Engine temperature guide for patch 4.11.1

With improved radiator and overheating modelling introduced in 4.11 patch, flying and fighting in Il-2 Sturmovik series has become even more challenging. Virtual pilots, just like their real life WWII counterparts, now have to learn to keep their engines cool.. Engine management was quite complex and very specific to the actual aircraft and / or engine type. Extensive manual has been always issued for the pilots as it was necessary for them to know their aircraft and it's limits in detail. This included the temperature limitations and recommended engine settings for each phase of the flight (e.g. take off, climb, cruise).

Of course, this is not feasible for Il-2, where you can become a pilot of dozens of various planes in any air force involved, all during one evening if you wish. As with many other aircraft systems, temperature management is therefore still simplified - but you will find that very often, you will be able to fly your favourite plane exactly ''by the book''. This is because same principles as in real life now apply for your virtual engine management, if you want to be successful in combat, return in one piece and last but not least - use the same aircraft in your next sortie. Please refer to the 4.11 guide regarding general rules and recommendations concerning new overheating system. You will quickly learn how to manage your engine to keep flying effectively and without 'overheating' HUD message, which is often the only way of seeing that you have exceeded permitted temperature limits and damage is imminent if you don't adjust your settings - be it radiator flaps, RPM or manifold pressure. Now real pilots have had no HUD message reminding them that the running too hot, they had to watch the cockpit instruments closely and constantly. Especially in hot environments like North Africa, the temperature gauges have become the most crucial (and also most watched) instruments in the cockpit. We know how important it is for the pilot to be able to determine the actual temperatures and see how hot his engine is running in every moment of the flight. Therefore, we made sure that all engine temperature related cockpit instruments in 4.11.1 are working correctly. You will be now able to prevent overheating situations completely in every aircraft modelled, and you will be also able to determine, which temperatures limit you're exceeding (e.g. coolant or oil), so you can adjust accordingly. Please refer to the Il-2 Sturmovik aircraft guide to see the exact position of relevant instruments in each and every aircraft.

If you're not entirely familiar with temperature gauges and what they display, please feel free to continue reading this guide. With the amount of flyable aircraft, it is obviously impossible to get into deeper detail, but we hope this general guide will provide you enough information to understand the basics and to be able to read these instruments in any aircraft you come across in the sim:

Coolant Temperature - also referred to as 'water temperature'. This is one of the two gauges to watch in your liquid cooled engines (Mikulin AM-38, Daimler Benz DB605, Rolls-Royce Merlin). Heat produced by the engine is partially absorbed by the liquid circulating through the large metal parts of the engine and then taken away to the radiator to cool down. Cool water then returns to the engine, repeating the process. The pilot could control the coolant temperature by fully opening the radiators flaps (making the cooling process in the radiator more

Various water temperature gauges:

VVS instrument LaGG-3, Il-2 | RAF instrument Spitfire | USAAF instrument P-39, P-40 | Luftwaffe instruments Ju-87, Fw 190D

effective by increasing the amount of cool air flowing through it) or by lowering the manifold pressure (throttle). If you fly full power for longer period of time, you will see your water temperature climb steeply, more so at slow speed, e.g. in a climb. Water temperature gauges usually range from 0 - 140°C with the limit being around 120°C. This is the temperature where your water begins to boil and is no longer effective in taking the heat out of your engine.

Various cylinder head temperature gauges:

Japanese instrument J2M, Ki-84 | RAF instrument Fokker DXXI | Italian instrument Re.2000 | VVS instrument I-15bis | USAAF instrument P4U-1

Cylinder Head Temperature (CHT) **-** this is what the radial engines have got instead of coolant temperature. Radial engines (BMW 801, Pratt & Whitney R-2000, Shvetsov ASh-82, Nakajima Sakae) are air cooled - cylinders are exposed to the flow of cold outside air and the heat produced by the engine is taken away through the cowling flaps. The pilot has control of the CHT by opening or closing these flaps (this is still called 'Radiator' control in Il-2). With the flaps fully open, more air is allowed out to cool the cylinders down. An other way is to reduce CHT is to reduce power i.e. reduce boost/MAP. If you fly full power for longer period of time, you will see your CHT climb steeply, more so at slow speed, e.g. in a climb with radiator closed. The CHT gauges usually range 0 - 350°C with the limit being around 250°C.

