SUPERMARINE SPITFIRE

GUIDE BY CHUCK

PERFORMANCE SHEET

TEMPERATURES

	(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
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

	(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
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

	(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
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

TABLE OF CONTENT - SPITFIRE

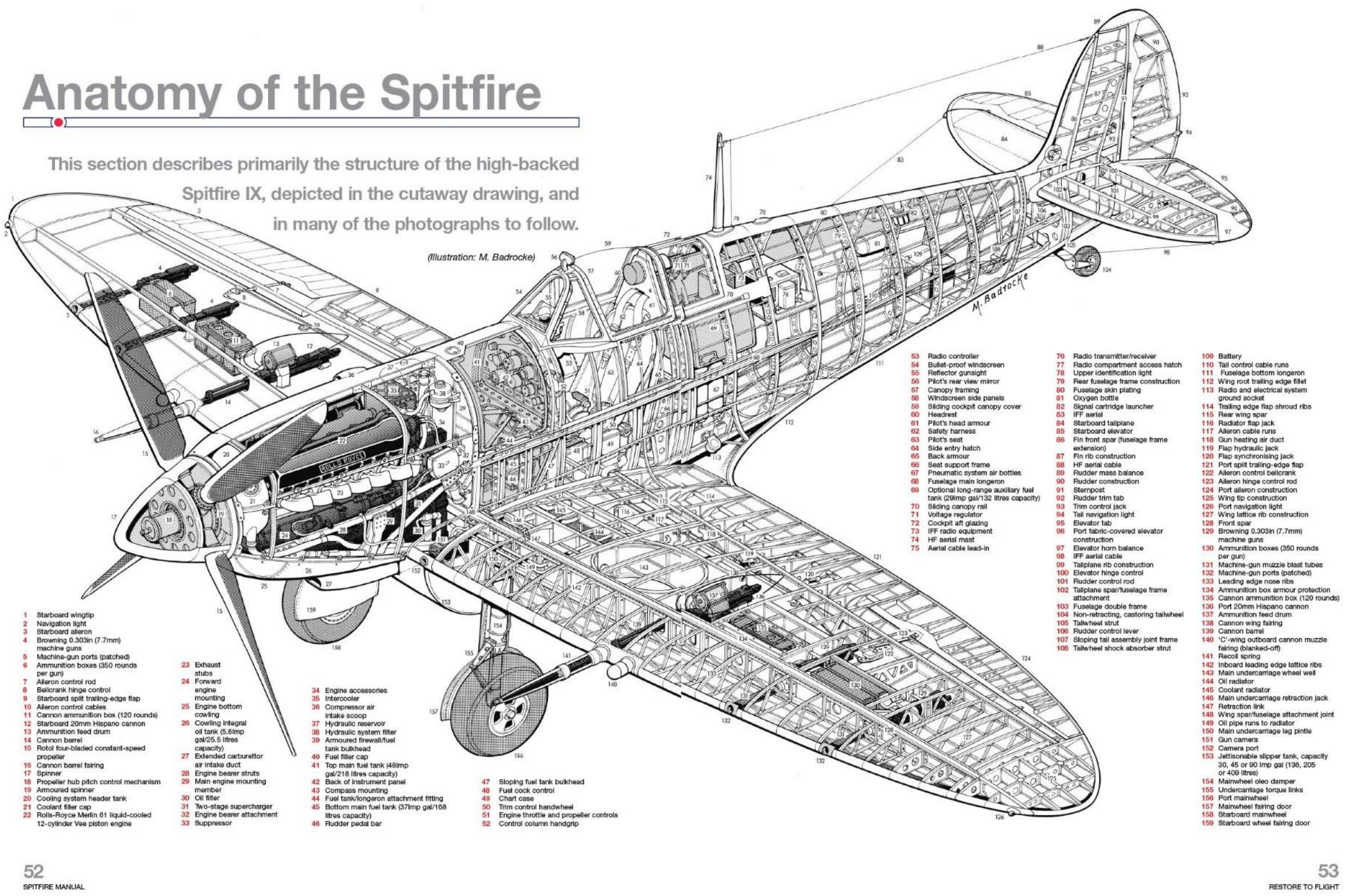
PART 1: AIRCRAFT HISTORY

The **Supermarine Spitfire** was designed as a short-range, high-performance interceptor aircraft by Reginald J. Mitchell, chief designer at Supermarine Aviation Works (which operated as a subsidiary of Vickers-Armstrong from 1928).

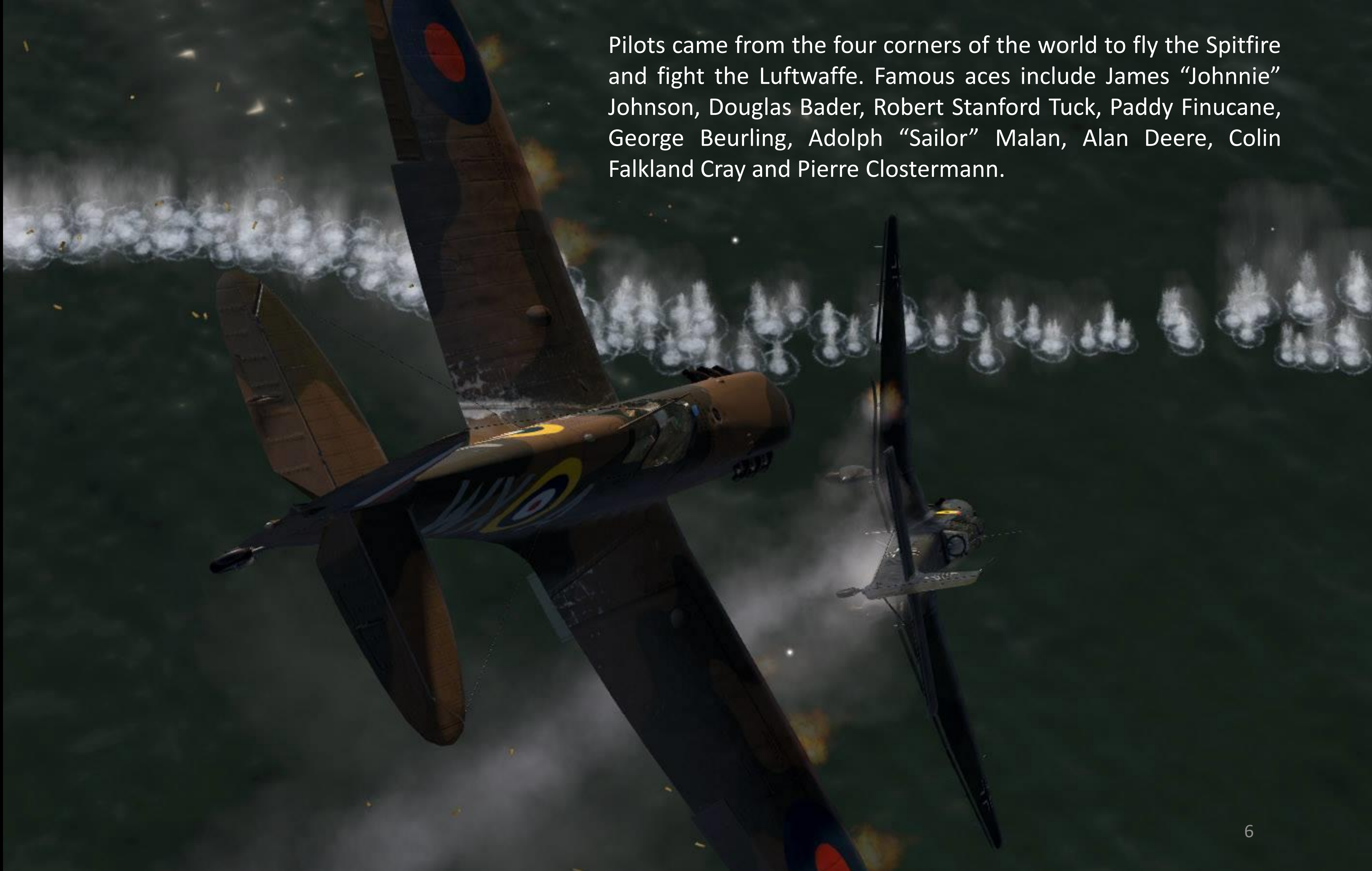
In accordance with its role as an interceptor, Mitchell designed the Spitfire's distinctive elliptical wing to have the thinnest possible cross-section; this thin wing enabled the Spitfire to have a higher top speed than several contemporary fighters, including the Hawker Hurricane. Mitchell continued to refine the design until his death from cancer in 1937, whereupon his colleague Joseph Smith took over as chief designer, overseeing the development of the Spitfire through its multitude of variants. During the Battle of Britain (July–October 1940), the Spitfire was perceived by the public to be the RAF fighter, though the more numerous Hawker Hurricane shouldered a greater proportion of the burden against the Luftwaffe. However, because of its higher performance, Spitfire units had a lower attrition rate and a higher victory-to-loss ratio than those flying Hurricanes.

PART 1: AIRCRAFT HISTORY

In 1934, Mitchell and the design staff decided to use a semi-elliptical wing shape to solve two conflicting requirements; the wing needed to be thin, to avoid creating too much drag, while still able to house a retractable undercarriage, plus armament and ammunition. An elliptical planform is the most efficient aerodynamic shape for an untwisted wing, leading to the lowest amount of induced drag. The ellipse was skewed so that the centre of pressure, which occurs at the quarter-chord position, aligned with the main spar, thus preventing the wings from twisting. Mitchell has sometimes been accused of copying the wing shape of the Heinkel He 70, which first flew in 1932; but as Beverly Shenstone, the aerodynamicist on Mitchell's team, explained "Our wing was much thinner and had quite a different section to that of the Heinkel. In any case it would have been simply asking for trouble to have copied a wing shape from an aircraft designed for an entirely different purpose."

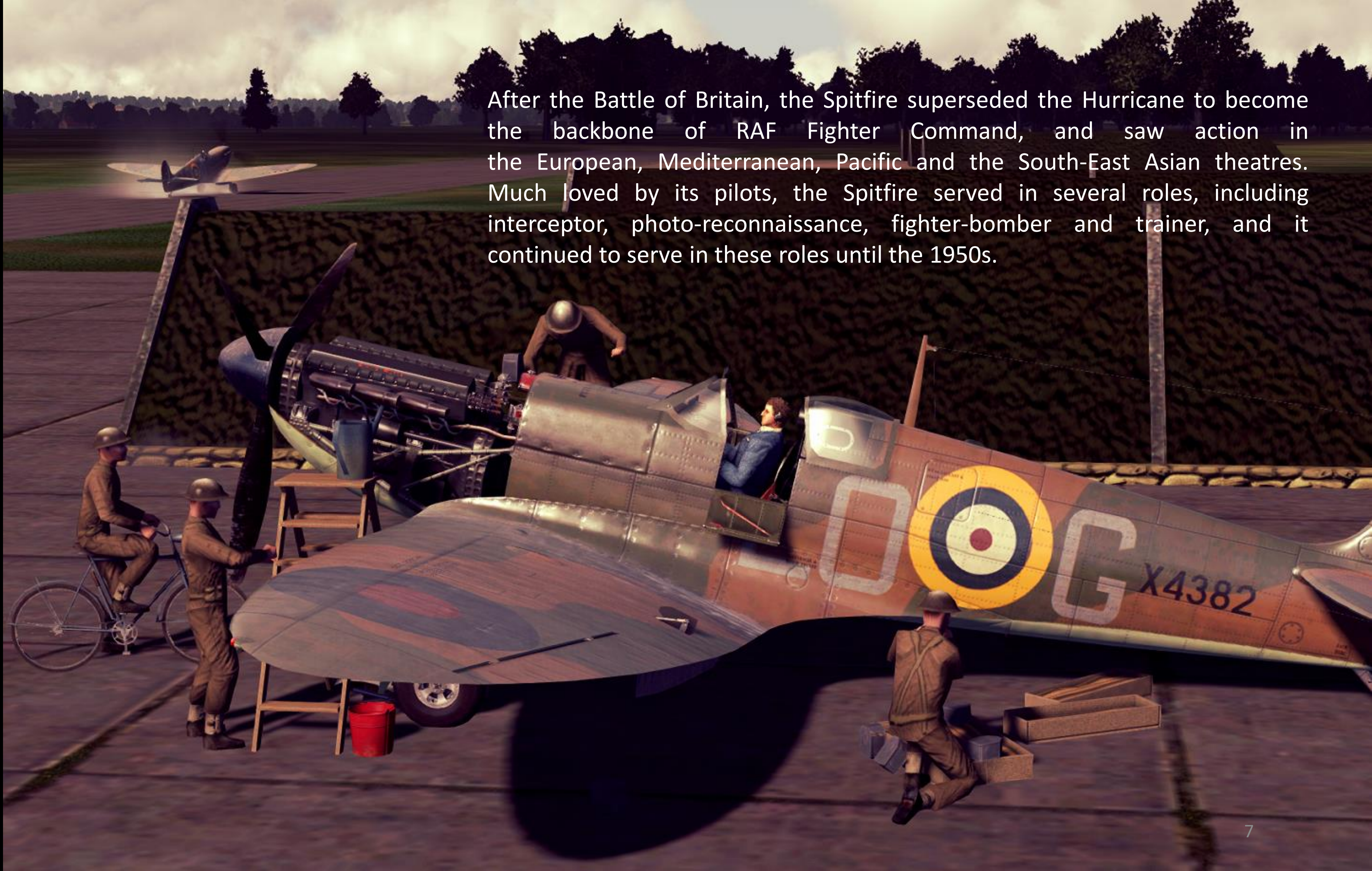


PART 1: AIRCRAFT HISTORY



Pilots came from the four corners of the world to fly the Spitfire and fight the Luftwaffe. Famous aces include James “Johnnie” Johnson, Douglas Bader, Robert Stanford Tuck, Paddy Finucane, George Beurling, Adolph “Sailor” Malan, Alan Deere, Colin Falkland Cray and Pierre Clostermann.

PART 1: AIRCRAFT HISTORY



After the Battle of Britain, the Spitfire superseded the Hurricane to become the backbone of RAF Fighter Command, and saw action in the European, Mediterranean, Pacific and the South-East Asian theatres. Much loved by its pilots, the Spitfire served in several roles, including interceptor, photo-reconnaissance, fighter-bomber and trainer, and it continued to serve in these roles until the 1950s.

PART 2: AIRCRAFT VARIANTS

	(Unit)	SPITFIRE MK I	SPITFIRE MK I 100 OCT	SPITFIRE MK IA	SPITFIRE MK IA 100 OCT	SPITFIRE MK IIA
TEMPERATURES						
Water Rad Min / Max	Deg C	60 115	60 115	60 115	60 115	60 130
Oil Rad (OUTBOUND) Min / Max	Deg C	40 95	40 95	40 95	40 95	40 100
ENGINE SETTINGS & PROPERTIES						
Engine & Fuel grade		Merlin II - 87 octane fuel	Merlin II – 100 octane fuel	Merlin III – 87 octane fuel	Merlin III – 100 octane fuel	Merlin XII – 100 octane fuel
Takeoff RPM	RPM	3000 FINE	3000 FINE	3000	3000	3000
Takeoff Manifold Pressure	UK: PSI GER: ATA ITA: mm HG	+6	+6	+6	+6	+9
Climb RPM	RPM	COARSE	COARSE	2650	2700	2850
Climb Manifold Pressure	UK: PSI GER: ATA ITA: mm HG	+6	+6	+6	+6	+9
Normal Operation/Cruise RPM	RPM	COARSE	COARSE	2600	2700	2650
Normal Operation/Cruise Manifold Pressure	UK: PSI GER: ATA ITA: mm HG	+3	+3	+3	+3	+6
Combat RPM	RPM	COARSE	COARSE	2800	2800	2850
Combat Manifold Pressure	UK: PSI GER: ATA ITA: mm HG	+6	+6	+6	+6	+9
Emergency Power/ Boost RPM @ km	RPM	2850 COARSE 5 min MAX	2850 COARSE 5 min MAX	2850 5 min MAX	2850 5 min MAX	3000 5 min MAX
Emergency Power / Boost Manifold Pressure @ Sea Level	UK: PSI GER: ATA ITA: mm HG	+6	+12 BCO-ON	+6	+12 BCO-ON	+12 BCO-ON
Landing Approach RPM	RPM	3000 FINE	3000 FINE	3000	3000	3000
Landing Approach Manifold Pressure	UK: PSI GER: ATA ITA: mm HG	As required	As required	As required	As required	As required
Top Speed @ Sea Level	UK: MPH GER-ITA: km/h	**272**	**298**	**282**	**312**	**300**
Notes & Peculiarities		Fit with a De-Havilland Two Speed Propellor, maximum RPMs are not restricted by the propellor governor. The two settings available are either 'Fine Pitch' or 'Coarse Pitch'.		Fit with a Rotol Constant Speed Propellor, maximum RPMs at 3000. The difference between Two Speed and Constant Speed Props will be explained on the next page.		The Spitfire IIa has better performance (and top speed) than the IA btwn 10,000ft and 25,000ft.

The propeller installed on your aircraft means that a specific prop mechanism is used. The De Havilland DH5-20 two-pitch props were used on early Spitfire and Hurricane variants, mainly during the Battle of France. However, pilots realized that two-pitch props could be manually fine-tuned between FINE and COARSE to gain slightly better engine performance at desired engine RPMs. The Constant-Speed Rotol propeller was the logical next step in this idea. With CSU governors, the propeller pitch was automatically adjusted in order to gain a desired engine RPM. This reduced the workload of experienced pilots and allowed overall slightly better engine and aircraft performance.

