditions.
- Bombsight height setting can be determined by simply reading the altimeter and substracting the target elevation (assuming the altimeter pressure altitude was set correctly for the pressure conditions in Home Base).
- The bombsight height, in our case will be our altimeter altitude (6,000 m) minus the target elevation (158 m). The bombsight height will have to be set at more or less 5,840 m. Keep in mind that the altitude can change due to many factors and that your bombsight height is AGL, and will always require you to substract target elevation to be accurate.

PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL – PHASE 1: PLANNING THE MISSION
HOW AM I DOING IT?

ALTITUDE: 6,000 M AMSL
ABOVE SEA LEVEL

BOMBSIGHT HEIGHT
5,842 m AGL

The bombsight height, in our case will be our altimeter altitude (6000 m) minus the target elevation (158 m). The bombsight height will have to be set at more or less 5840 m. Keep in mind that the altitude can change due to many factors and that your bombsight height is AGL (above ground level), and will always require you to substract target elevation to be accurate.

NOTE: the max bombsight altitude for the Ju-88 is 6,000 m.

TARGET ELEVATION: 158 m

HAWKINGE
ALTITUDE: 158 m AMSL

ENGLISH CHANNEL
ALTITUDE: 0 m AMSL

CALAIS MARCK
ALTITUDE: 2 m AMSL

BOMBING TUTORIAL – PHASE 1: PLANNING THE MISSION
HOW AM I DOING?

- Caution: our altitude and speed set on the bombsight will **not** be the values read on the altimeter and airspeed indicators.
- We have already seen why the bombsight height must be the altitude value read on the altimeter minus the target elevation.
- **Indicated Airspeed** (IAS) is the speed you read on your airspeed indicator. It is driven by your Pitot tube and a barometric static port. Air pressure varies with altitude (the higher you go, the less air there is). IAS is corrected for the surrounding air pressure but **not** for air density.
- **True Airspeed** (TAS) is indicated airspeed corrected to take into account air density (which, like we said, depends on your current altitude).
- The bombsight requires a True Airspeed input, **not** an indicated airspeed.
- Fortunately, there is an interpolation table available in the Cliffs of Dover manual to help you get an approximation of TAS. We will see how to use this table in the next page.

PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL – PHASE 1: PLANNING THE MISSION
HOW AM I DOING?

We will aim for an indicated airspeed (IAS) of 300 km/h (read on the airspeed gauge) at an altitude of 5,840 m.

1. Pick the appropriate row for IAS (300 km/h).
2. Pick the appropriate columns for nearest altitudes (5,000 and 6,000 m)
3. Take note of the TAS values in the table 386 km/h and 407 km/h)
4. Because the TAS values are close enough and that bombsight airspeed only goes into increments of 10, we can approximate the resulting TAS value to approx. an average value of **400 km/h**. It is not the exact value, but in our case, since we are too lazy to take a calculator and do the interpolation manually, it should be precise enough.