Oil Temperature - oil serves as a lubricant in any aircraft engine (radial or inline) and with the metal parts - pistons, cylinders, valves moving fast and touching, the oil between them also absorbs lots of heat. Therefore, engine oil is circulating in similar fashion to the coolant liquid, and is being taken away from the engine into the oil cooler, where its cooled. Cool oil is then brought back to the engine again to serve its purpose. To keep the engine running safely and well lubricated, pilot had to watch his oil pressure and oil temperature - especially with high revs (with engine parts moving at faster pace) the oil temp increases more quickly and can lead

to overheating. Some aircraft (American, German or British) displayed the inlet oil temperature - where the cool oil entered the engine. Some aircraft (Russian for example) had instruments showing the outlet oil temperature from the place, where hot oil was leaving the engine. Some aircraft showed both temperatures as they were both useful to the pilot (e.g. Regianne Re.2000). Please refer to the appendix containing all temperature limitations for every flyable plane in the sim. The values around 100°C are inlet temperatures, the ones you find to be around 120°C are outlet oil temperatures (instruments ranging usually 0-130°C). If you find your oil temperature rising and approaching the limit value, lower your RPM via propeller pitch control.

Various oil temperature gauges:

VVS instrument Yak-7, La-5 | Italian instrument MC.202 | LW instrument Fw 190A | RAF instrument Beaufighter | Japanese instrument Ki-43

General flying tips:

Watch your temperatures all the time, avoid using excessive power settings for longer periods of time. Only stretch your engine when it needs be - at take off, during actual combat. Use maximum permissible climb settings to get to your desired altitude and cool your engine down while cruising. The more headroom you'll have before combat the better - that means that you can fly at full power longer if you need to. Fly fast - the speed of the outside air is helping you to cool down your cylinders or coolant. Fly high - the temperature of the outside air is helping you to cool down your engine, too. Don't underestimate your environment - hot maps make it harder for you to keep your engine cool, as hotter air is cooling your engine. Watch your temperatures at all times and for general advice, please refer to following chapter of this document for temperatures set on various maps in the sim.

I. Assorted list of all in-game maps with their temperatures

Eastern Front:

Bessarabia …..	24°C
Iasi (online) …..	25°C
Odessa (online) …..	20°C
Kurland winter …..	1°C
Kurland autumn …..	8°C
Murmansk …..	1°C
Murmansk summer …..	20°C
Gulf of Finland …..	15°C
Gulf of Finland winter …..	-20°C
Crimea …..	25°C
Kuban …..	24°C
Moscow …..	-17°C
Moscow summer …..	17°C
Kursk …..	20°C
Stalingrad …..	-15°C
Stalingrad summer …..	20°C
Kiev …..	25°C
Lvov …..	20°C
Prokhorovka …..	20°C
Smolensk …..	22°C

European Theater of Operations:

Slovakia summer …..	15°C
Slovakia winter …..	0°C
Norway …..	17°C
NWEurope …..	18°C
Balaton …..	25°C
Balaton winter …..	-5°C
Ardennes …..	23°C
Ardennes winter …..	-5°C
Berlin …..	17°C
Normandy (3 maps) …..	21°C

Pacific Theater of Operations:

Hawaii ….....	25°C
Solomons (6 maps) ….....	23-26°C
Manchuria ….....	22°C
Khalkhin Gol ….....	26°C
Burma ….....	27°C
Singapore ….....	27°C
Midway ….....	25°C
Marianas ….....	26°C
New Guinea ….....	26°C
Chichi Jima ….....	28°C
Guadalcanal (2 maps) ….....	23°C
Tarawa ….....	27°C
Coral Sea ….....	23°C
Iwo Jima ….....	27°C
Okinawa ….....	27°C
Kyushu ….....	25°C
Palau ….....	27°C
Wake Island ….....	27°C

Mediterranean Theater of Operations:

MTO ….....	28°C
Italy (online) ….....	20°C
Desert (online) ….....	28°C

Generic online maps:

Net1, Net2 (summer) ….....	28°C
Net1 (winter) ….....	-17°C
Net2 (winter) ….....	-10°C
Net Islands ….....	17°C
Net 3 (summer) ….....	15°C
Net Mountains ….....	14°C
Net 5 (summer) ….....	12°C
Net 6 Island ….....	15°C
Net 7 Islands ….....	20°C
Net 8 Islands (both maps) ….....	25°C
Sands of time ….....	30°C
Empty 1-4 (summer) ….....	12°C
Empty 1-2 (winter) ….....	-17°C

II. Assorted list of flyable aircraft in Il-2 with respective engine temperature limits.

First figure represents maximum permitted Water temperature (or Cylinder head temperature for radial engines), second figure stands for oil temperature limit. Some aircraft only have temperature stated in which case there is only one temperature gauge. This is also the case for jets and rocket propelled aircraft. British made aircraft show inlet oil temperatures on the respective dial as do German aircraft except for gauges located outside the cockpit - on the engine nacelles.