Propeller Pitch Terminology

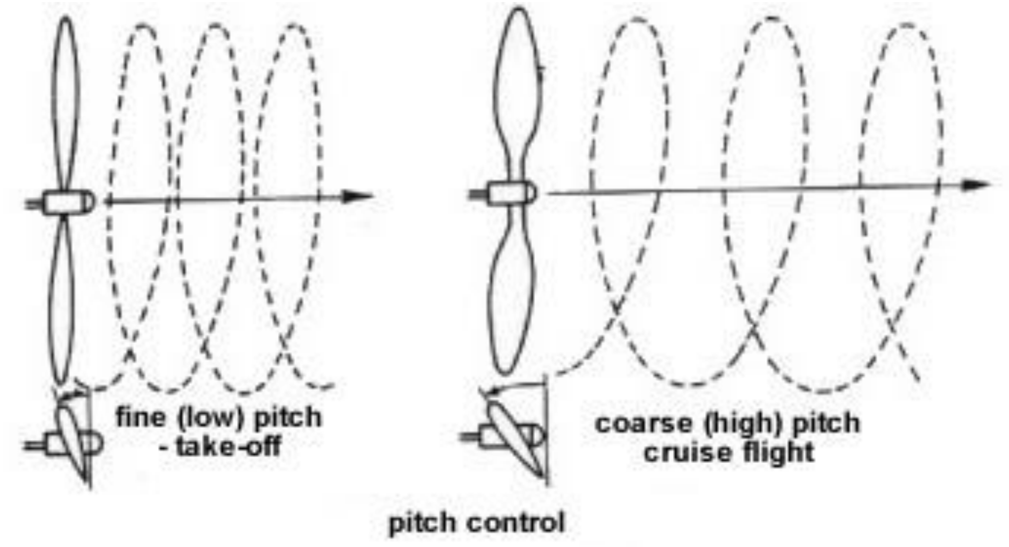
RAF	Fine	Coarse	Feathered	RAF
USAAC	Flat / Low	High	Feathered	USAAC
Luftwaffe	Startstellung (Start Position)	Reisestellung (Cruise Position)	Segelstellung (Sail Position)	Luftwaffe

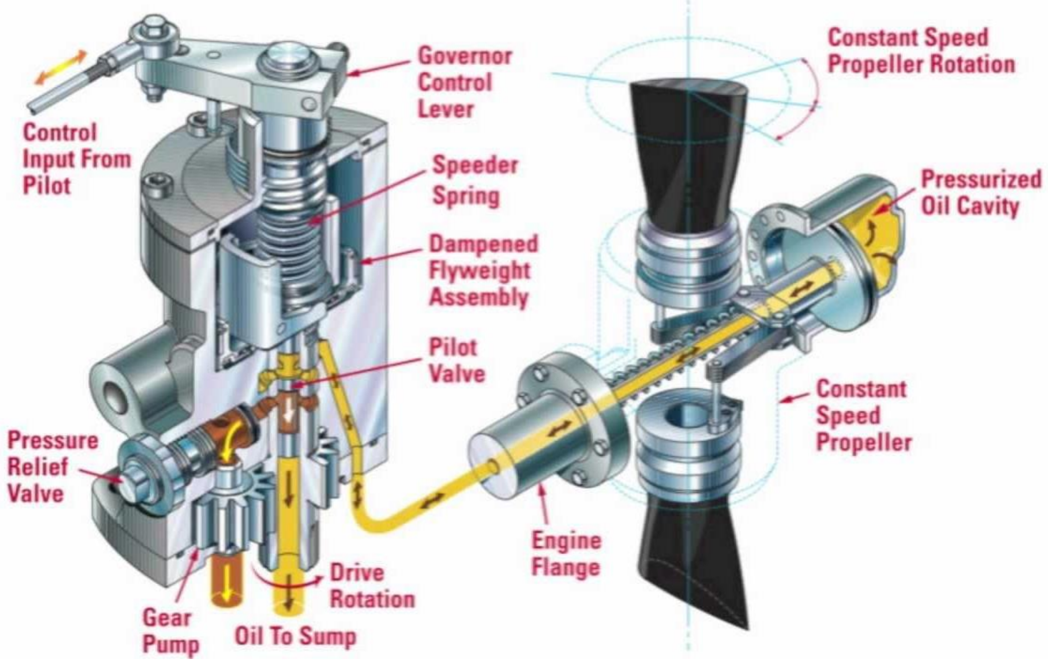
Propeller Types

Propeller Types	Definition	Example
Fixed Pitch (FP)	Propeller Pitch Angle is fixed and cannot be changed.	Tigermoth
Variable Pitch (VP)	Propeller Pitch Angle may be changed by the pilot in flight. May be fully variable or limited to a defined set of positions. Susceptible to overspeed/overrev.	Hurricane DH5-20, Spitfire MkIa, Bf 109E-3
Constant Speed (CS)	Variable Pitch Propeller governed by a Constant Speed Unit (CSU). Governor maintains a commanded RPM and prevents propeller overspeed/overrev.	Hurricane Rotol, Spitfire MkII, Blenheim MkIV
Luftschauben Verstellautomatik (LV)	Propeller with an automatic pitch changing device that prevents overrevs. Additionally, every throttle position has a corresponding RPM that is maintained within narrow limits by the automatic device. May be switched off.	Bf 109E-4, 109E-4/B

Propeller Operations

Propeller	Operation
De Havilland 5-20 (RAF) VP (hydraulic)	The DH 5-20 VP propeller functions as a pilot selectable two pitch prop. Pitch Ranges from 5° (Fully Fine) to 20° (Fully Coarse). Moving the Propeller Pitch Control selects the pitch angle (fine or coarse). Fine Pitch will result in higher RPMs and Coarse Pitch will result in lower RPMs for a given throttle setting.
Rotol (RAF) CS (hydraulic)	The Rotol is a VP prop with a CSU. The CSU governor provides for 35° of pitch change and will automatically adjust the pitch angle to maintain a commanded RPM. This will prevent overspeed until the CSU unit hits the "Full Coarse" stops at which point overspeed becomes possible. The Propeller Pitch Control commands the governor to maintain a constant RPM. "Fully Fine" commands "maximum RPM". Retarding the Pitch Control commands a lower RPM setting. "Fully Coarse" commands "Positive Coarse Lock" at which point the prop will function as a FP prop in the "Fully Coarse" position.



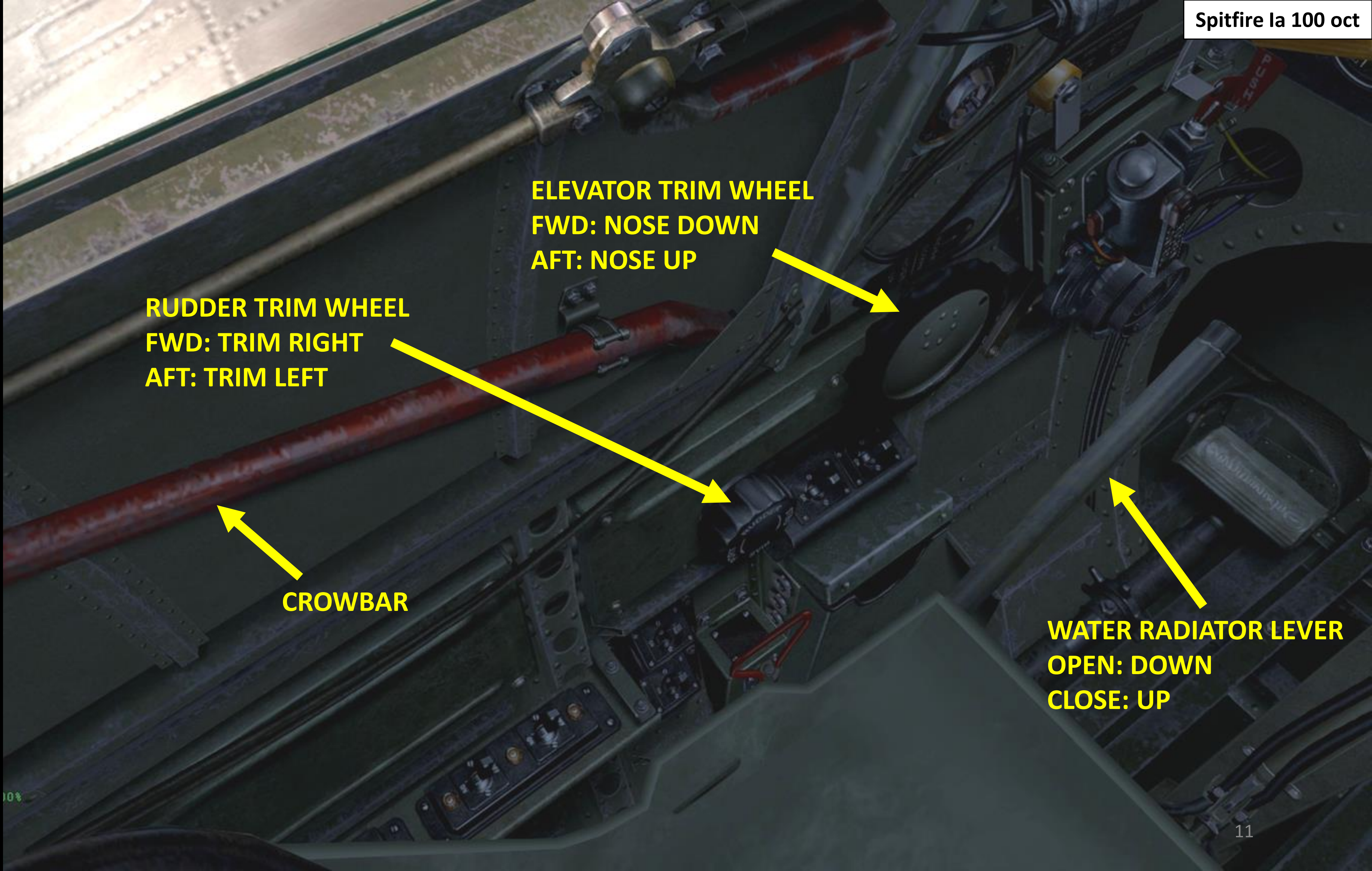


Constant Speed Prop Mechanism

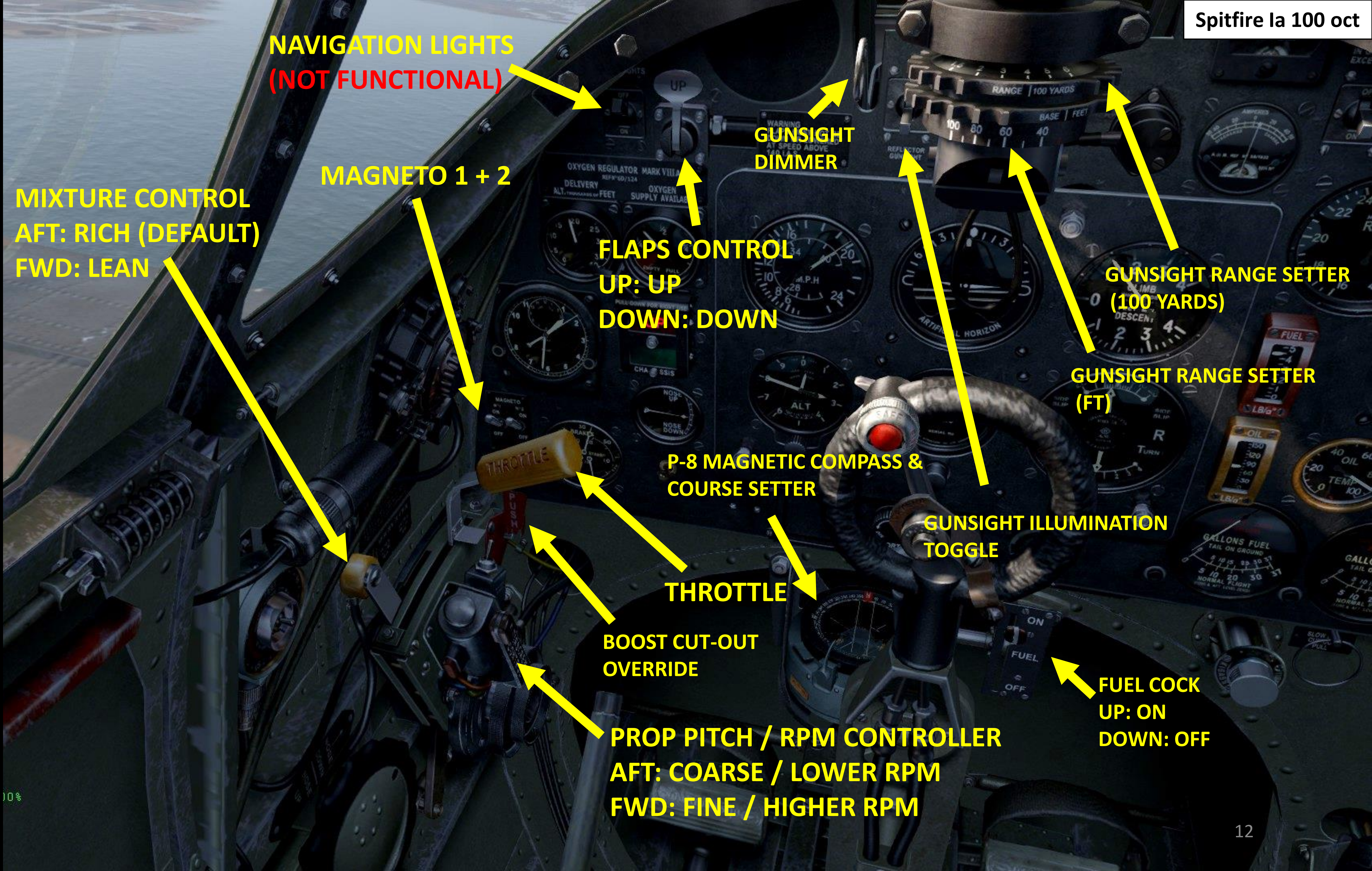
A **constant-speed unit** (CSU) or **propeller governor** is the device fitted to one of these propellers to automatically change its pitch so as to attempt to keep engine speed constant. Most engines produce their maximum power in a narrow speed band. The CSU can be said to be to an aircraft what the CVT is to the motor car: the engine can be kept running at its optimum speed no matter what speed the aircraft is flying through the air. The advent of the CSU had another benefit: it allowed the designers of aircraft engines to keep ignition systems simple - the automatic spark advance seen in motor vehicle engines is simplified in aircraft engines.

A **controllable-pitch propeller** (CPP) or **variable-pitch propeller** is a type of propeller with blades that can be rotated around their long axis to change their pitch. If the pitch can be set to negative values, the reversible propeller can also create reverse thrust for braking or going backwards without the need of changing the direction of shaft revolutions. Such propellers are used in propeller-driven aircraft to adapt the propeller to different thrust levels and air speeds so that the propeller blades don't stall, hence degrading the propulsion system's efficiency. Especially for cruising, the engine can operate in its most economical range of rotational speeds. With the exception of going into reverse for braking after touch-down, the pitch is usually controlled automatically without the pilot's intervention. A propeller with a controller that adjusts the blades' pitch so that the rotational speed always stays the same is called a constant speed propeller (see paragraph above). A propeller with controllable pitch can have a nearly constant efficiency over a range of airspeeds.