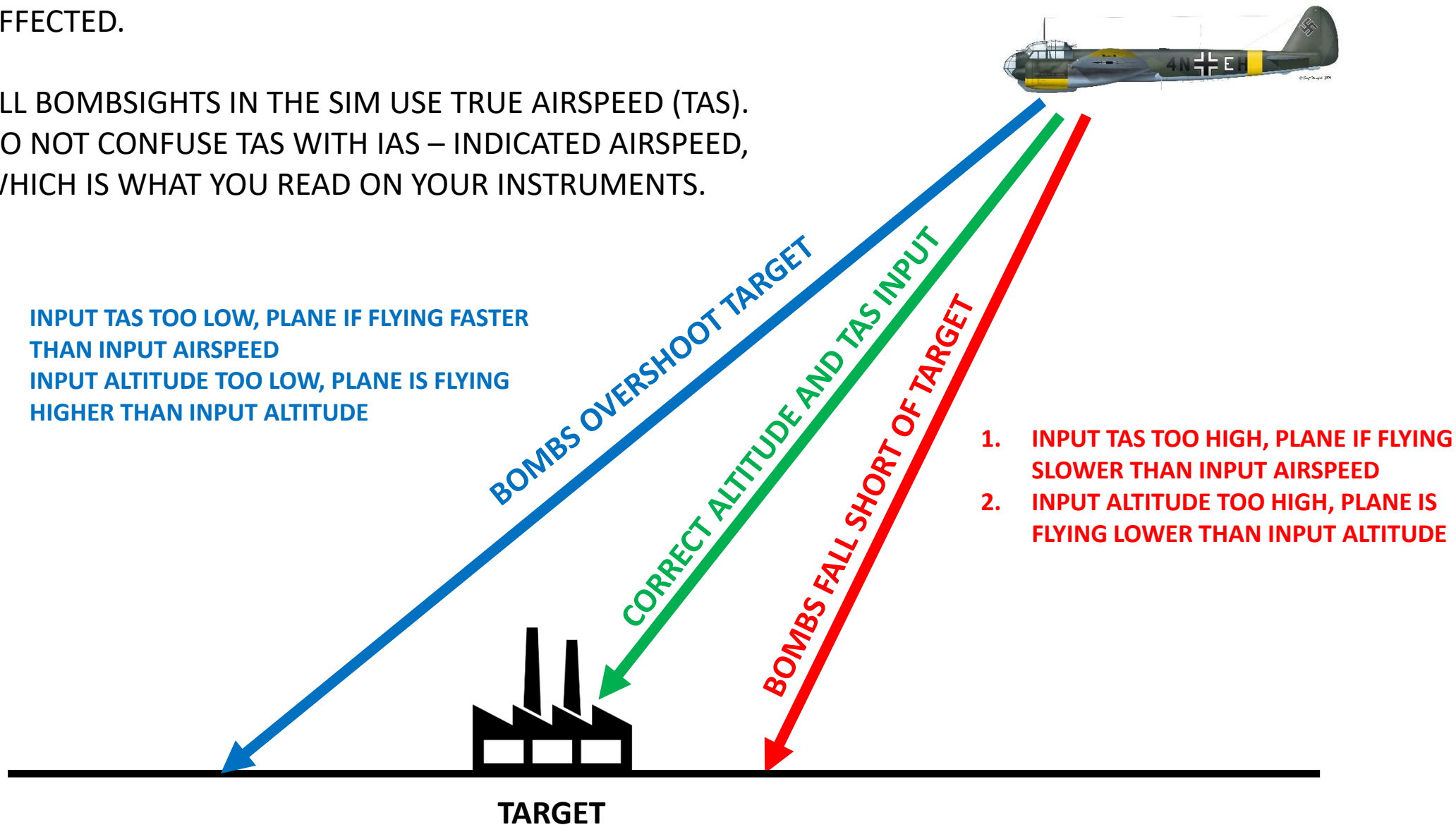
Metric (speed in km/h, altitude in metres)

Metres / Km/h	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
200	210	220	232	244	257	271	286	301	317	334
250	262	276	290	305	322	339	357	376	396	418
300	315	331	348	366	386	407	428	451	476	501
325	341	358	377	397	418	440	464	489	515	543
350	367	385	404	425	448	471	496	521	549	577
375	393	413	433	456	480	505	531	559	588	618
400	419	440	462	486	512	538	566	596	627	660
425	446	468	491	516	544	572	602	633	666	701
450	472	495	520	547	576	605	637	670	705	742
500	524	549	575	604	634	666	699	734	771	810
550	576	604	633	664	698	733	769	808	848	891
600	628	658	690	725	761	799	839	881	925	972
650	681	713	748	785	825	866	909	955	1003	1053

PART 11: BOMBING TUTORIAL

PRESUME ONE FACTOR, ALTITUDE OR TAS, IS CORRECT AND THE OTHER INCORRECT. BOMB TRAJECTORY WILL BE AFFECTED.

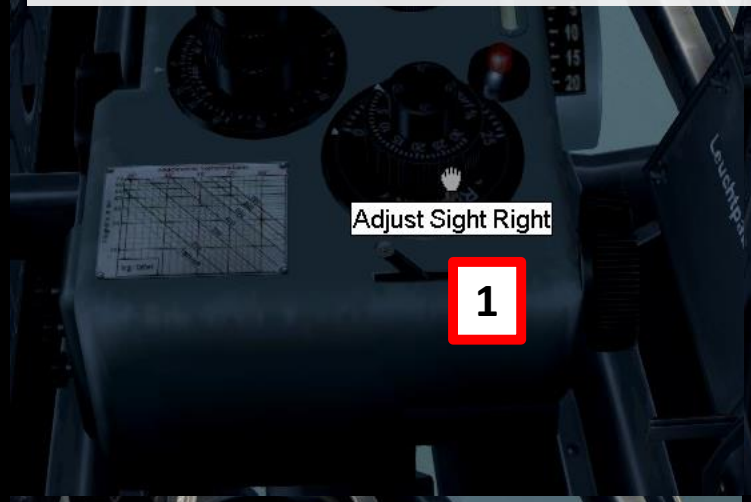
ALL BOMBSIGHTS IN THE SIM USE TRUE AIRSPEED (TAS). DO NOT CONFUSE TAS WITH IAS – INDICATED AIRSPEED, WHICH IS WHAT YOU READ ON YOUR INSTRUMENTS.