Team Fusion NOTE: *The Spitfire Mk I 2-pitch system could in fact be used with limitations as a Variable Pitch system. Though not exactly designed with this in mind it was found by pilots that careful use of the Prop pitch control allowed them to set any desired RPM rather than just Coarse or Fine pitch setting. This did not provide the complete flexibility of a dedicated VP system but did allow intermediate RPM control. This was good for certain flight phases like climb and Cruise. Due to limitations in the Pitch plunger design it does not really lend itself to combat flying. In this patch we have enabled the pilot to select a desired RPM. Blade angle change rates are still the same as was used in the original 2 Pitch system. We have not changed the 3d modelling of the Pitch lever, this will be done at a later stage. In the real aircraft the Pitch Change control was of a plunger or Push Pull type control.*


ELEVATOR TRIM WHEEL
FWD: NOSE DOWN
AFT: NOSE UP
RUDDER TRIM WHEEL
FWD: TRIM RIGHT
AFT: TRIM LEFT
CROWBAR
WATER RADIATOR LEVER
OPEN: DOWN
CLOSE: UP

PART 3: AIRCRAFT & COCKPIT FAMILIARIZATION



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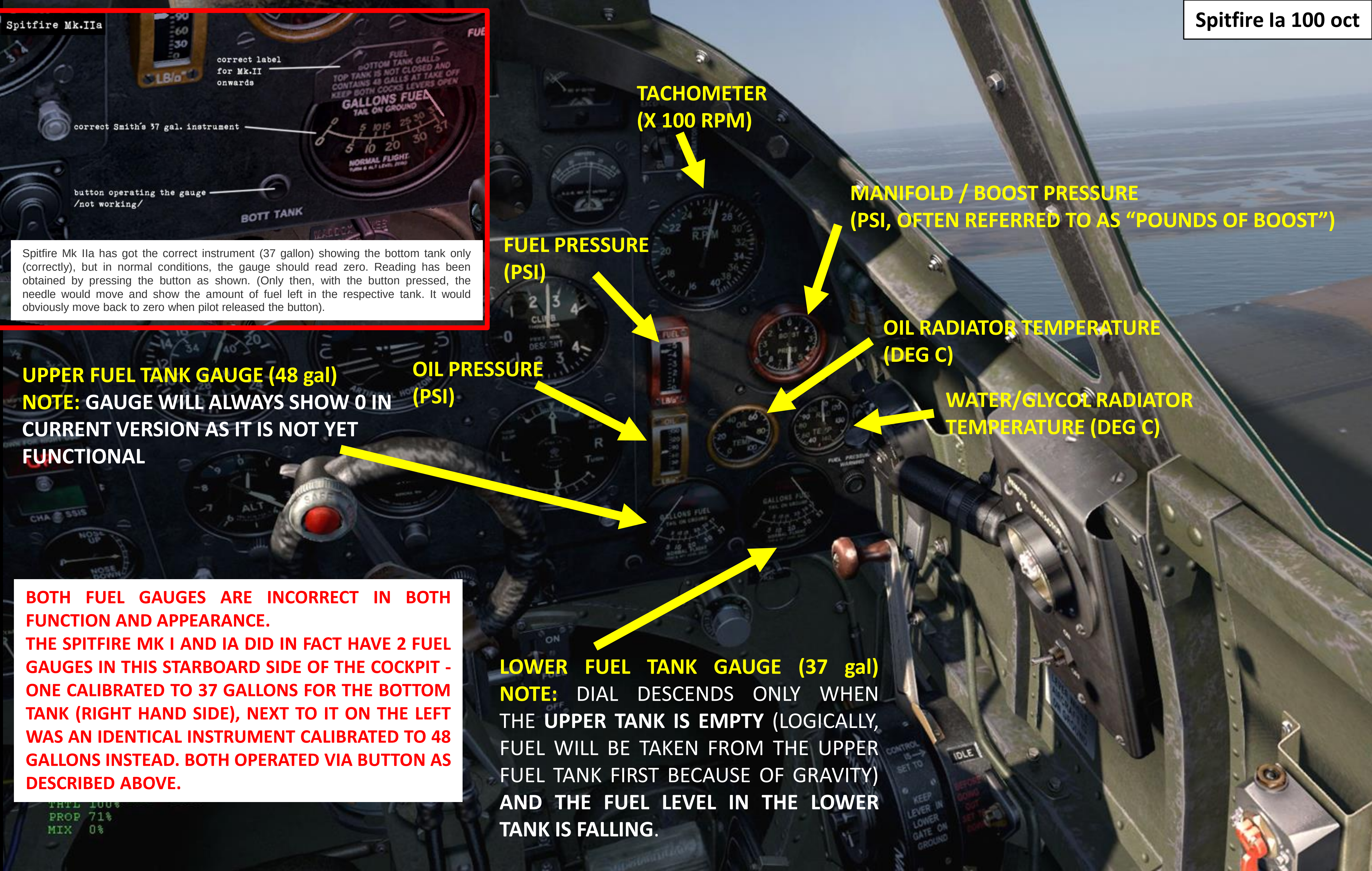
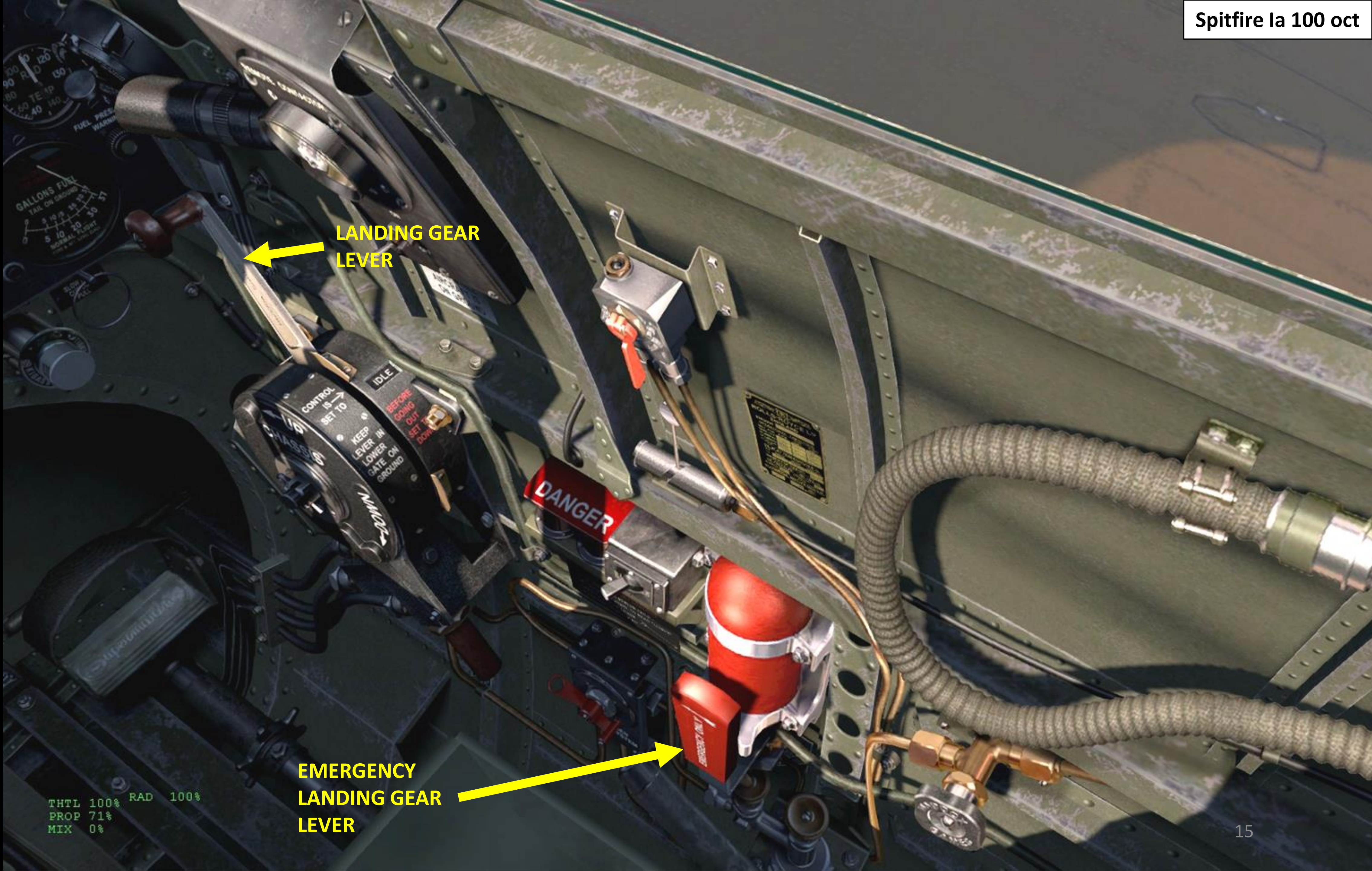
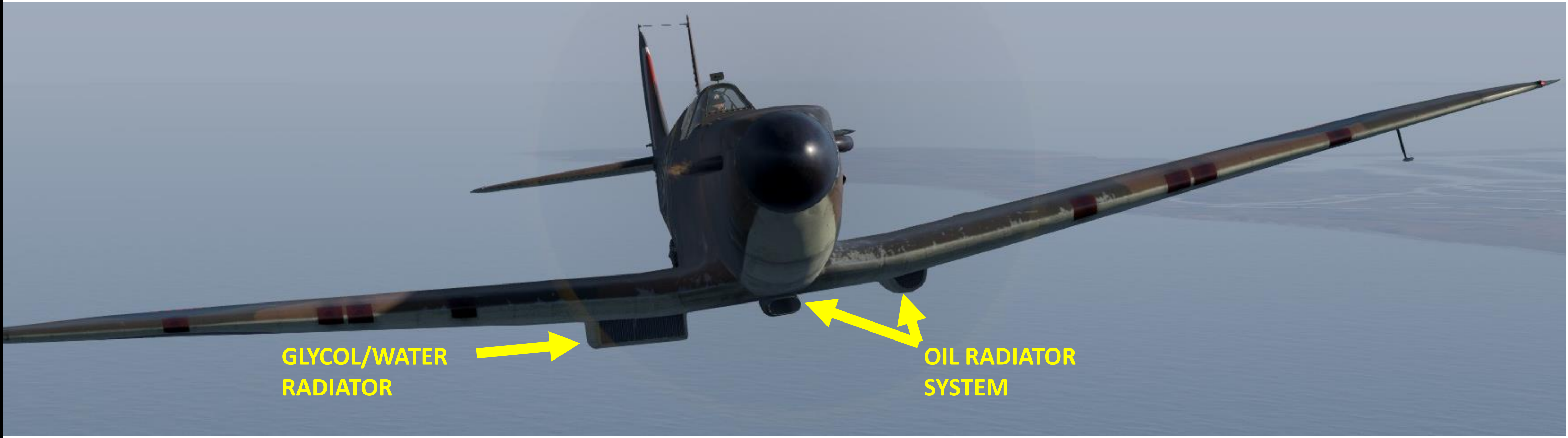


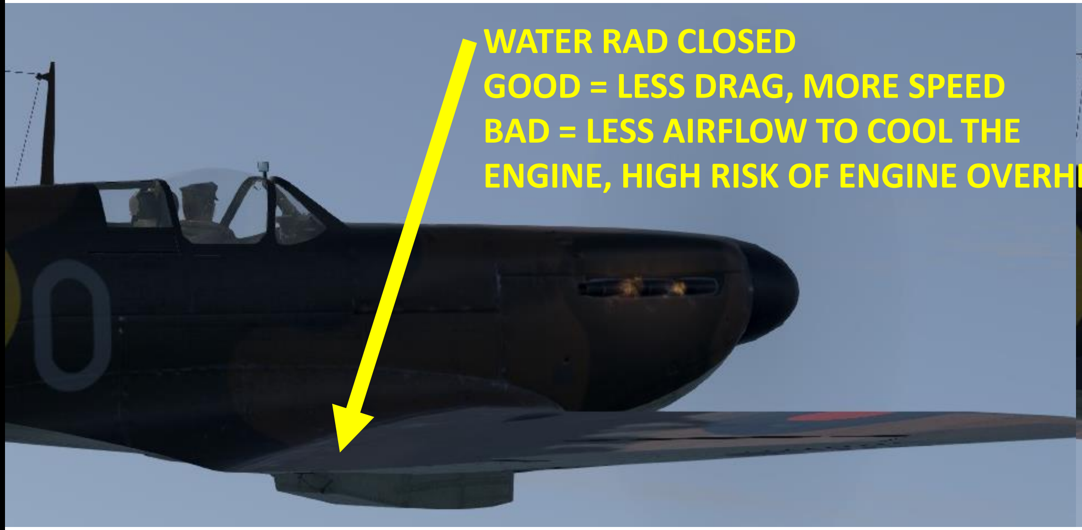
Spitfire Mk IIa has got the correct instrument (37 gallon) showing the bottom tank only (correctly), but in normal conditions, the gauge should read zero. Reading has been obtained by pressing the button as shown. (Only then, with the button pressed, the needle would move and show the amount of fuel left in the respective tank. It would obviously move back to zero when pilot released the button).

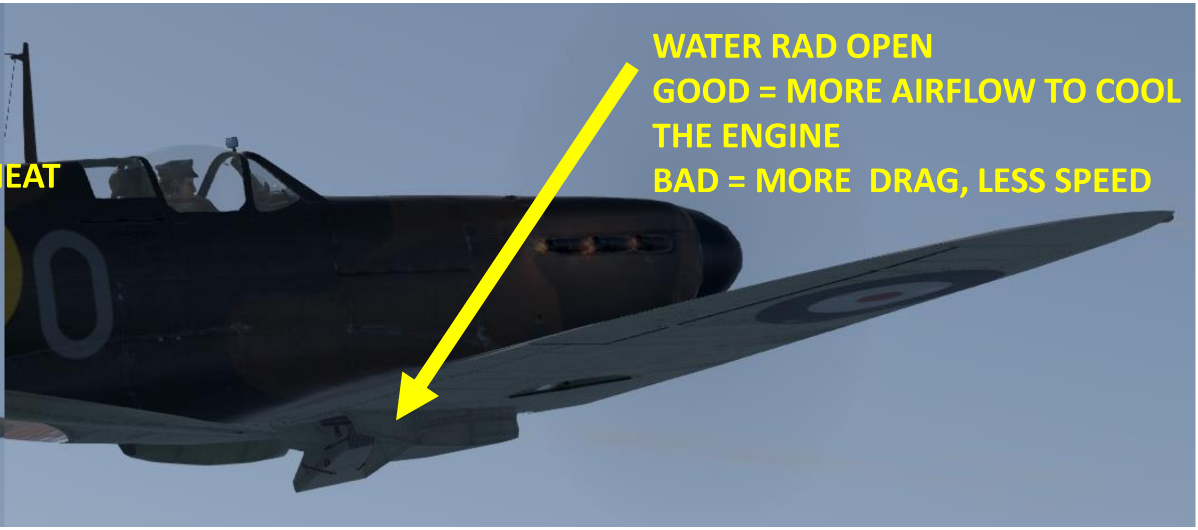
BOTH FUEL GAUGES ARE INCORRECT IN BOTH FUNCTION AND APPEARANCE. THE SPITFIRE MK I AND IA DID IN FACT HAVE 2 FUEL GAUGES IN THIS STARBOARD SIDE OF THE COCKPIT - ONE CALIBRATED TO 37 GALLONS FOR THE BOTTOM TANK (RIGHT HAND SIDE), NEXT TO IT ON THE LEFT WAS AN IDENTICAL INSTRUMENT CALIBRATED TO 48 GALLONS INSTEAD. BOTH OPERATED VIA BUTTON AS DESCRIBED ABOVE.


LANDING GEAR LEVER
EMERGENCY LANDING GEAR LEVER
DANGER
THTL 100%
PROP 71%
MIX 0%
RAD 100%

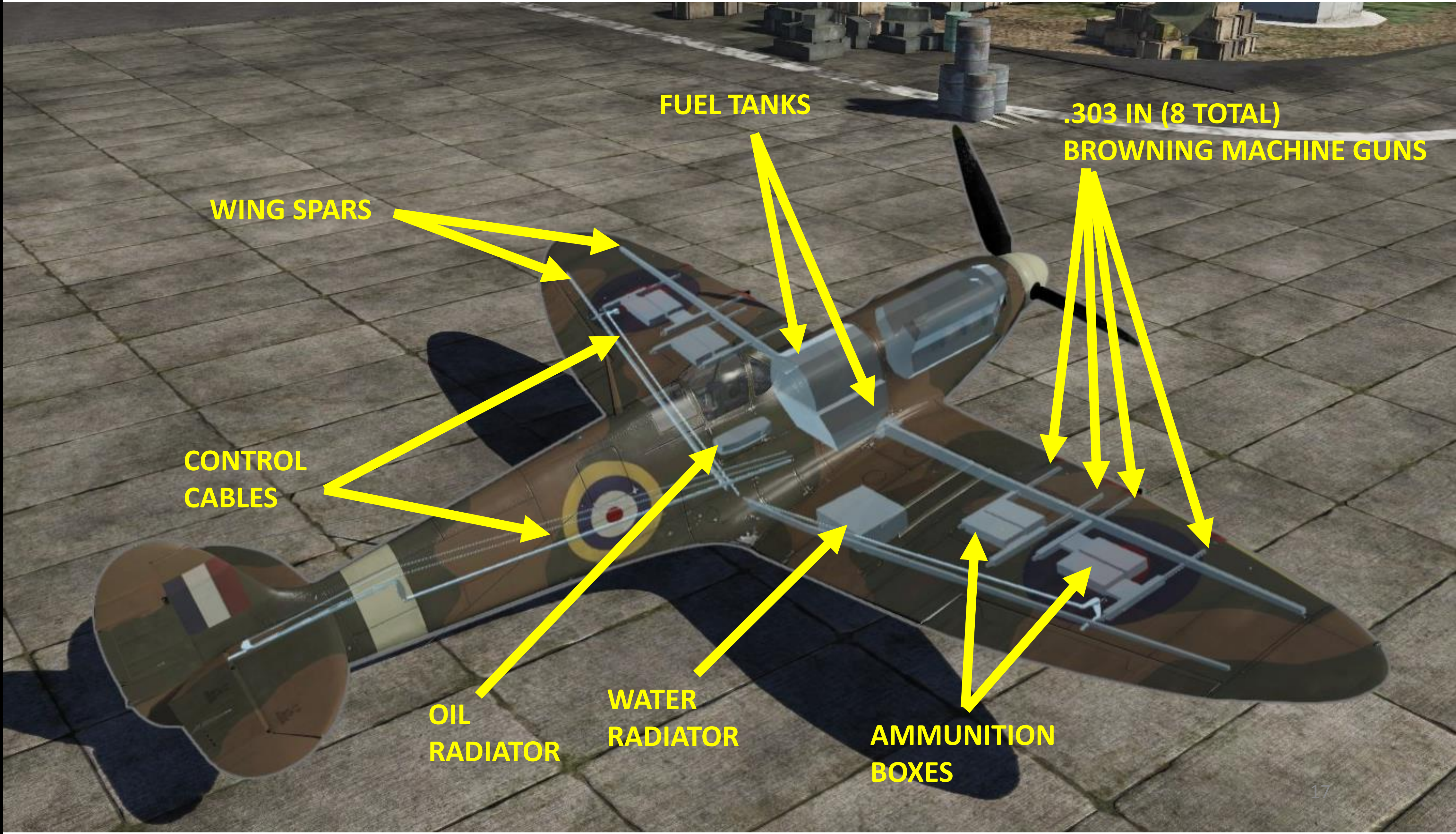
CHECK THE "ENGINE MANAGEMENT" SECTION FOR RECOMMENDED RADIATOR SETTINGS.







CRITICAL COMPONENTS



RAF

HOW TO RECOGNIZE A TAIL NUMBER

The system used for most British aircraft flying in the Battle of Britain was rather uniform regardless of plane type or squadron.

Tail Number. Usually a single-character letter from A to Z. Numbers entered into the Tail Number field will be translated into a corresponding letter, such as 2 into B, 11 into K, etc.

The only exception is the Tiger Moth when assigned to the London School of Flying regiment. In this case the aircraft code will consist of three letters.

Serial Number. Usually a five-character string starting with a letter and followed by four numbers.

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 #
Hurricane Mk I	No. 151 Squadron	*DZ*-**E**	**L1754**
Hurricane Mk I	No. 312 Squadron	*DU*-**J**	**L1926**
Spitfire Mk I	No. 74 Squadron	*ZP*-**J**	**K9867**
Spitfire Mk II	No. 41 Squadron	*EB*-**Z**	**P7666**
Blenheim Mk IV	No. 40 Squadron	*BL*-**V**	**R3612**
Short Sunderland	No. 201 Squadron	*ZM*-**Q**	**T9087**

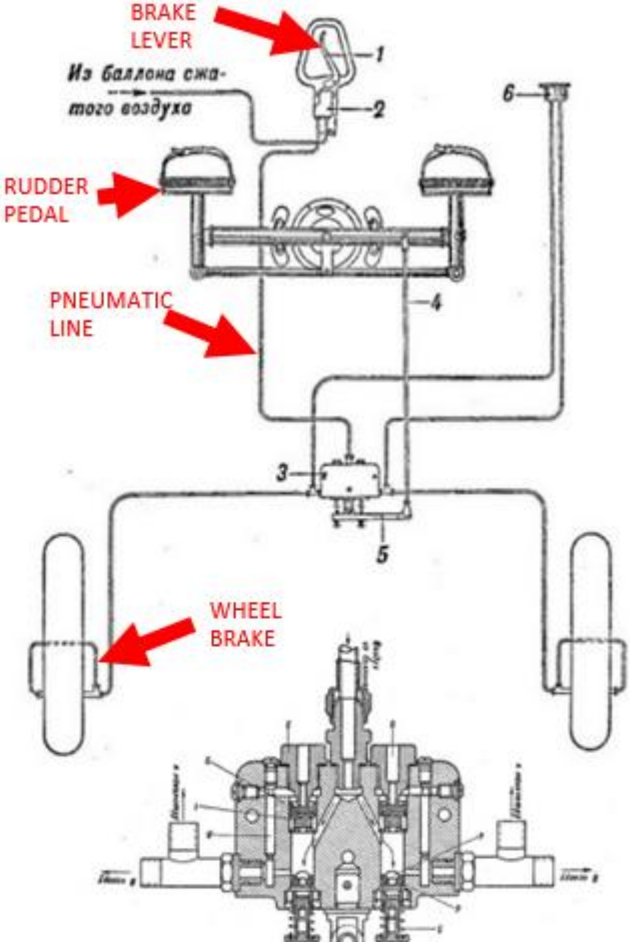
PART 4: CONTROLS

SUPERMARINE SPITFIRE (ALL MARKS)		
DESCRIPTION	MAPPED TO	ESSENTIAL / NON-ESSENTIAL
Wheel Chocks		ESSENTIAL
toggle primary cockpit illumination		CLICKABLE IN COCKPIT
toggle secondary cockpit illumination		CLICKABLE IN COCKPIT
increase sight distance (gunsight range)		CLICKABLE IN COCKPIT
decrease sight distance (gunsight range)		CLICKABLE IN COCKPIT
adjust gunsight left (gunsight wingspan)		CLICKABLE IN COCKPIT
adjust gunsight right (gunsight wingspan)		CLICKABLE IN COCKPIT
toggle gunsight illumination		CLICKABLE IN COCKPIT
course setter - increase		CLICKABLE IN COCKPIT
course setter - decrease		CLICKABLE IN COCKPIT
directional gyro - increase		CLICKABLE IN COCKPIT
directional gyro - decrease		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 and rudder)	Joystick hat switch	ESSENTIAL
Field of View + (allows you to zoom out)		ESSENTIAL
Field of View – (allows you to zoom in)		ESSENTIAL

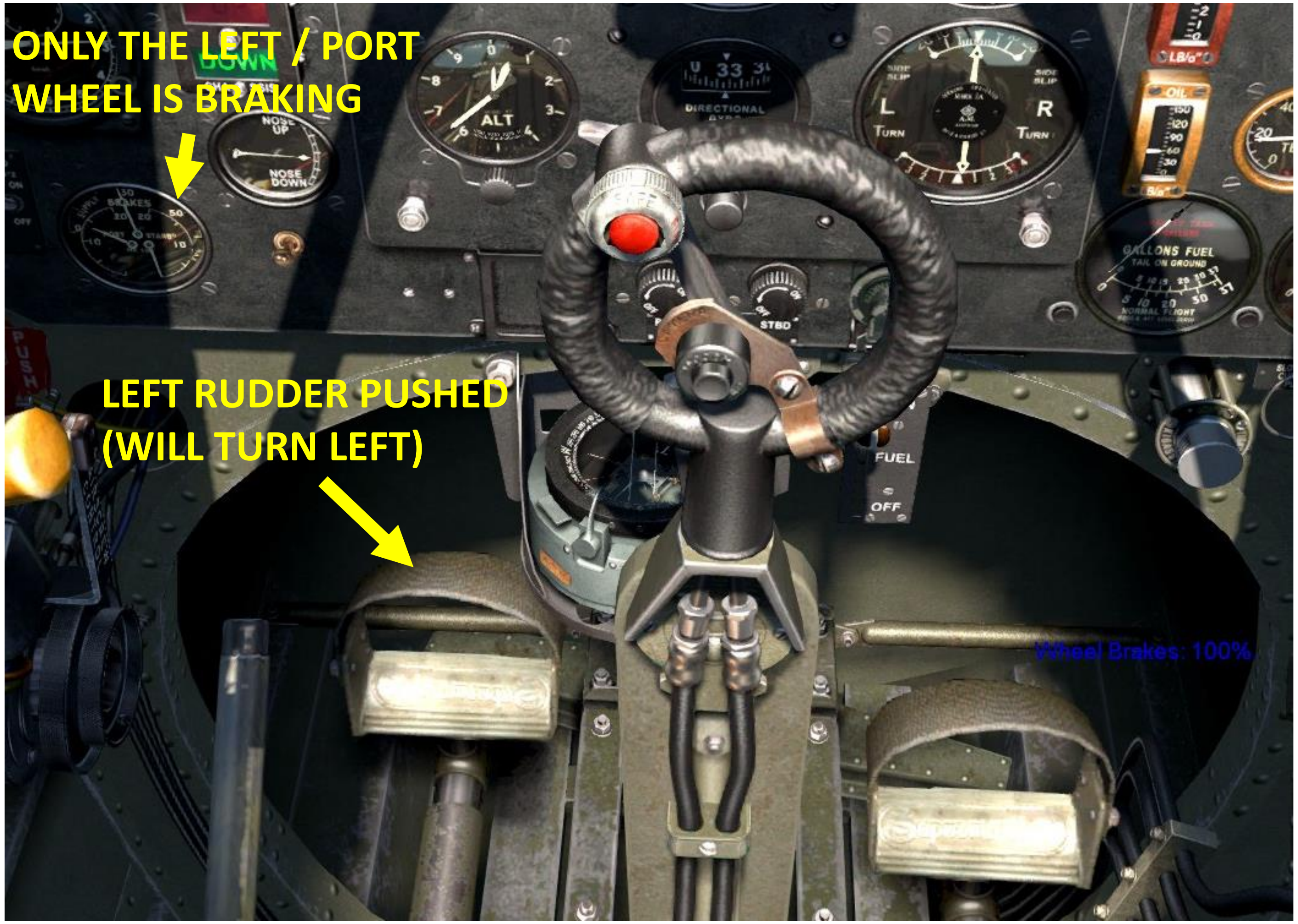
SUPERMARINE SPITFIRE (ALL MARKS)

DESCRIPTION	MAPPED TO	ESSENTIAL / NON-ESSENTIAL
lean to gunsight		NOT ESSENTIAL
fire guns	Joystick Gun Trigger	ESSENTIAL
throttle	Throttle axis	ESSENTIAL
boost cut-off (boost cut-out override)		ESSENTIAL
toggle canopy/hatch		ESSENTIAL
increase mixture		ESSENTIAL
decrease mixture		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
Wheel brakes		ESSENTIAL
bail out		ESSENTIAL
engage emergency undercarriage system		CLICKABLE IN COCKPIT
Toggle Independent Mode (allows you to use/hide mouse cursor)	F10	ESSENTIAL

- Unlike the Bf.109, the Spitfire uses differential braking instead of toe brakes.
- In order to brake, you need to hold your “Full Wheel Brakes” key (which is physically mapped as a lever on your control column) while you give rudder input to steer your aircraft. Make sure you have adequate mixture, RPM and Manifold Pressure settings or your turn radius will suffer. Keep in mind that that for British and Italian aircraft, you use this braking system (Full Wheel Brakes key), while for the German aircraft you use toe brakes (“Full Left/Right Wheel Brakes” keys or “Left/Right Wheel Brakes” axes in your controls).



EXAMPLE OF DIFFERENTIAL BRAKING SYSTEM ADAPTED FROM RUSSIAN LAGG-3

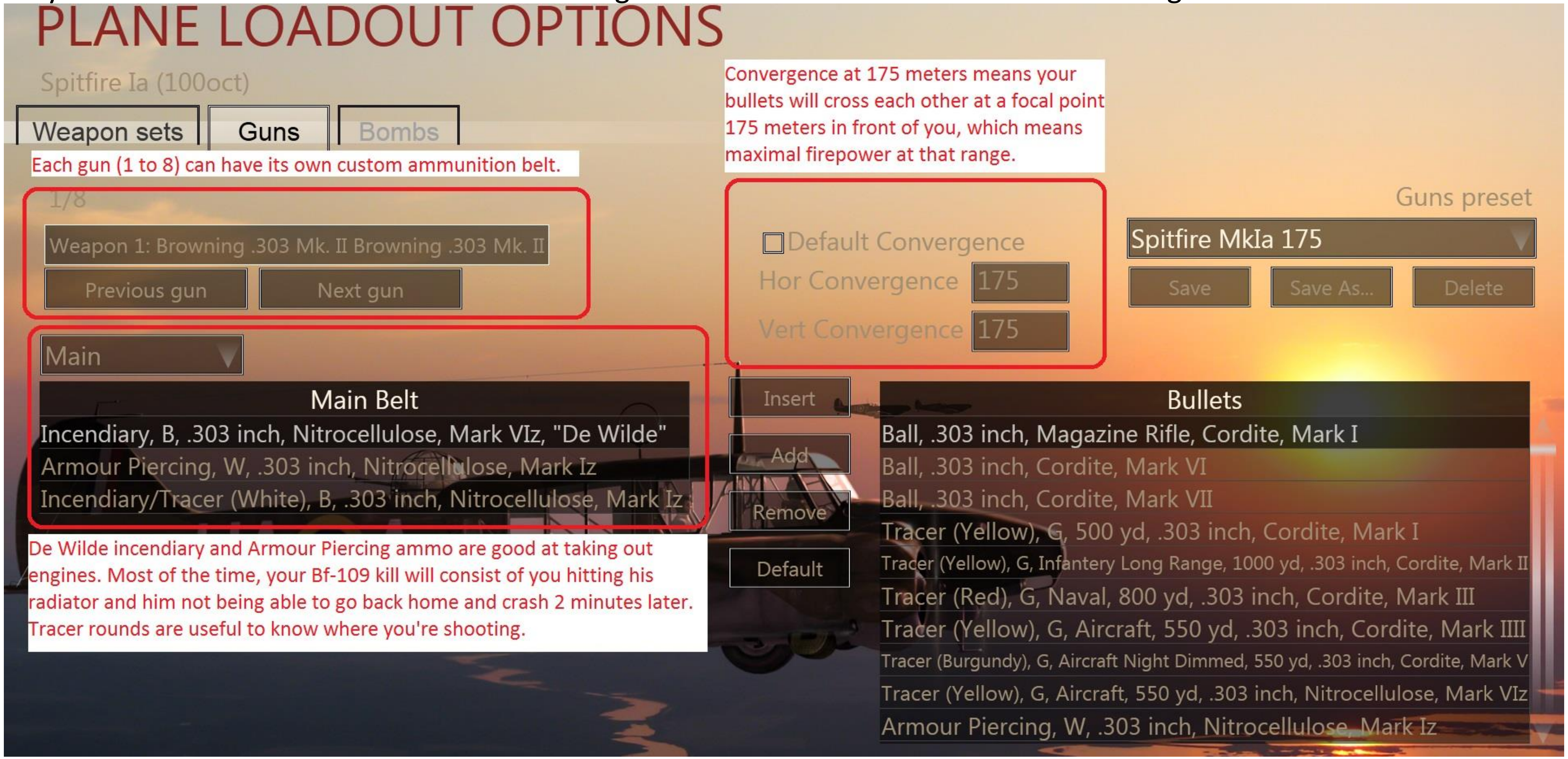


PART 5: WEAPONS AND ARMAMENT

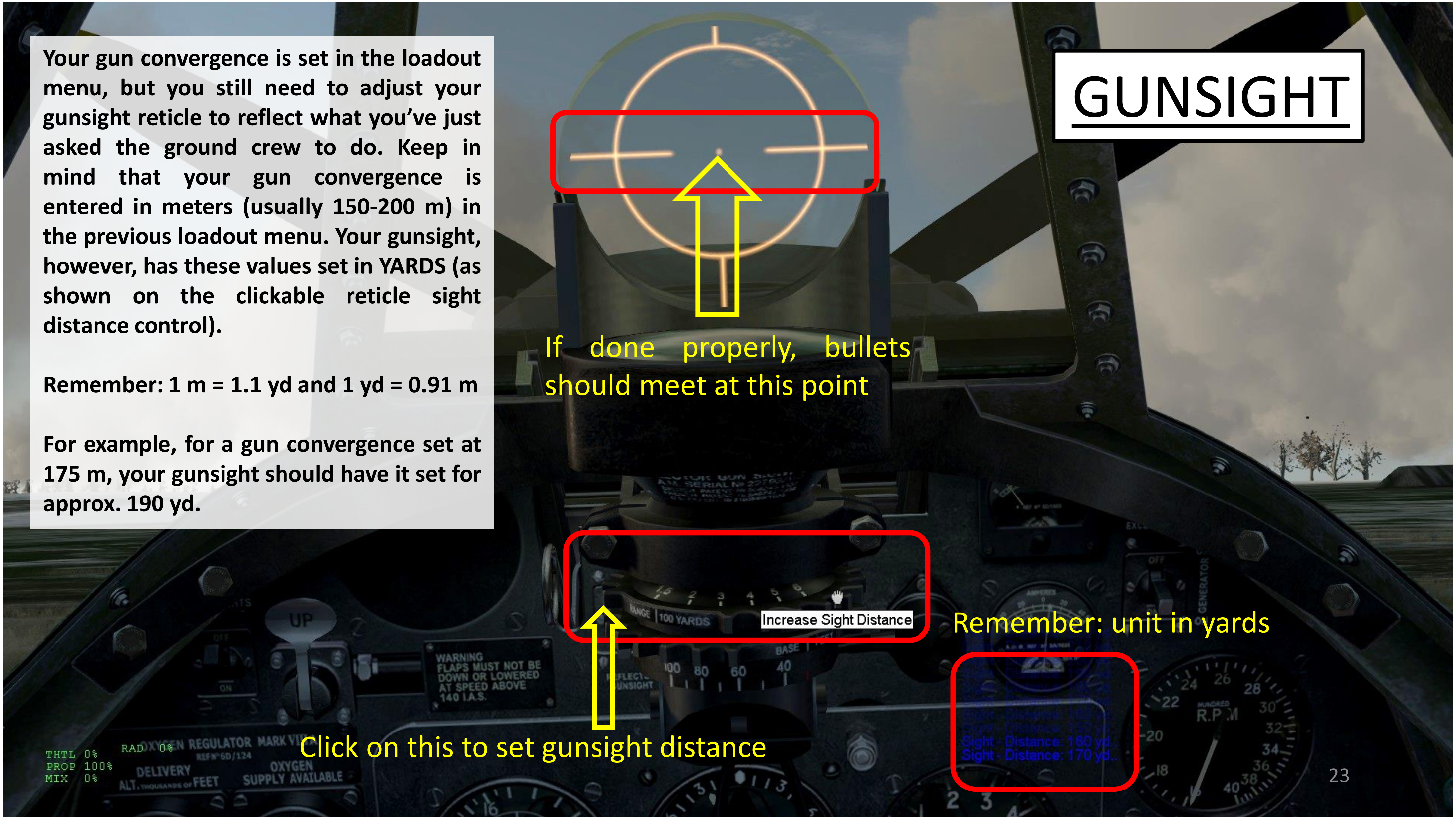
Recommended Machine-Gun Belt Loadout – **Browning Mk II (.303 in)**

1. **Incendiary**, Nitrocellulose, Mark Viz, **“De Wilde”**
2. **Armour Piercing**, W. Nitrocellulose, Mark Iz
3. **Incendiary/Tracer (White)**, B. Nitrocellulose, Mark Iz (recommended for outer guns only)

The Spitfire is armed with 8 .303 Browning machine-guns. Hispano Cannons only came with B wing marks (while the only marks available in the game so far have the A wing) the This caliber is very unlikely to create structural damage, so you are better off to aim for critical 109 components like the engine and water radiators under the wings. Recommended loadout is a belt of mixed armour piercing and De Wilde incendiary. Incendiary/Tracer rounds can be used for outer guns to help you adjust your aim. I recommend a horizontal convergence of 175 meters and a vertical convergence of 175 meters.