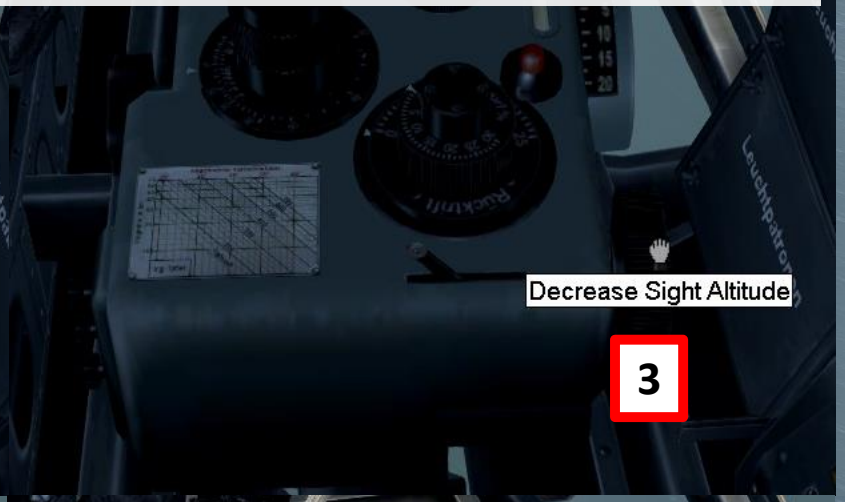


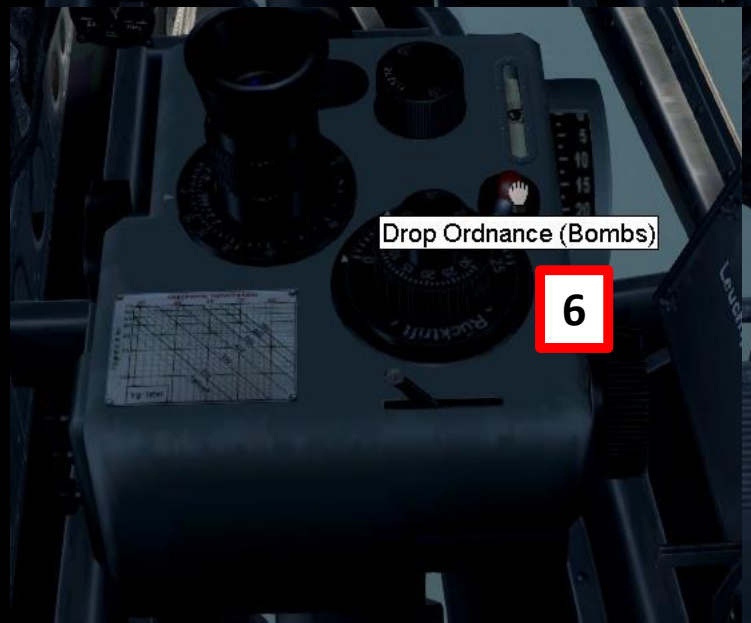
PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL – PHASE 1: PLANNING THE MISSION
HOW AM I DOING?

Be smart: set up your bombsight in advance (set airspeed and altitude at which you want to bomb) while you are still on the ground. This will save you time and trouble. In our case, we will enter a bombsight airspeed of 400 km/h and an altitude of 5840 m.







1. WIND CORRECTION
2. BOMBSIGHT AIRSPEED INPUT (TAS)
3. BOMBSIGHT ALTITUDE INPUT (AGL)
4. BOMB DISTRIBUTOR DELAY
5. BOMB SALVO QTY
6. DROP BOMBS

PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL – PHASE 1: PLANNING THE MISSION WHAT CAN HELP ME OR KILL ME? HOW DO I GET HOME?

- WHAT CAN HELP ME OR KILL ME?
  - Know where your enemy patrol routes are, where battles usually take place and avoid these places when you are doing your flight plan.
  - Give fighter escorts a rendezvous point so they can link up with you and protect you.

- HOW DO I GET HOME?
  - In our case, we will simply do a 180 once we dropped our bombs and head back home.

PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL
PHASE 4: FLYING TO TARGET

- Once we have taken off, we will follow a magnetic heading of 296 to Hawkinge.
- You can use the compass traditionally to fly there manually, but you can also use the auto-pilot.
- In order to use the auto-pilot and know where you are going, you will need to set up your magnetic compass and directional gyro differently than shown in the compass navigation section.
- **Course Mode** is a mode where auto-pilot takes over rudder control to make your aircraft travel following a given heading. You still have control over ailerons and elevator. Course mode is generally used when climbing or descending. In this mode, climb rate is better controlled through elevator trim rather than pure elevator input.
- **Mode 22 (Straight n' Level)** is a mode where auto-pilot takes over rudder, elevator and aileron controls to make your aircraft travel following a given heading. You will have no control over any of your control surfaces. Mode 22 is used when cruising or when level-bombing as this mode will want to make you stay level at a given heading.