Interestingly enough, Spitfire marks (for example the Mk Ia) included a “letter”, which described the wing type installed. The early A type was for 8 browning machine guns. The B type (not in-game yet) was an A type wing modified to have 1 Hispano-Suiza cannon and 2 Browning machine-guns per wing. The C type (not in-game yet) only came in 1942 and was the “Universal Wing”, which allowed either 8 Brownings (A), 4 Brownings and 2 Hispano-Suiza cannons (B) or 4 Hispanos. This particular “C” design allowed great flexibility in terms of armament.



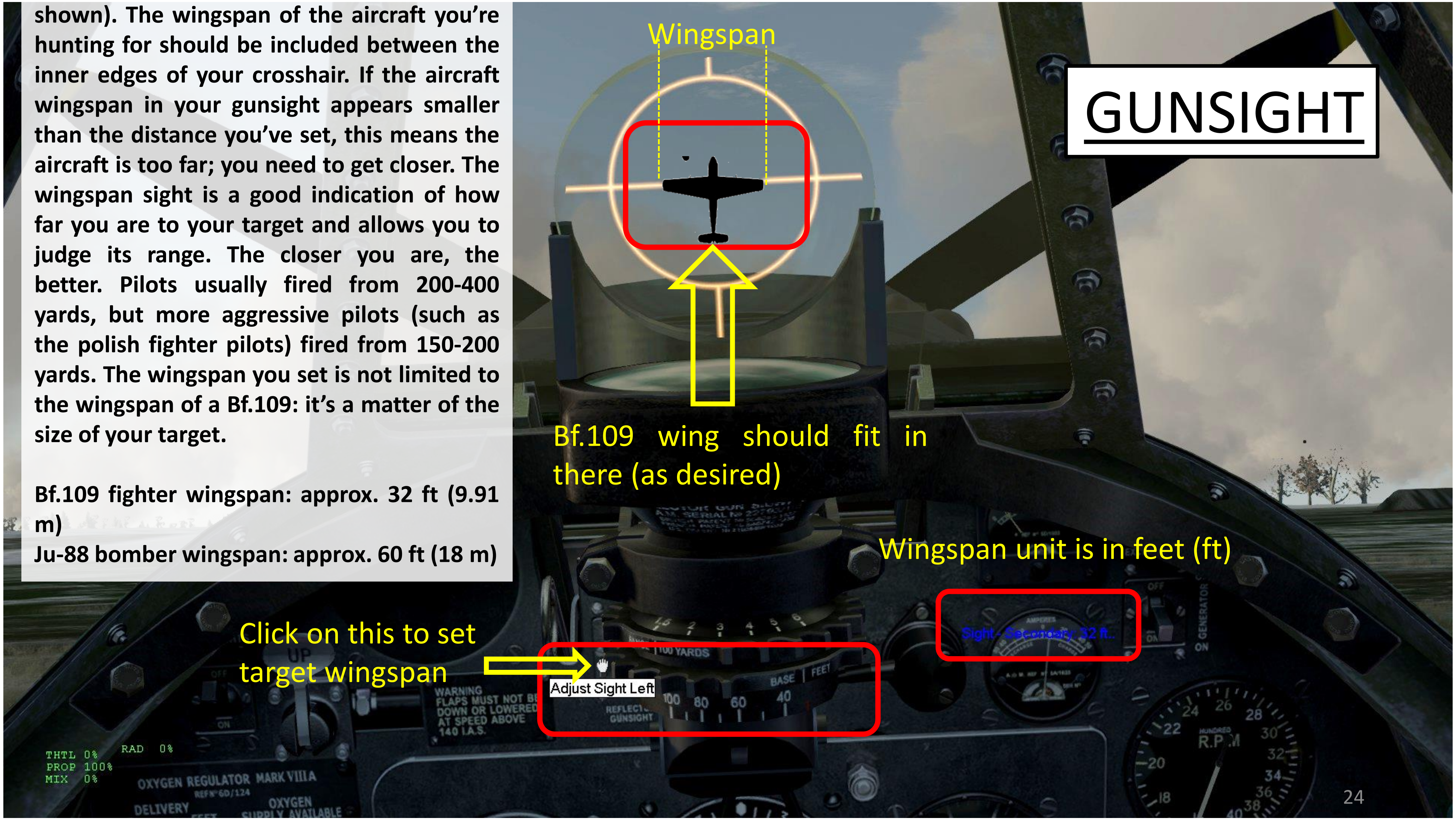
Your gun convergence is set in the loadout menu, but you still need to adjust your gunsight reticle to reflect what you’ve just asked the ground crew to do. Keep in mind that your gun convergence is entered in meters (usually 150-200 m) in the previous loadout menu. Your gunsight, however, has these values set in YARDS (as shown on the clickable reticle sight distance control).

Remember: 1 m = 1.1 yd and 1 yd = 0.91 m

For example, for a gun convergence set at 175 m, your gunsight should have it set for approx. 190 yd.

Next is your wingspan adjustment on your gunsight. The wingspan of an aircraft is the distance between the tip of each wing (as shown). The wingspan of the aircraft you're hunting for should be included between the inner edges of your crosshair. If the aircraft wingspan in your gunsight appears smaller than the distance you've set, this means the aircraft is too far; you need to get closer. The wingspan sight is a good indication of how far you are to your target and allows you to judge its range. The closer you are, the better. Pilots usually fired from 200-400 yards, but more aggressive pilots (such as the polish fighter pilots) fired from 150-200 yards. The wingspan you set is not limited to the wingspan of a Bf.109: it's a matter of the size of your target.

Bf.109 fighter wingspan: approx. 32 ft (9.91 m)
Ju-88 bomber wingspan: approx. 60 ft (18 m)



PART 5: WEAPONS AND ARMAMENT

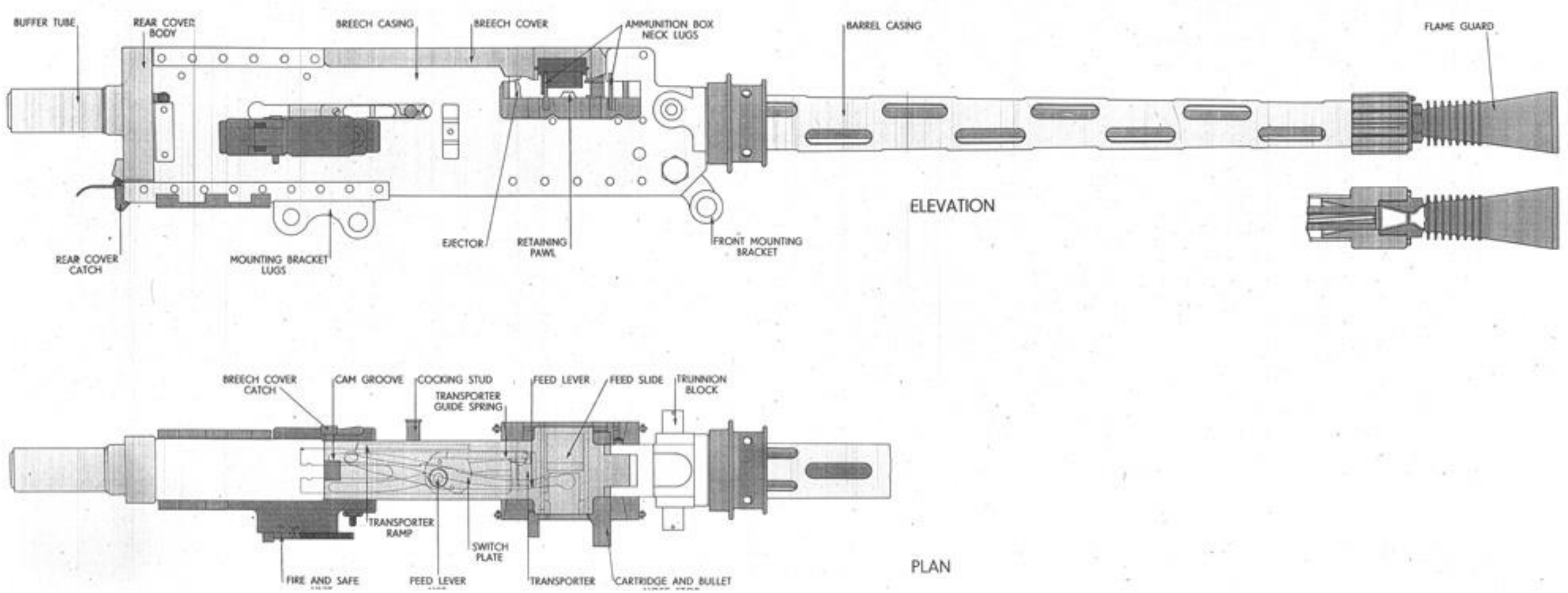
ROYAL AIR FORCE SIGHT DATA

ONE | ONE

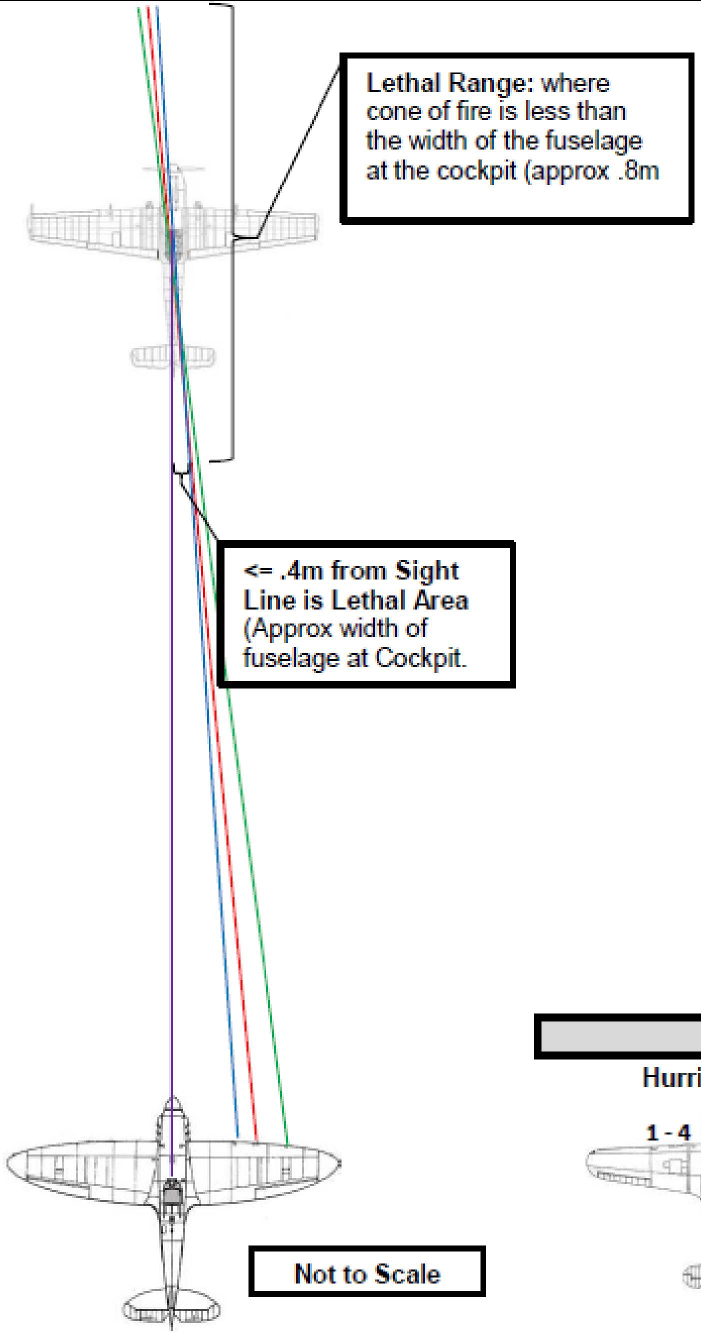
Luftwaffe Aircraft	Wingspan			GM2 MKII SIGHT (118 mils)		
	Meters	Yards	Feet	Range (m)	Range (yds)	Range (ft)
Fiat CR.42	9.70	10.61	31.8	82	90	270
Bf-109E	9.87	10.79	32.4	84	91	274
Bf 108B-2	10.50	11.48	34.4	89	97	292
Fiat G.50	10.96	11.99	36.0	93	102	305
Ju-87B-2	13.80	15.09	45.3	93	102	305
Bf-110C	16.30	17.83	53.5	138	151	453
Do 17Z-1	18.00	19.69	59.1	153	167	500
Ju-88A-1	20.08	21.96	65.9	170	186	558
Fiat BR20M	21.56	23.58	70.7	183	200	599
He 115B-2	22.28	24.37	73.1	189	206	619
He-111H-2	22.50	24.61	73.8	191	209	626
He 59C-2	23.70	25.92	77.8	201	220	659
FW 200C-1	32.85	35.93	107.8	278	304	913

GENERAL ARRANGEMENT OF THE ·303 INCH BROWNING GUN TYPE A. MARK II.

PLATE 1



Rg of AC when wingtips touch Sight Ring



Spitfire Convergence - meters (yds)		
Lethal Range Centered on Convergence		
205 (224)	240 (262)	275 (301)
188 (206)	220 (241)	252 (276)
171 (187)	200 (219)	229 (250)
154 (168)	180 (197)	206 (225)
137 (150)	160 (175)	183 (200)
119 (130)	140 (153)	161 (176)
102 (112)	120 (131)	138 (151)
85 (93)	100 (109)	115 (126)

Hurricane Convergence - meters (yds)		
Lethal Range Centered on Convergence		
193 (211)	240 (262)	287 (314)
177 (194)	220 (241)	263 (288)
160 (175)	200 (219)	240 (262)
144 (157)	180 (197)	216 (236)
128 (140)	160 (175)	192 (210)
112 (122)	140 (153)	168 (184)
96 (105)	120 (131)	144 (157)
81 (89)	100 (109)	119 (130)

Gun Numbering

ONE

ONE

TWO — ROYAL AIR FORCE WEAPON DATA — TWO

RAF Machinegun Ammunition

Weapon	Nomen	Type	Fill	Burnout	Tracer Color	Smoke Trail	Notes
Browning .303 cal	Mk I	Ball					
	Mk VI	Ball					
	Mk VII	Ball					
	B Mk Iz	Incend	Ph			Yes	Burns
	B Mk VI	Incend	SR379				Schauzeichen
	G Mk I	Tracer		500 yd	Yellow		
	G Mk II	Tracer		1000 yd	Yellow		
	G Mk III	Tracer		800 yd	Red		
	G Mk IV	Tracer		550 yd	Yellow		
	G Mk V	Tracer		550 yd	Burgandy		Slow Tracer
	G Mk VIz	Tracer		550 yd	Yellow		
	W Mk Iz	AP					Steel Core
	O Mk I	Observer					
Hispano MkI 20mm		Ball					
	Mk Iz	HE	Pentolite				
		HE-T	Pentolite		Red		

Notes

Fill: Ph (Phosph.)

SR379: Incendiary Mixture of Aluminum/Magnesium Alloy and Barium Nitrate - Mg/Al,Ba(NO3)2

Pentolite: 50% PETN and 50% TNT

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

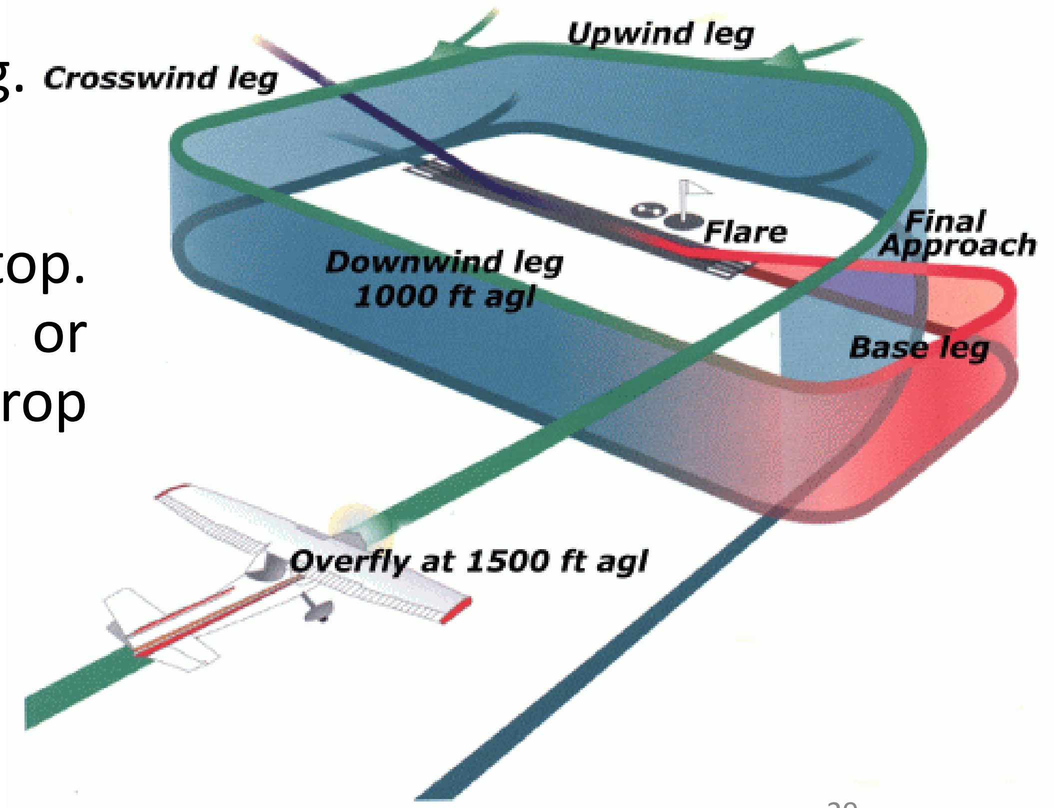
PART 6: TAKEOFF

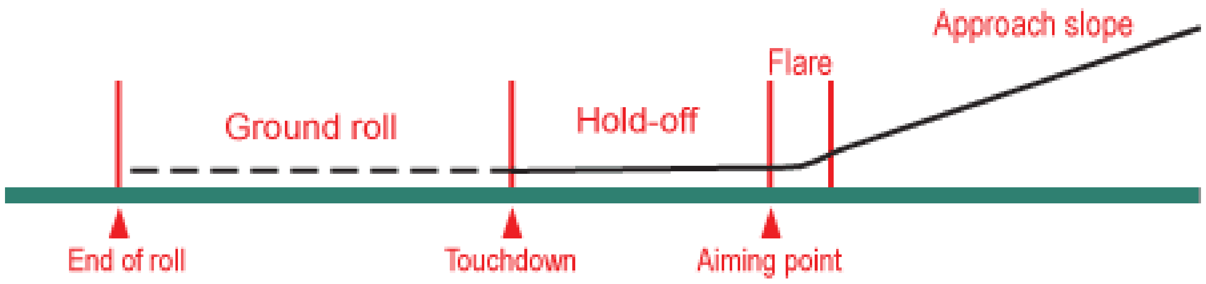
NOTE: This procedure is NOT the real-life start-up procedure, it has been simplified in the sim.

1. Open fuel cock (ON)
2. Ensure that mixture is set to fully rich (by default it is).
3. Set your prop pitch to full fine (100 %).
4. Crack throttle half an inch forward.
5. Water radiator shutter fully open.
6. Turn both magnetos ON
7. Make sure your propeller is clear ("Clear prop!")
8. Engine ignition! (press "I" by default)
9. Wait for oil temperature to reach at least 40 deg C and water rad temperature to reach at least 60 deg C.
10. Taxi to the runway. You can taxi with low oil/water temps without any problem as long as you keep your throttle under 20 %. If you throttle up while your oil is not yet warm, you will hear your engine shake and cough.
11. Make sure you are facing yellow panels on the runway. This means you are facing the right direction for takeoff.
12. Flaps up.
13. Perform last takeoff checks: Canopy Closed, Flaps up, Rad fully open, Full Fine prop pitch, good oil & water rad temperatures.
14. Gradually throttle up. Compensate for engine torque and wind using right aileron and rudder pedals to keep the aircraft straight. Slightly push the control column forward to lift the tail.
15. Rotation is at 110-120 mph.
16. Raise landing gear and set RPM to 2800 max for climb.

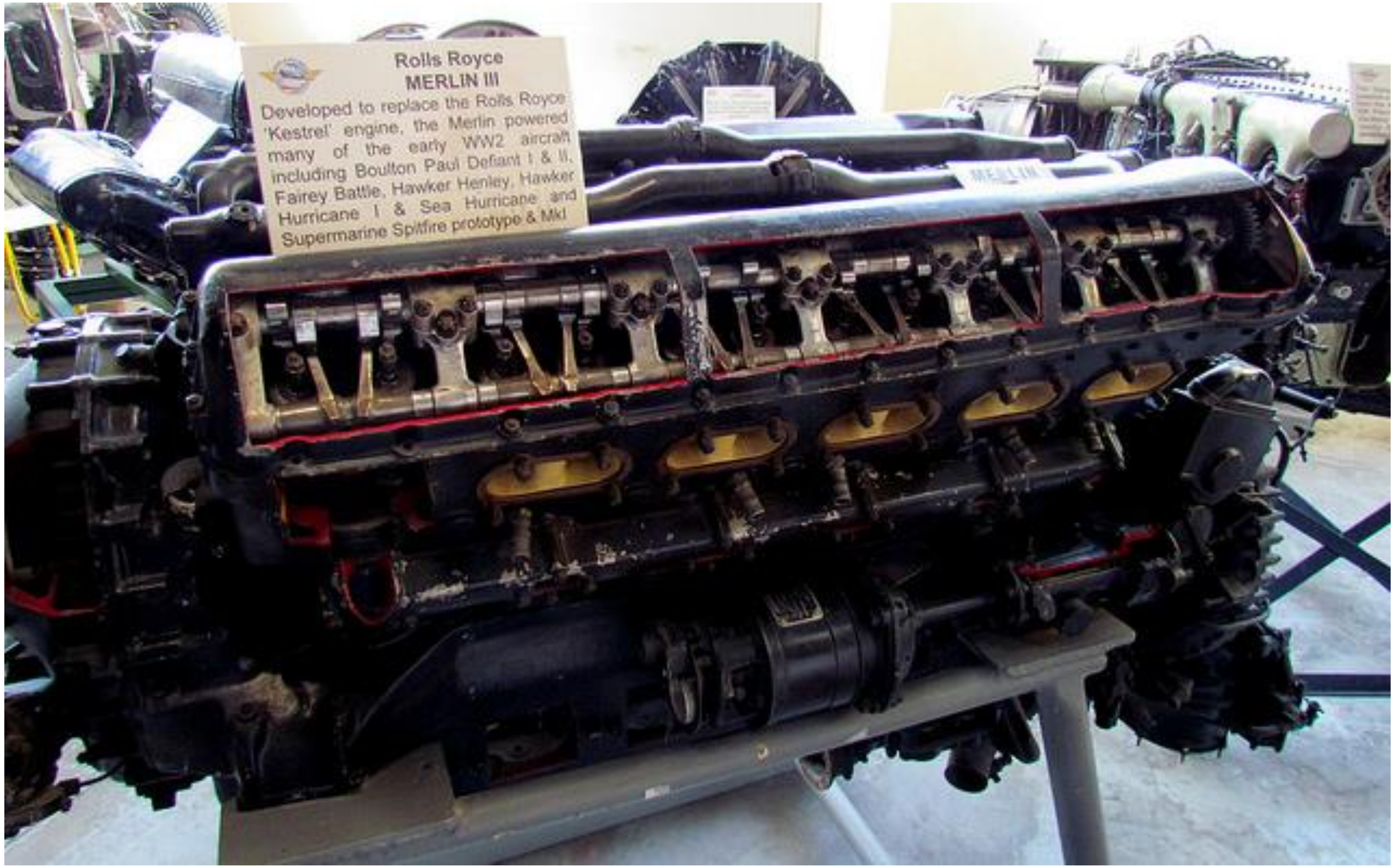
PART 7: LANDING

1. Start your approach at 160 mph @ approx. 1500 ft.
2. Rads fully open (100 %) and RPM set to 3000 (max).
3. Deploy flaps (down) and landing gear.
4. Cut throttle and try to keep your nose pointed to the end of the runway.
5. Touchdown at 90 mph in a 3-point landing.
6. Stick 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



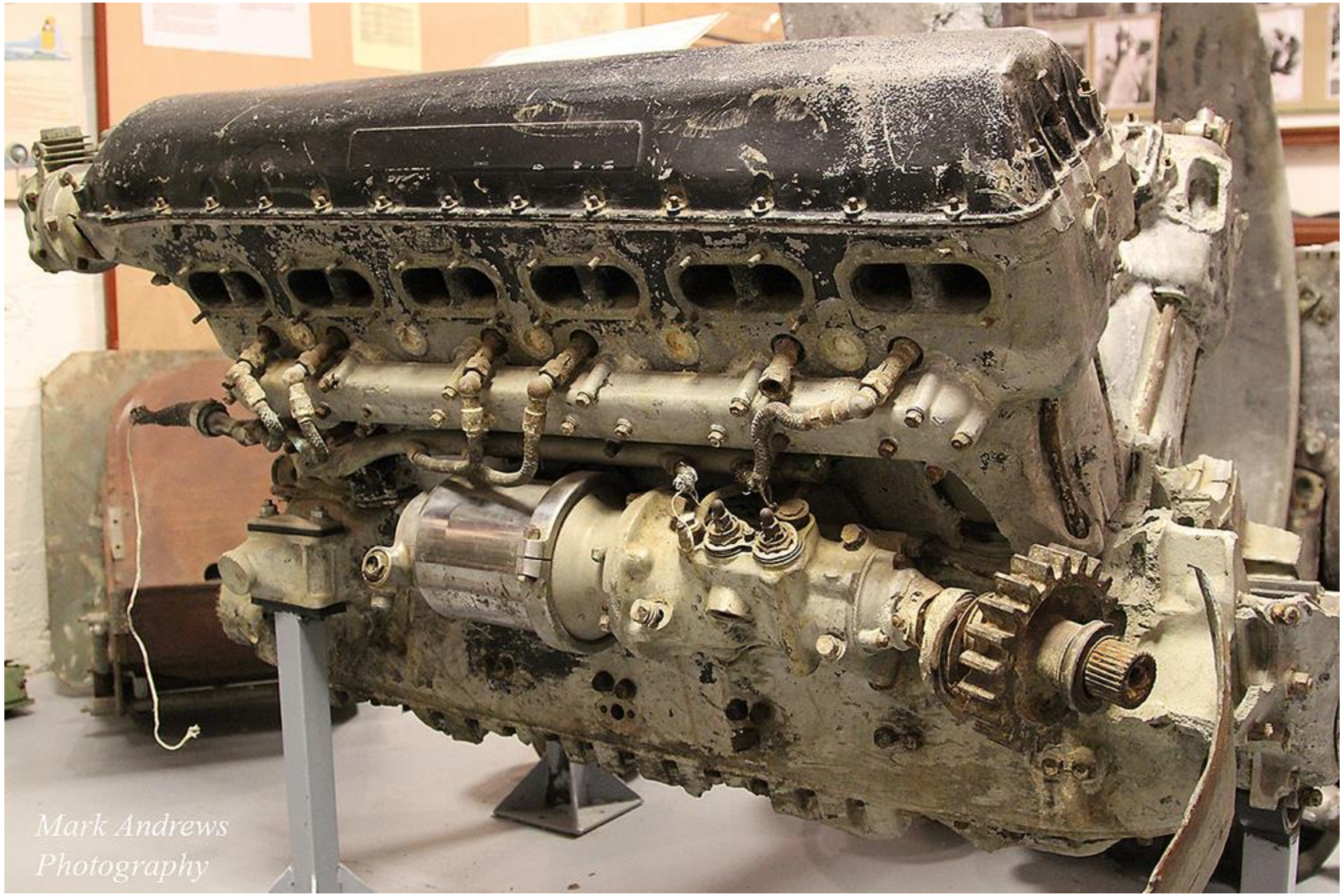
MERLIN III

Like the Merlin II, the Merlin III was originally built to run on 87 octane Fuel. It had a number of improvements to engine reliability over the Merlin II, and therefore was more capable of sustaining the high power generated at +12 boost, but still needs to be treated with care. Like the Merlin II, Pilots should be cautious of using +12 boost and 3000 rpm with the Merlin III except in all out high speed level flight. Use of these ratings in low speed maneuver or steep low speed climbs will cause rapid overheating.

MERLIN II

Both the Spitfire I and Hurricane I DH5-20 are equipped with the Rolls-Royce Merlin II engine, which is an earlier version of the Merlin III. This engine is slightly less refined than the Merlin III and is more prone to overheat and damage when stressed. Pilots need to be aware of their limits. The Merlin II was originally built to run at a maximum of +6 boost Manifold pressure on 87 octane gasoline, but advances in Gasoline refining technology produced 100 octane gasoline in time for the Battle of Britain. With 100 octane fuel, the Merlin II was capable of +12 boost pressure and greatly improved horsepower. However, as mentioned, this is an older generation engine, and needs to be treated with care when using high boost and rpm.

PART 8: ENGINE MANAGEMENT



The supercharger on the Merlin II and III were not capable of achieving full +12 boost to their original 16,250 ft Full Throttle Height. While nominally the Merlin II and III on 100 octane have ratings of 1310 hp, that is only achieved to a Full Throttle Height of 10,500 ft. By 16,250 ft, both engines are rated at 1030 hp, and from that altitude up, their performance is no better than an 87 octane fueled Merlin III.

MERLIN XII

The Merlin XII was a newer generation of engine, and had a number of important improvements.

First, it was designed to run on both 87 and 100 octane fuel, and was a stronger and more durable engine. Second, while has a lower maximum horsepower rating of 1175, it was capable of sustaining 1090 hp up to its Full Throttle Height of 17,550ft. Third, and very importantly, the Merlin XII had a newer design Radiator and cooling system, which was fully pressurized, an advantage over the partially pressurized Merlin III or the unpressurized Daimler Benz engines. The Merlin XII used a more efficient mixed glycol/water coolant system, compared to the full glycol systems of the earlier Merlin and the Daimler Benz. As a result, the Merlin XII is capable of maintaining +9 boost and 2850 rpm for 30 minutes. The limit for the Merlin II and III using 100 octane is 2700rpm and +6 boost for 30 minutes.

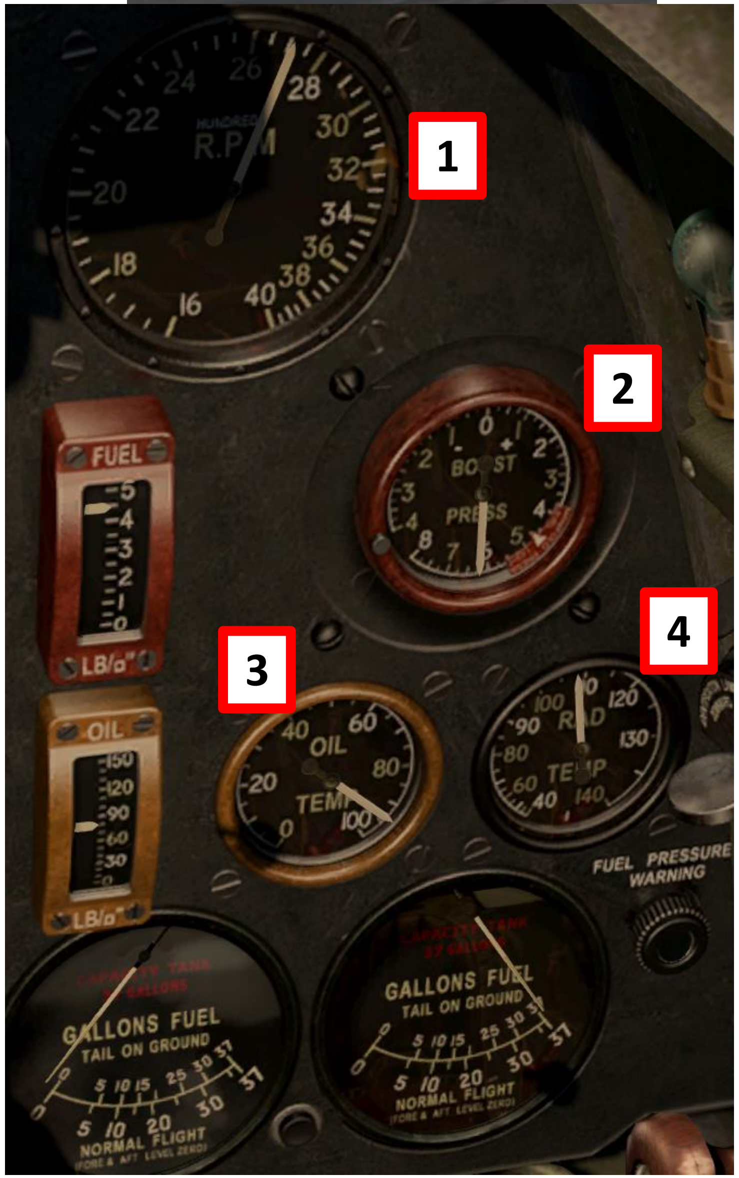
PART 8: ENGINE MANAGEMENT

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) shows 2700 RPM. The boost (2) reads +6 lbs/in^2 (psi). The radiators can be approximated from the lever position or read from the info window in %
    (100 % = fully open).
  - The resulting RPM is affected by both boost pressure and prop pitch (5).
  - Water Radiator settings:
    - 70 % during normal operation
    - 70+ % during combat
    - 40-50 % over 20,000 ft during cruise
    - 100 % during takeoff & landing