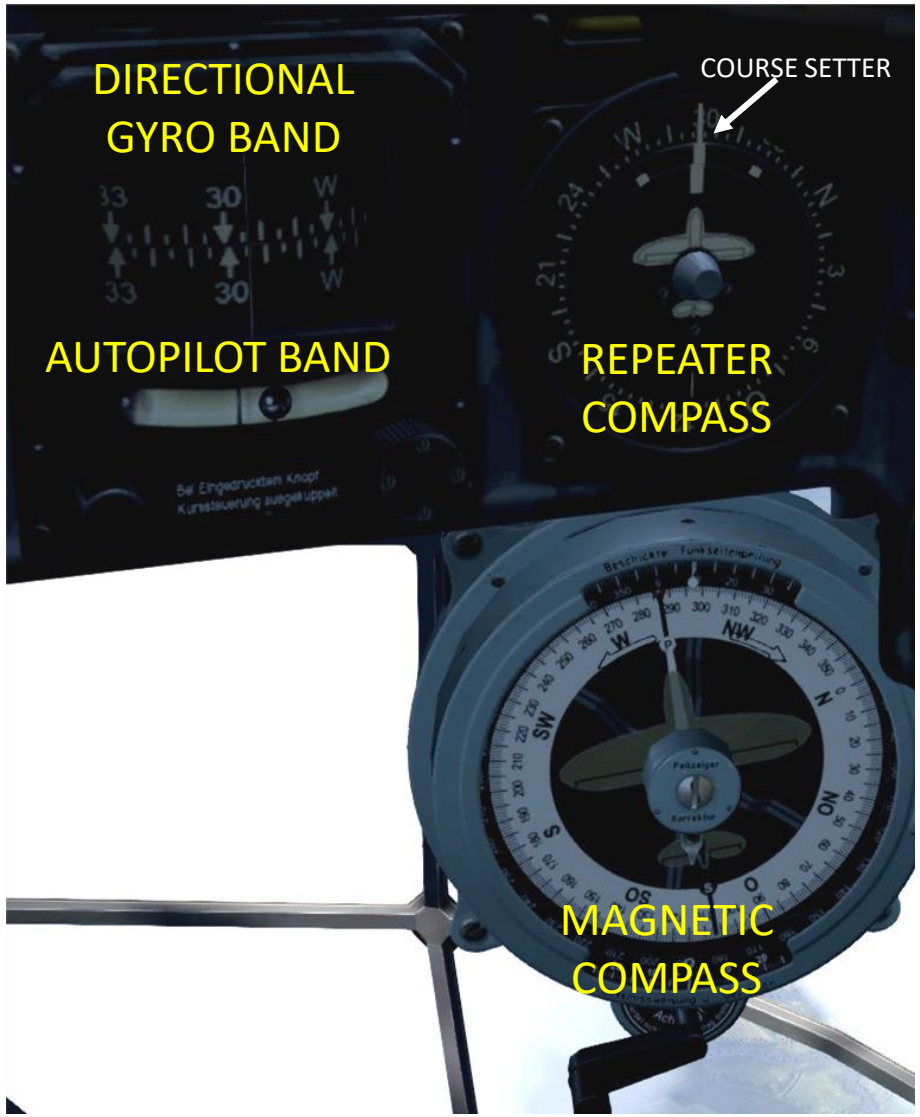
  Note: Mode 22 will often make your aircraft go into a dive (- 5 m/s approx) for approximately one minute. It is normal: the aircraft will try to gain speed in the process. You should lose from 500 to 800 m after Mode 22 is engaged. The climb rate will eventually stabilize to "0". If you intend on bombing the target from 6,000 m, make sure you are 500-800 m higher before you engage Mode 22.

PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL
PHASE 4: FLYING TO TARGET

JU-88 AUTOPILOT OPERATION TABLE

STEP	ACTION
1	SET/SYNCHRONIZE DIRECTIONAL GYRO TO THE SAME HEADING READ ON THE MAGNETIC COMPASS.
2	SET A COURSE TO DESIRED HEADING USING THE COURSE SETTER ON THE REPEATER COMPASS
3	ALIGN AIRCRAFT WITH COURSE SETTER BY CONSULTING THE REPEATER COMPASS (FOLLOW THE WHITE INDICATOR).
4	WHEN AIRCRAFT IS ALIGNED WITH COURSE SETTER, ALIGN AUTOPILOT BAND WITH THE DIRECTIONAL GYRO BAND USING THE “AUTOPILOT RIGHT” OR “AUTOPILOT LEFT” CONTROLS.
5	WHEN AUTOPILOT/GYRO BANDS ARE LINED UP, ENGAGE DESIRED AUTOPILOT MODE (COURSE MODE OR MODE 22)
6	WHEN AUTOPILOT IS ENGAGED, STEER AIRCRAFT USING THE “AUTOPILOT RIGHT” OR “AUTOPILOT LEFT” CONTROLS FOR BIG CORRECTIONS. STEER AIRCRAFT USING THE “DIRECTIONAL GYRO INCREASE/DECREASE” CONTROLS FOR SMALL COURSE CORRECTIONS. USING THE DIRECTIONAL GYRO IS USUALLY A BETTER WAY TO USE THE AUTOPILOT AS THE PILOT HAS BETTER CONTROL OVER HIS SHIP.



PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL
PHASE 5: BOMBING RUN

BOMBSIGHT

BOMBSIGHT

JU-88 BOMBSIGHT OPERATION TABLE
HIGH ALTITUDE LEVEL BOMBING (AUTO MODE)

STEP	ACTION
1	ENGAGE AUTO-PILOT IN MODE 22 WHEN YOU HAVE SIGHT ON TARGET AND YOU ARE ALIGNED WITH IT. (SEE AUTOPILOT TABLE)
2	FIND YOUR TARGET USING THE “INCREASE/DECREASE SIGHT DISTANCE” CONTROLS AND YOUR AUTOPILOT CONTROLS.
3	OPEN BOMB BAY DOORS AND ARM YOUR BOMBS IF NOT DONE ALREADY ON THE GROUND.
4	SELECT BOMB BAYS 1 & 2 (ALL).
5	SELECT BOMB DISTRIBUTION MODE (SINGLE/SERIES/SALVO). FOR HIGH ALTITUDE, SALVO IS RECOMMENDED.
6	SELECT BOMB DISTRIBUTOR DELAY (“0” IS RECOMMENDED FOR HIGH ALTITUDE PRECISION BOMBING)
7	SELECT BOMB SALVO QTY (“MAX” IS RECOMMENDED IF YOU WANT TO DROP ALL YOUR PAYLOAD).
8	CHECK AIRSPEED AND ALTITUDE IN THE BOMBARDIER SEAT.
9	CONVERT READ INDICATED AIRSPEED INTO TRUE AIRSPEED AND USE THIS VALUE FOR BOMBSIGHT AIRSPEED INPUT.
10	CONVERT ALTITUDE INTO HEIGHT (READ ALTITUDE MINUS TARGET ELEVATION) AND USE THIS VALUE FOR BOMBSIGHT ALTITUDE INPUT.
11	STEER THE AIRCRAFT USING THE “AUTOPILOT RIGHT” OR “AUTOPILOT LEFT” CONTROLS (SEE AUTOPILOT TABLE) AND USE YOUR “INCREASE/DECREASE BOMBSIGHT DISTANCE” CONTROLS TO LINE UP BOMBSIGHT RETICLE ON THE TARGET. YOU CAN FINE-TUNE COURSE CORRECTIONS WITH THE DIRECTIONAL GYRO INCREASE/DECREASE CONTROLS.
12	TOGGLE BOMBSIGHT AUTOMATION, MAKE SURE THE BOMBSIGHT IS TRACKING THE TARGET. IN AUTO MODE, RETICLE DRIFT WILL OCCUR IF WRONG BOMBSIGHT INPUT IS ENTERED OR IF THE AIRCRAFT IS DRIFTING LATERALLY FROM THE TARGET. YOU CAN COMPENSATE FOR SMALL DRIFT BY INCREASING SLIGHTLY BOMBSIGHT AIRSPEED INPUT WITHOUT A MAJOR IMPACT ON DROP PRECISION. YOU CAN FINE-TUNE COURSE CORRECTIONS WITH THE DIRECTIONAL GYRO INCREASE/DECREASE CONTROLS.
13	WAIT FOR THE FIREWORKS. BOMBS SHOULD BE RELEASED AUTOMATICALLY BETWEEN APPROX. 28 DEG @ 4,000 METERS AND 22 DEG FOR 6,000 METERS. **BOMBSIGHT RETICLE “SPLITS” (OR SPREAD) THE BOMBS, WHICH MEANS THAT MOST BOMBS WILL BE DROPPED IN FRONT OF THE RETICLE AND THE REST BEHIND THE RETICLE.**

PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL
PHASE 5: BOMBING RUN

OTHER USEFUL COMMANDS (APPLICABLE TO JU-88)	
DROP BOMBS	B
OPEN BOMB BAY DOOR	N
CLOSE BOMB BAY DOOR	L_CTRL+N
ARM BOMBS (AXIS BOMBERS ONLY)	L_CTRL+W
SWITCH CREW POSITION (BOMBARDIER/PILOT)	C
LEAN TO GUNSIGHT	JOYSTICK BTN (CUSTOM KEY)
COURSE AUTO-PILOT MODE - PREVIOUS	A
COURSE AUTO-PILOT MODE – NEXT	S
COURSE AUTO-PILOT ADJUST COURSE LEFT	L_CTRL+A
COURSE AUTO-PILOT ADJUST COURSE RIGHT	L_CTRL+S

This layout is created with ease of access in mind. Bombsight altitude, velocity and wind correction are already clickable on the sight itself. This layout should allow the user to go through everything he needs set up instinctively following the numpad from 0 to 9.