	(Unit)	SPITFIRE MK I	SPITFIRE MK I 100 OCT	SPITFIRE MK IA	SPITFIRE MK IA 100 OCT	SPITFIRE MK IIA
TEMPERATURES						
Water Rad Min Max	Deg C	60 115	60 115	60 115	60 115	60 130
Oil Rad (OUTBOUND) Min Max	Deg C	40 95	40 95	40 95	40 95	40 100

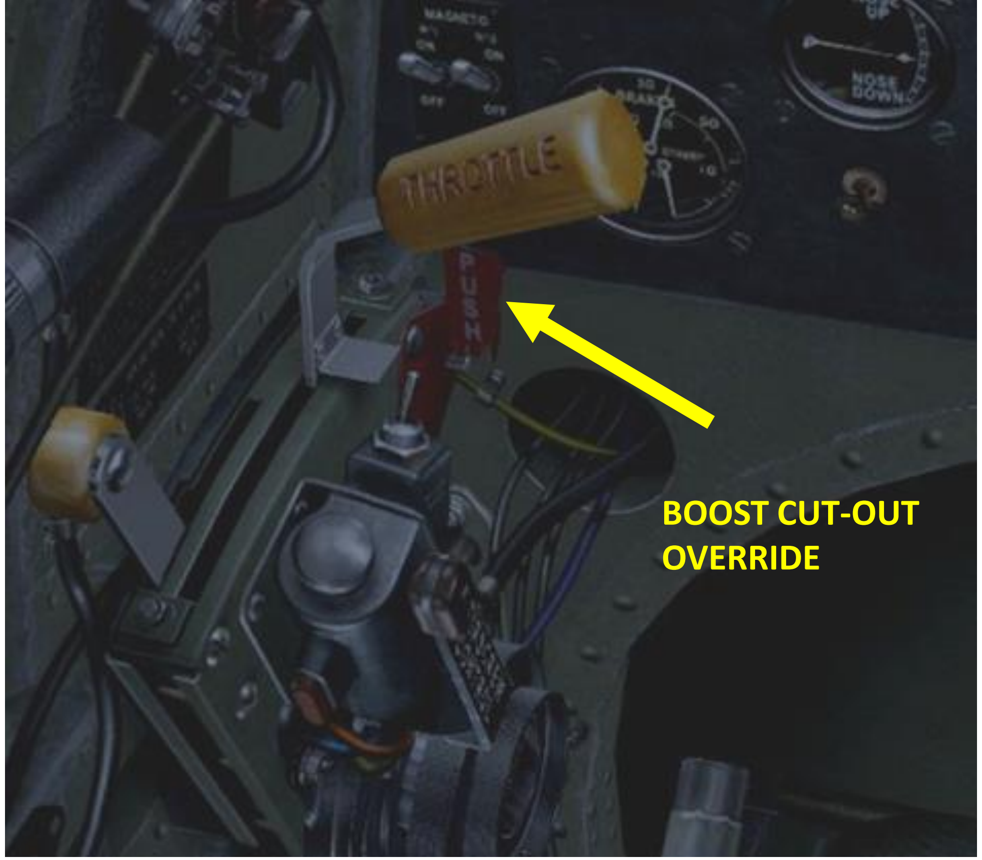


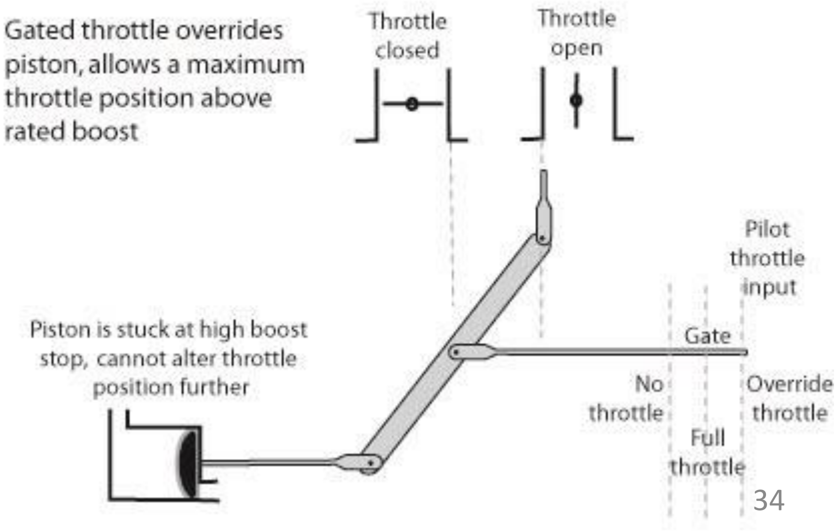
Boost cut-out override (BCO)

The Boost control override did not originate as an emergency power setting, but was adapted to be so by the British. In original form, it was just a way of disabling the boost controller in case of malfunction, thus making the system directly link the pilot handle to the throttle valve and giving him the ability to set any boost the supercharger was capable of (but without control, boost would change with altitude).

CloD shows the Spitfire red tab rotating a little cam allowing the throttle handle to go further, which is not the actual case and confuses the red tab with the throttle gate which appears as an additional overboost system on the (reality) Spit II. In fact the red tab in Spit I/II pulled a cable which opened a channel around the valve, which applied suction to the valve piston and forced it to the right in Figure 1 and stay there, thus disabling the controller. The Hurricane is correct in that the red tab is replaced by a knob that pulls the cable (the "tit").

Although it is hard to find references on this, it is easy to see how the BCO could become an unofficial emergency power switch. A pilot could pull it and try for a bit more boost than the rated 6.25 psi, and hopefully get a bit more power without damaging the engine.





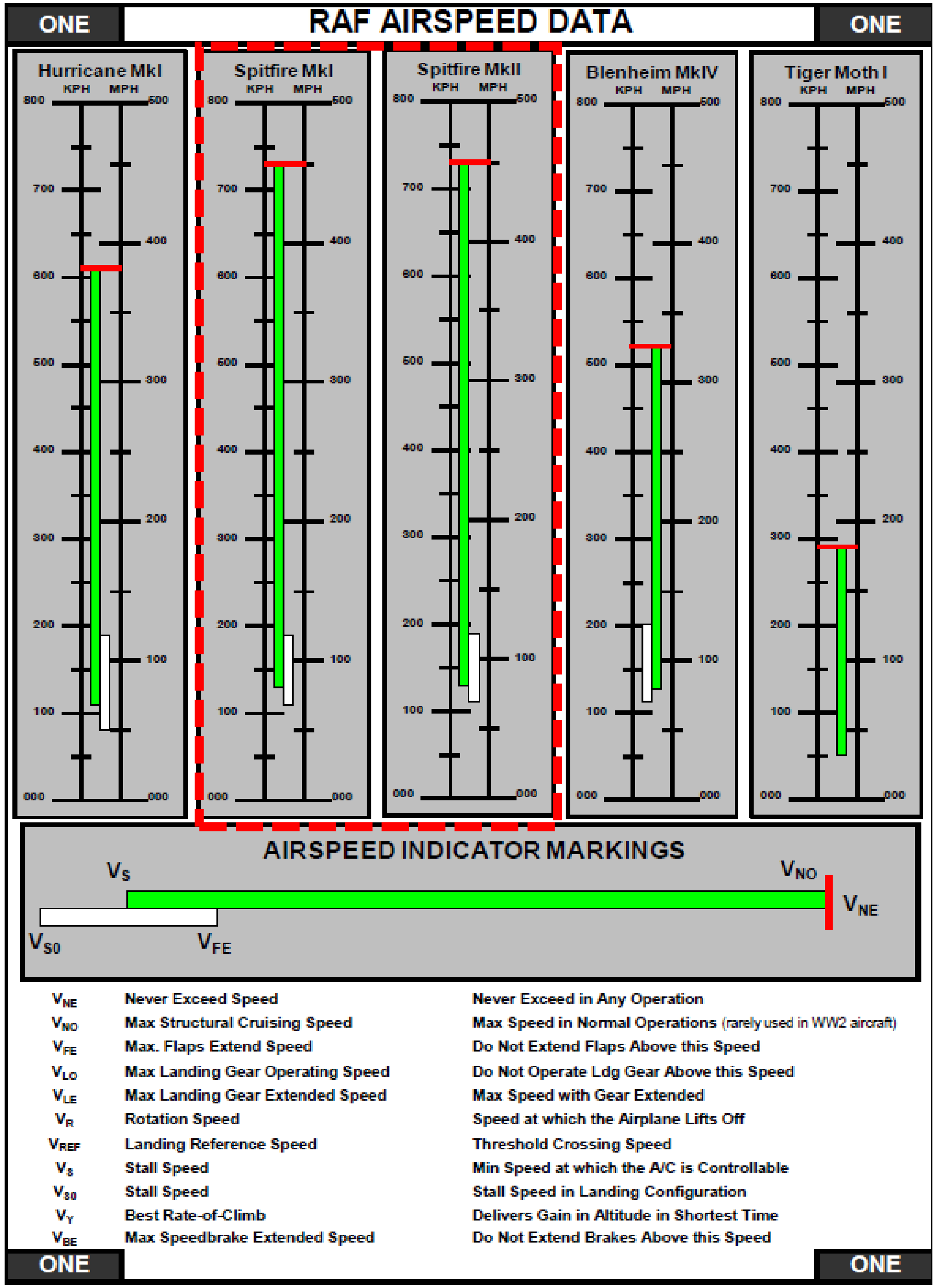
PART 9: AIRCRAFT PERFORMANCE

AIRSPEEDS

Takeoff – Rotation	UK: mph GER/ITA: km/h	120
Max Dive Speed		420
Optimal Climb Speed		165
Landing – Approach		160
Landing – Touchdown		90

- In comparison to the Bf.109, the Spitfire has a better turn rate. However, the Bf.109 has a superior climb rate and dive speed. The preferred way of fighting the 109 is when you have an altitude advantage.
- The Spitfire has better performance at higher altitudes (over 20,000 ft) than the 109. Use this to your advantage.
- 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	Spitfire Mk I		ONE
Aircraft Type	**Engine & Prop**	**Fuel**	**Reference**
Spitfire Mk Ia	Merlin III / Rotol CSP	87/100 Oct	Pilot's Notes: AP 1565A; Date

AIRSPEED LIMITATIONS

	Design Speeds	MPH	
V_{NE}	Never Exceed Speed	450	Never Exceed in Any Operation
V_{FE}	Max. Flaps Extend Speed	140	Do Not Extend Flaps Above this Speed
V_{LO}	Max Landing Gear Operating Speed	160	Do Not Operate Ldg Gear Above this Speed
V_{LE}	Max Landing Gear Extended Speed	NA	Max Speed with Gear Extended
V_{R}	Rotation Speed	NA	Speed at which the Airplane Lifts Off
V_{REF}	Landing Reference Speed	NA	Threshold Crossing Speed
V_{S}	Stall Speed	79	Min Speed at which the A/C is Controllable
V_{S0}	Stall Speed	71	Stall Speed in Landing Configuration
V_{Y}	Best Rate-of-Climb	160	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	MPH Range	Description
White Arc	71 - 140 MPH	Full Flap Operating Range. Lower Limit is Max. Weight V_{S0} . Upper Limit Max Speed w/Flaps Extended.
Green Arc	79 - 450 MPH	Normal Operating Range. Lower Limit is Max. Weight V_{S} . Upper limit Is Max Structural Cruising Speed.
Red Line	450 MPH	Maximum Speed for ALL operations.

ONE	Spitfire Mk II		ONE
Aircraft Type	**Engine & Prop**	**Fuel**	**Reference**
Spitfire Mk II	Merlin XII / Rotol CSP	87/100 Oct	Pilot's Notes: AP 1565B; July 1940

AIRSPEED LIMITATIONS

	Design Speeds	MPH	
V_{NE}	Never Exceed Speed	450	Never Exceed in Any Operation
V_{FE}	Max. Flaps Extend Speed	140	Do Not Extend Flaps Above this Speed
V_{LO}	Max Landing Gear Operating Speed	160	Do Not Operate Ldg Gear Above this Speed
V_{LE}	Max Landing Gear Extended Speed	NA	Max Speed with Gear Extended
V_{R}	Rotation Speed	NA	Speed at which the Airplane Lifts Off
V_{REF}	Landing Reference Speed	NA	Threshold Crossing Speed
V_{S}	Stall Speed	79	Min Speed at which the A/C is Controllable
V_{S0}	Stall Speed	71	Stall Speed in Landing Configuration
V_{Y}	Best Rate-of-Climb	160	Delivers Gain in Altitude in Shortest Time
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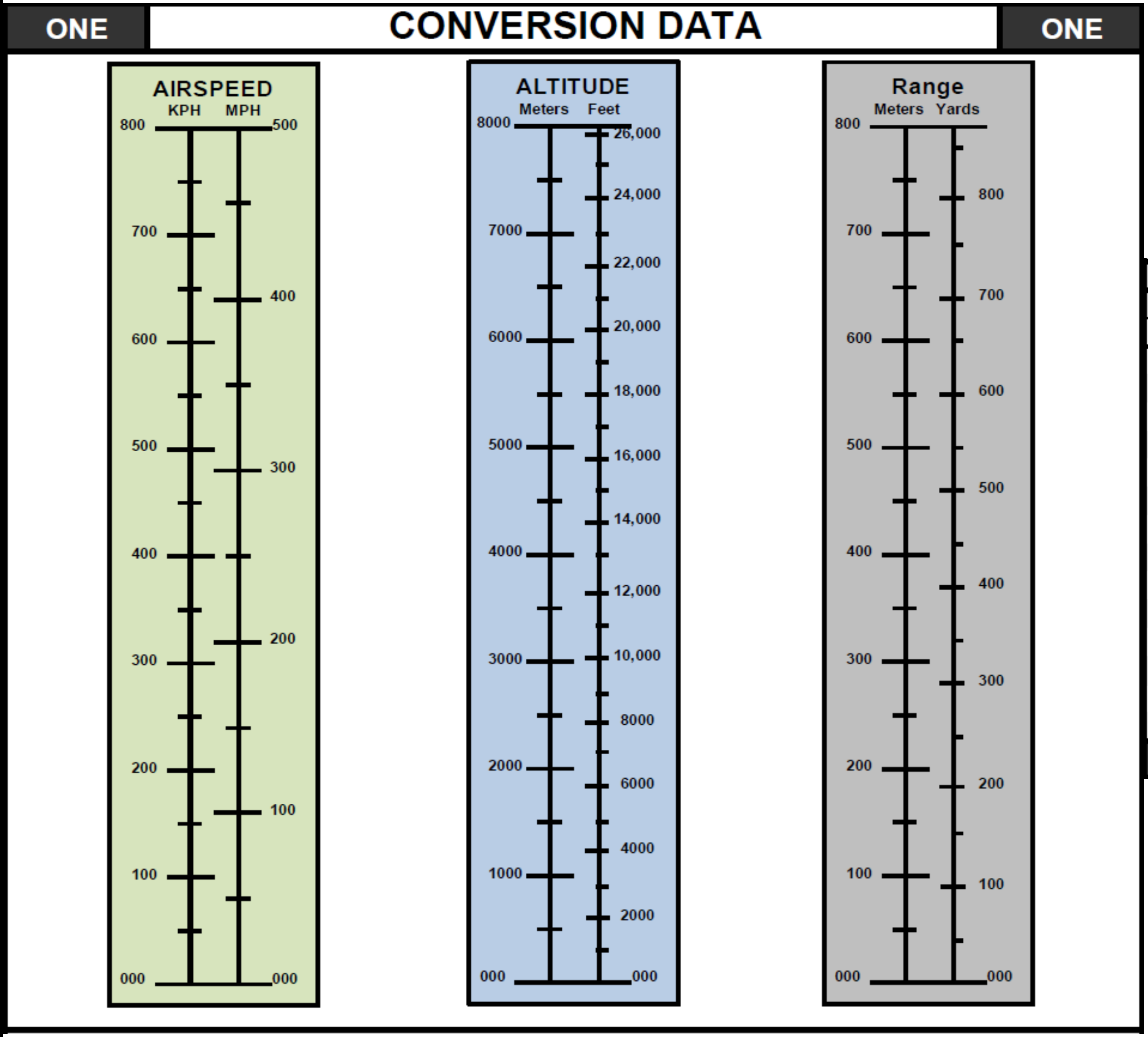
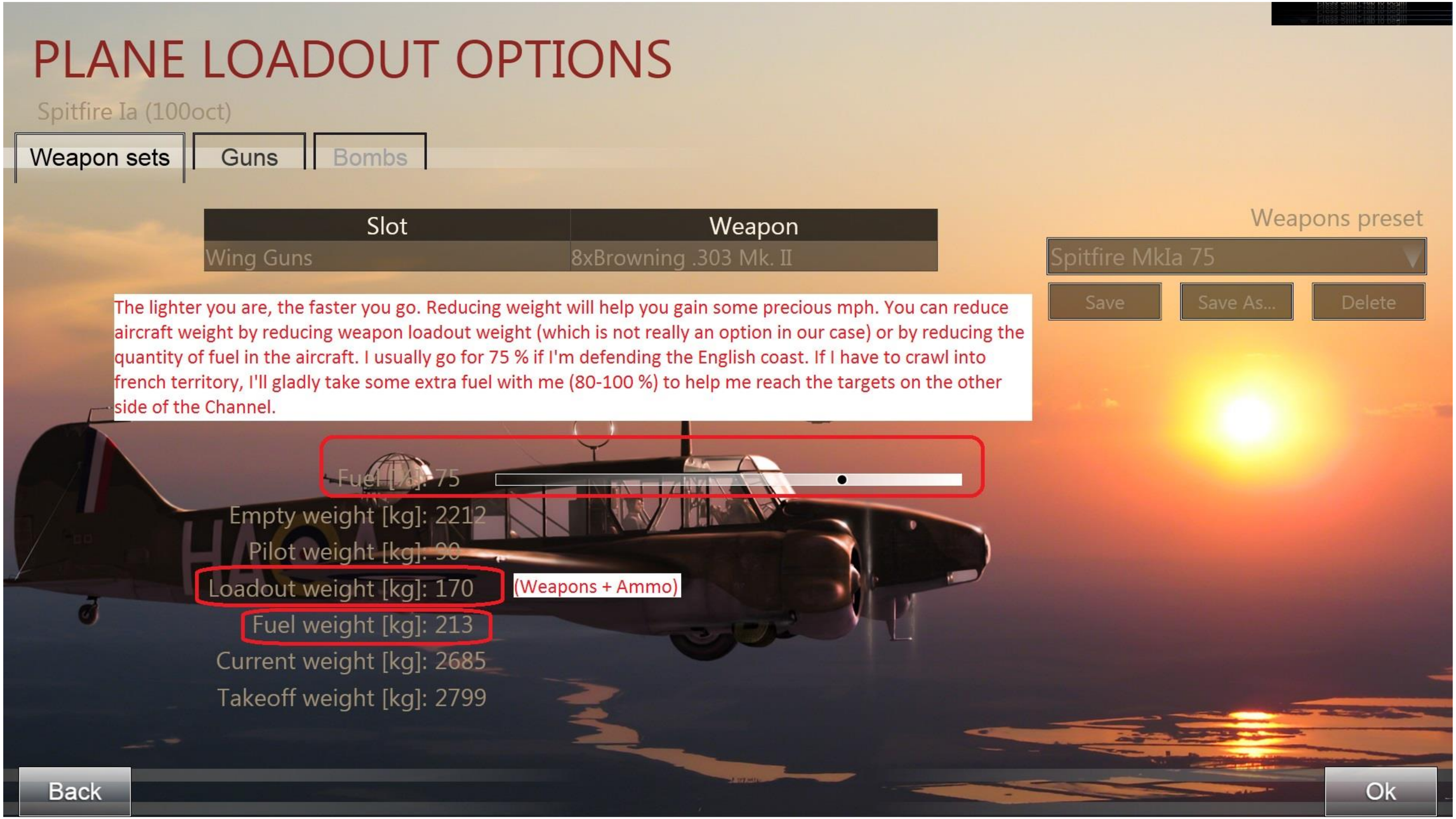
Red Line	450 MPH	Maximum Speed for ALL operations.