CAUTION: MAKE SURE THERE ARE NO CONFLICTS BETWEEN THESE KEYS AND OTHER CONTROLS. YOU WILL HEAR A "PING" WHEN YOU MAP A CONTROL IF THERE IS SUCH A CONFLICT.

CHUCK'S BOMBER NUMPAD (APPLICABLE TO JU-88)			
NUM	/ INCREASE DIRECTIONAL GYRO	* DECREASE DIRECTIONAL GYRO	- DECREASE COURSE SETTER
7 BOMB DISTRIBUTOR MODE PREVIOUS	8 BOMB DISTRIBUTOR MODE NEXT	9 TOGGLE BOMB DISTRIBUTOR SHORT DELAY	+ INCREASE COURSE SETTER
4 DECREASE BOMB DISTRIBUTOR DELAY	5 INCREASE BOMB DISTRIBUTOR DELAY	6 INCREASE SIGHT DISTANCE	
1 DECREASE BOMB SALVO QUANTITY	2 INCREASE BOMB SALVO QUANTITY	3 DECREASE SIGHT DISTANCE	ENTER TOGGLE BOMBSIGHT AUTOMATION
0 SELECT BOMB BAY PREVIOUS		. SELECT BOMB BAY NEXT	

PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL
PHASE 5: BOMBING RUN

So here is a quick reminder:

- ON THE GROUND

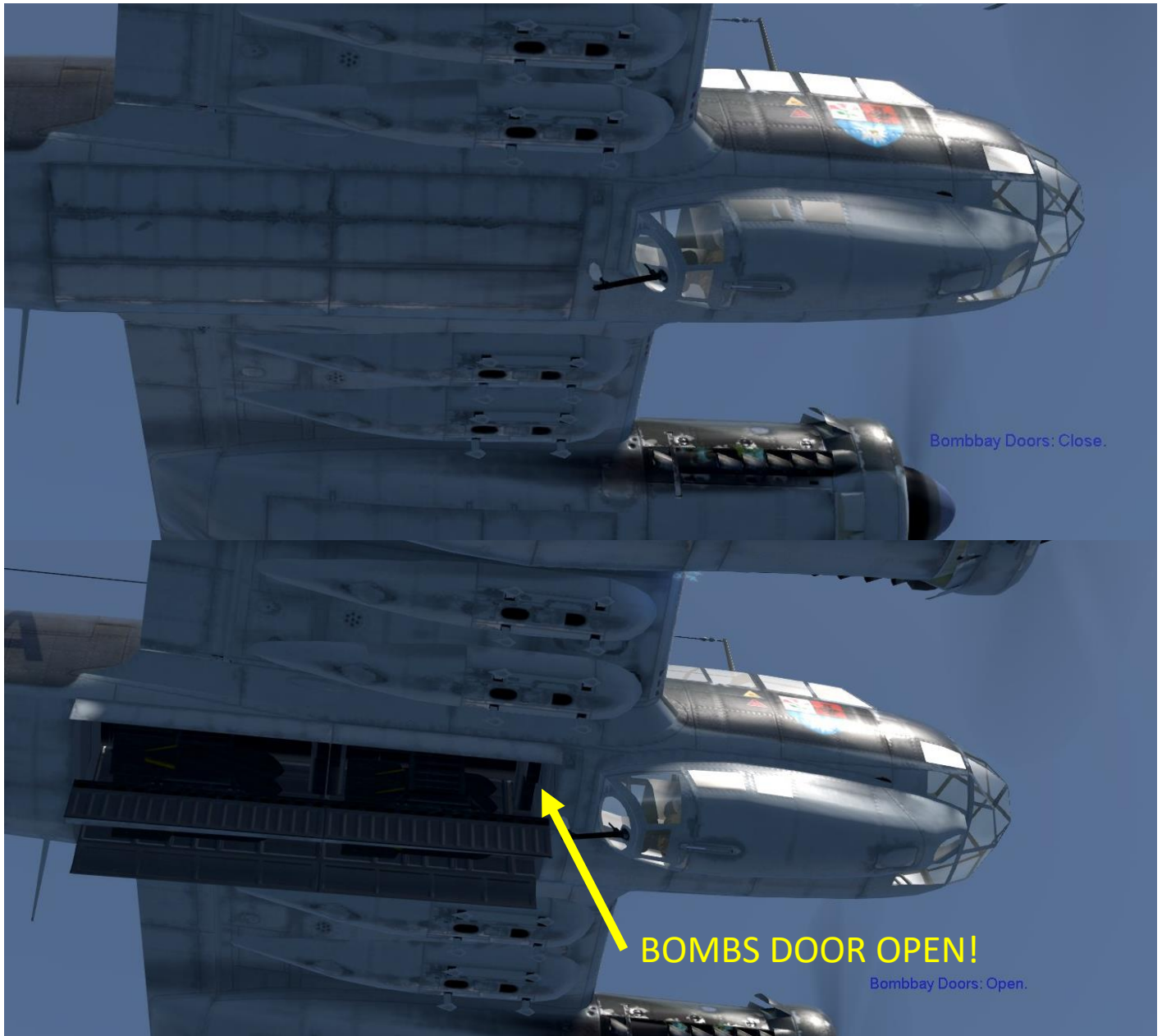
1. Set your predicted bomb run altitude and airspeed in your bombsight while on the ground.
2. For Ju-88, select desired bomb bays to be used (preferably all bomb bays selected). Select desired salvo quantity, release delay, distributor release mode (Salvo? Single?).
3. ARM bombs and fly to target.

- IN THE AIR

5. Find target and reach targeted altitude and airspeed
6. Open bomb bay doors
7. Follow steps detailed in the BOMBSIGHT OPERATION TABLE.
8. Thanks to all the work you did on the ground, you will see that there is not a whole lot to do in previous step apart from putting your bombsight cursor on the target, adjust slightly bombsight airspeed & altitude and press the Bombsight Automation key.
9. Jump into your ventral gunner to see hits on target.
10. Close bomb bay doors.
11. Go home for cookies and bratwurst.

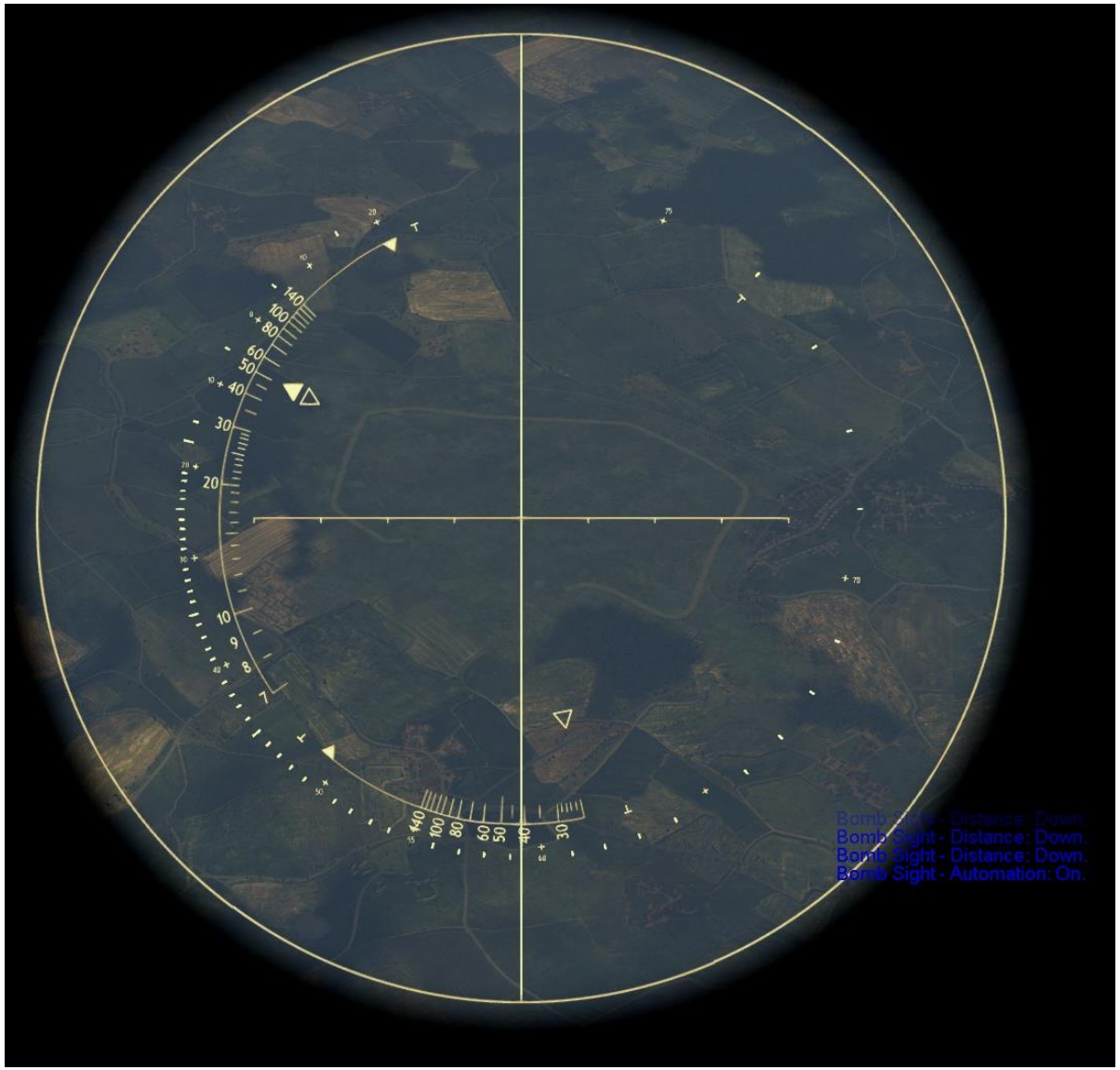
PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL
PHASE 5: BOMBING RUN