PART 9: AIRCRAFT PERFORMANCE

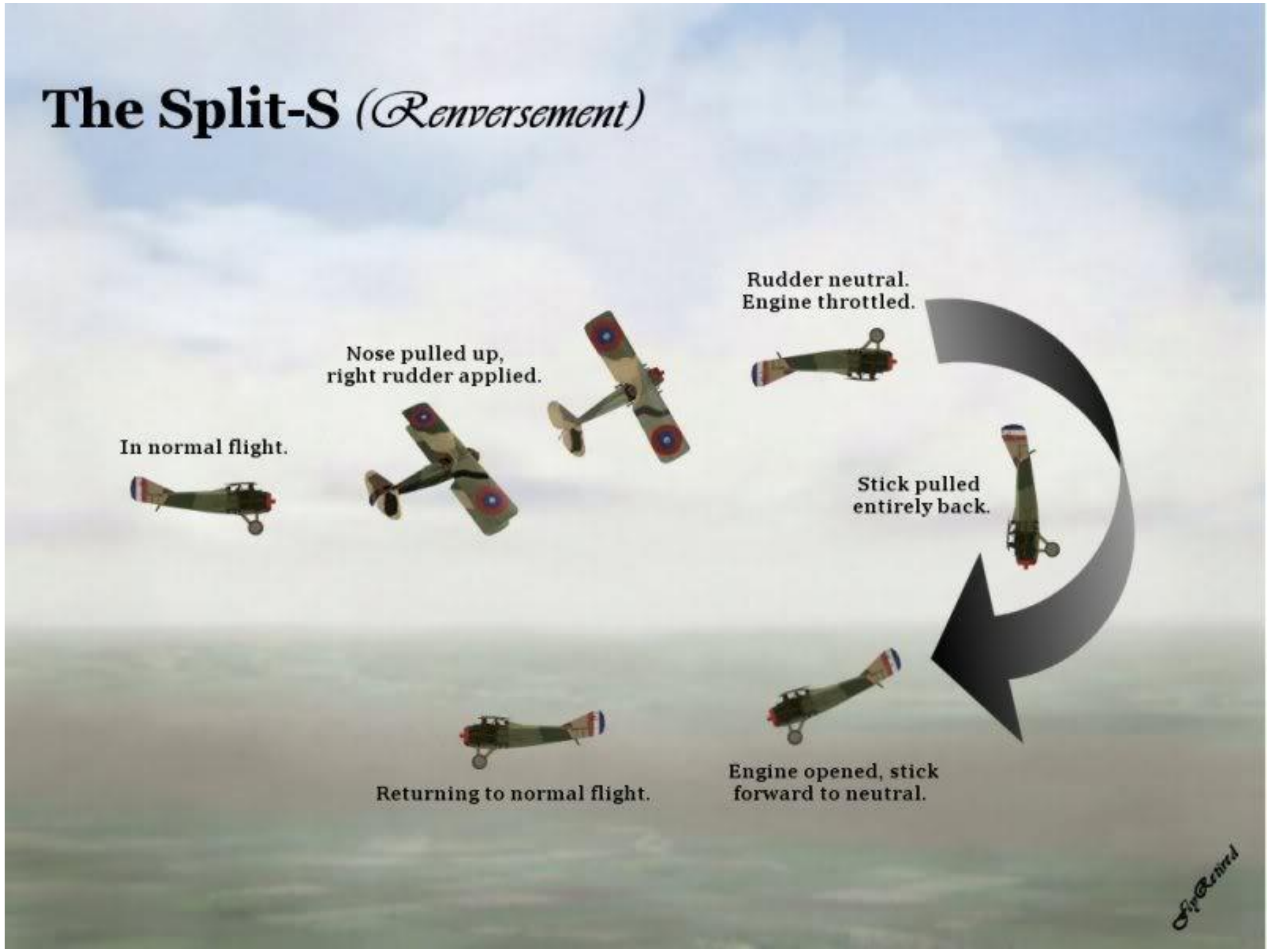


International Civil Aviation Organization International Standard Atmosphere							
Temperature		Altitude Above Sea Level		Atmospheric Pressure			Mach 1
°F	°C	feet	meters	inches Hg	mm Hg	psia	mph
59	15	SL	0	29.92	760	14.70	761
55	13	1000	305	28.86	733	14.17	758
52	11	2000	610	27.82	706	13.67	755
48	9	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 9: AIRCRAFT PERFORMANCE



- If you see a 109 on your tail, do not think: ACT. If you think, you're dead. This is why you need to know instinctively what to do if you have been unlucky enough to be put in that situation.
- Evasive manoeuvers when you have a 109 on your tail are only limited by your imagination. As long as it is unexpected, anything can work.
- Typically, pilots do a half-roll to the right or left and dive down by doing a Split-S.
- The reason for using the Split-S is that it is a positive-G manoeuver. Negative-G manoeuvers are usually avoided by Spitfire pilots (or any pilots flying an aircraft with an early Merlin engine) because the engine tends to cut-out.
- This peculiarity of the Merlin is attributed to the carburetor being starved of fuel during negative Gs (when you push the nose down). You can figure out why by shaking up and down a bottle of water that is half-full. This issue was eventually temporarily addressed in later Merlin variants with "Miss Shilling's Orifice", and later on fixed altogether with fully pressurized carburetors in 1943 .
- Bf.109s did not have this issue since they used direct fuel injection in the Daimler-Benz engines. Therefore power dives were frequently used to escape from Spitfires.



P-8 COMPASS TUTORIAL

- Using the magnetic compass and the gyro is quite useful to know where you are going.
- The gyro indicator itself does not indicate your heading. You need to set it manually in order to translate what the magnetic compass is telling you. You must set up your magnetic compass first by adjusting the "course setter" instrument on top of it, and once you can read your heading from your compass, THEN you set your gyro to reflect the compass' reading. Sounds complicated? It's not. We will see why in the next slide.
- 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 20,000 ft over France.
- 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.

PART 10: COMPASS TUTORIAL

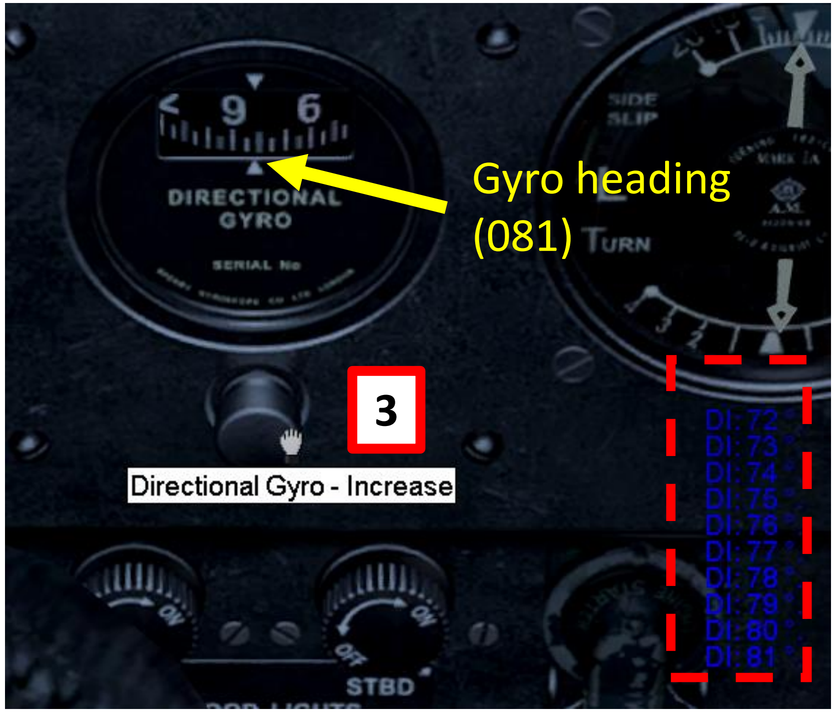
HOW TO SET UP YOUR GYRO & COMPASS

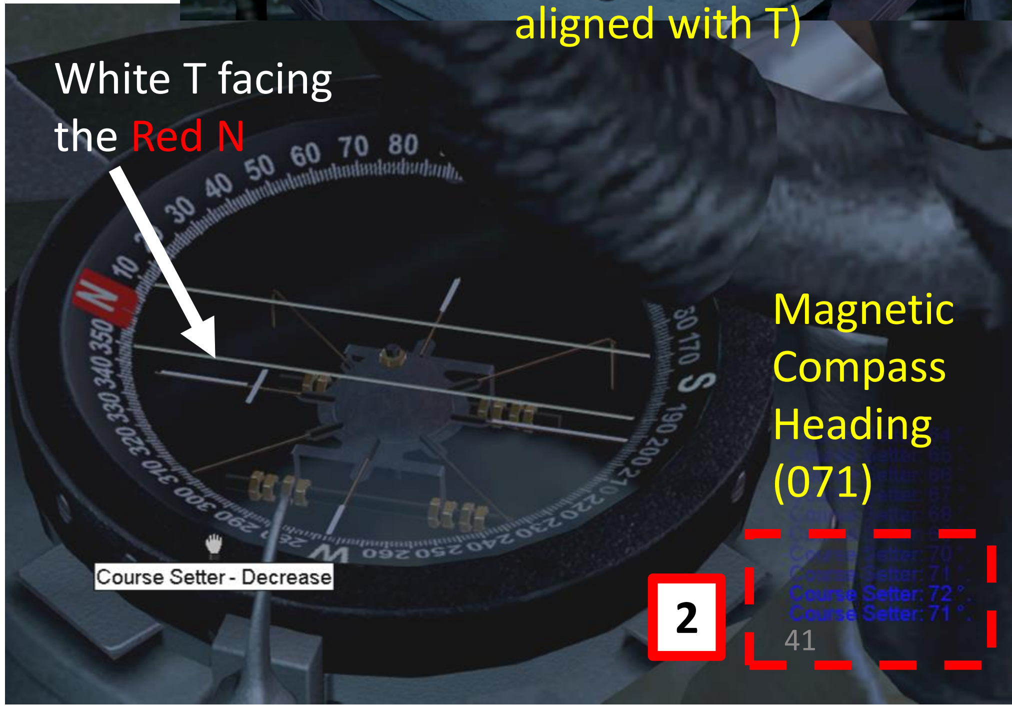
1. The white T on your **P-8 magnetic compass** indicates magnetic North. You always use that as a reference. It is hard to see because of the control column hiding part of it.

2. Align the red N on the white T by clicking on the course setter until both yellow-ish bars are parallel with it the white T. You will obtain a resulting "course" from the course setter (which is the blue text that pops up on your screen). Keep that number in mind. In our case, the number is a heading of 71. However, in order to take into account the effects of magnetic declination, you need to add 10 degrees to get the geographic north. For now, consider that your current heading is 81 degrees.

3. Set your directional **gyro compass** by clicking on the rotary knob to reflect the corrected heading obtained on your magnetic compass. In our case, set the gyro to 081. 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 gyro compass to orient yourself. If your gyro accumulates error after high-G manoeuvers, you can try to re-set it using steps 1 to 3.



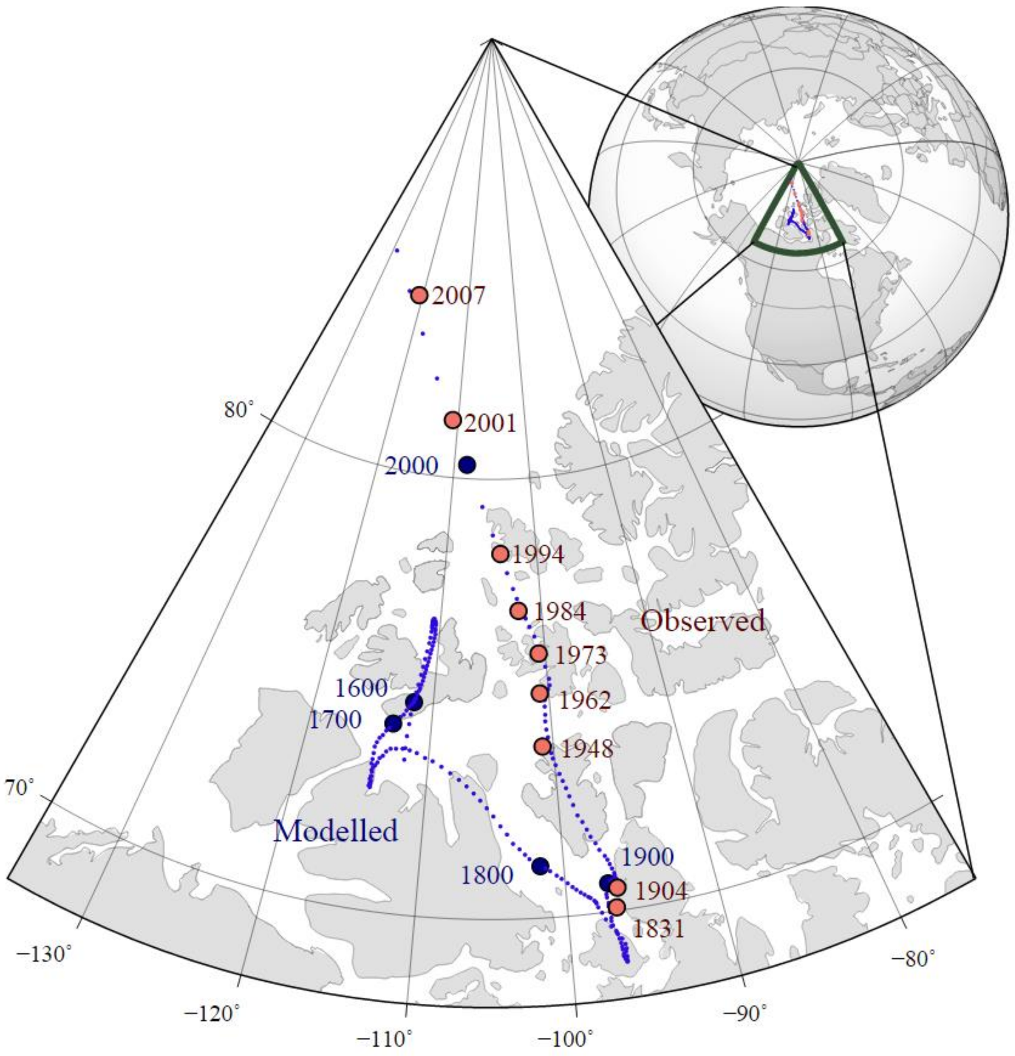


About Magnetic Declination

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.


DW O
L1043
DW K
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