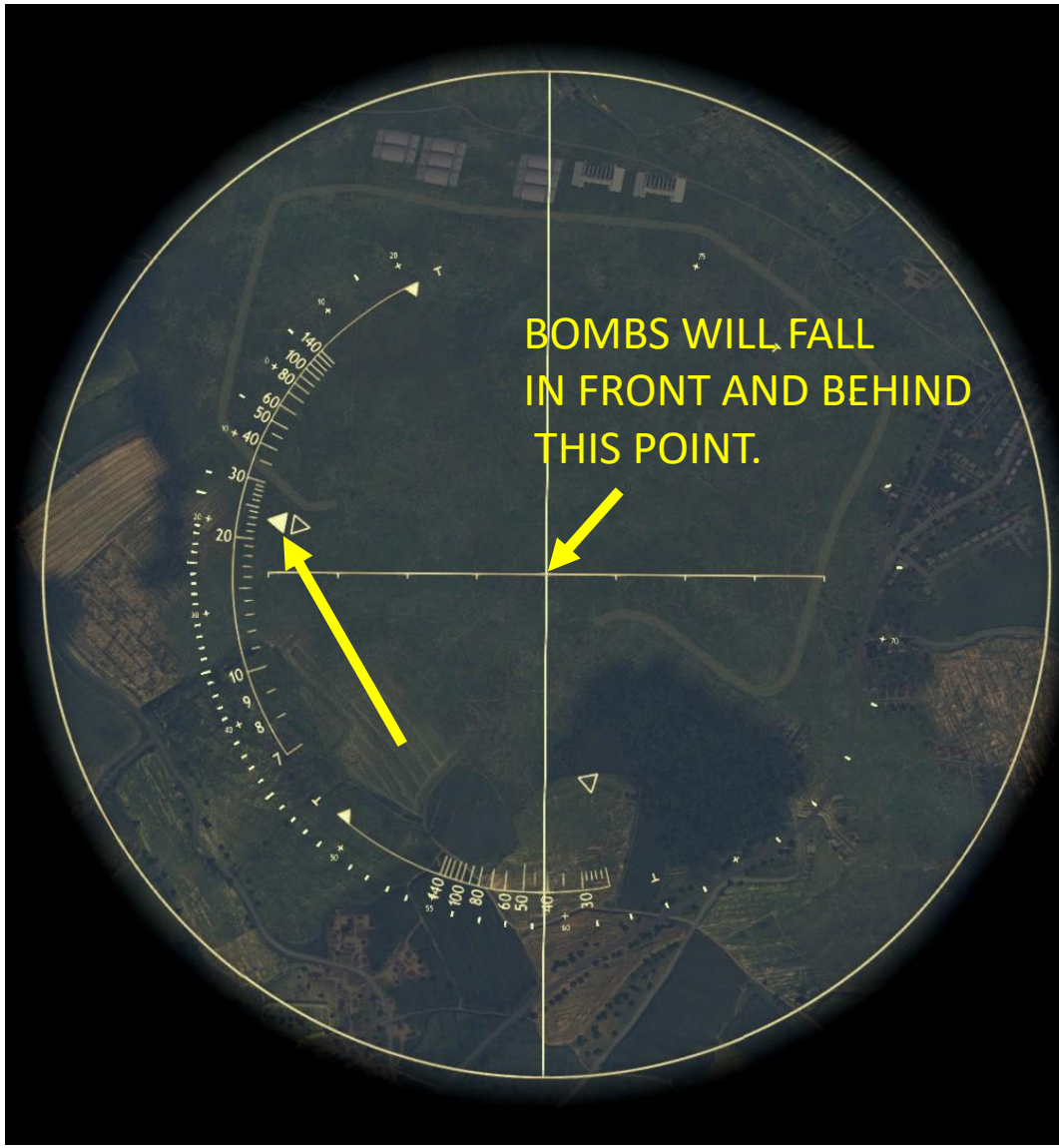


PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL
PHASE 5: BOMBING RUN



BOMBSIGHT AUTOMATION ENABLED



BOMBS ARE DROPPED AT APPROX 22 DEG

PART 11: BOMBING TUTORIAL

BOMBING TUTORIAL
PHASE 5: BOMBING RUN