R.A.F.

Beaufighter Mk.21	230°C / 100°C
Buffalo Mk.I	250°C / 95°C
Corsair Mk.I - Mk.IV	230°C / 100°C
Hurricane Mk.I	120°C / 93°C
Hurricane Mk.II	125°C / 95°C
Mosquito Mk.VI - Mk.XVIII	125°C / 90°C
Mustang Mk.III	125°C / 95°C
P-400	125°C / 95°C
Seafire Mk.III	125°C / 93°C
Spitfire Mk.V - Mk.IX	125°C / 90-95°C
Tempest Mk.V	130°C / 95°C
Tomahawk Mk.II	125°C / 95°C

Luftwaffe

Bf 109E	100°C / 80°C
Bf 109F-G	80°C
Bf 109K-4	115°C / 80°C
Bf 110G-2	115°C / 105°C
Do 335	115°C / 120°C
Fw 190A-F	80°C
Fw 190D	100°C / 80°C
He-111	100°C / 80°C
Hs 129	125°C
Ju 87B-2	95°C / 75°C
Ju 87D-G	120°C / 100°C
Ju 88	120°C / 140°C
Ta 152C	115°C / 120°C
Ta 152H	100°C / 90°C
Ar 234	640°C
Go 229	640°C
He 162	640°C
He Lerche	120°C
Me 163	950°C
Me 262	640°C
Ta 183	640°C

Russian aircraft show oil outlet temperature hence the higher figures. Aircraft showing both inlet and outlet temperatures (Il-10, I-185, Re.2000) have got the outlet (higher) temperature stated in this list. Russian combined jets do have extra figure for EGT limit of their jet engine.

VVS

I-15bis	260°C / 120°C
I-153	240°C / 125°C
I-16 type 5&6	260°C / 120°C
I-16 type 18&24	260°C / 125°C
I-185 M-71	255°C / 125°C
I-185 M-82A	230°C / 125°C
Il-2	125°C / 125°C
Il-4	240°C / 125°C
Il-10	115°C / 125°C
LaGG-3	110°C / 115°C
La-5&7	235°C / 125°C
MiG-3	115°C / 125°C
P-40E M-105	110°C / 90°C
Pe-2&3	110°C / 90°C
Pe-8	115°C / 130°C
TB-7	115°C / 130°C
Yak-1-9	110°C / 110°C
I-250	110°C / 110°C / 700°C
LaGG-3 RD	110°C / 115°C / 1000°C
La-7 R	235°C / 125°C / 650°C
Yak-3 R	110°C / 110°C / 650°C
Yak-15	650°C

Regia Aeronautica Italiana

Cr.42	130°C
G.50	250°C / 130°C
MC.200	250°C / 130°C
MC.202	100°C / 110°C
MC.205	105°C / 110°C
Re.2000	220°C / 120°C
SM.79	110°C

USAAF

A-20	220°C / 100°C
B-25	220°C / 100°C
F2A	250°C / 95°C
F4F	250°C / 95°C
F4U	230°C / 100°C
F6F	240°C / 100°C
P-38	130°C / 95°C
P-39	125°C / 95°C
P-63	125°C / 95°C
P-40	125°C / 95°C
P-47	250°C / 95°C
P-51	125°C / 95°C
SBD	250°C / 95°C
YP-80	800°C

IJAAF & IJNAF

A6M2	250°C / 87°C
A6M3-5	230°C / 90°C
A6M7	230°C / 90°C
D3A1	250°C / 97°C
G4M1	230°C / 87°C
J2M	250°C / 100°C
Ki-27	230°C / 120°C
Ki-43	230°C / 120°C
Ki-61	105°C / 105°C
Ki-84	230°C / 125°C
Ki-100	220°C / 125°C
N1K2	215°C / 95°C

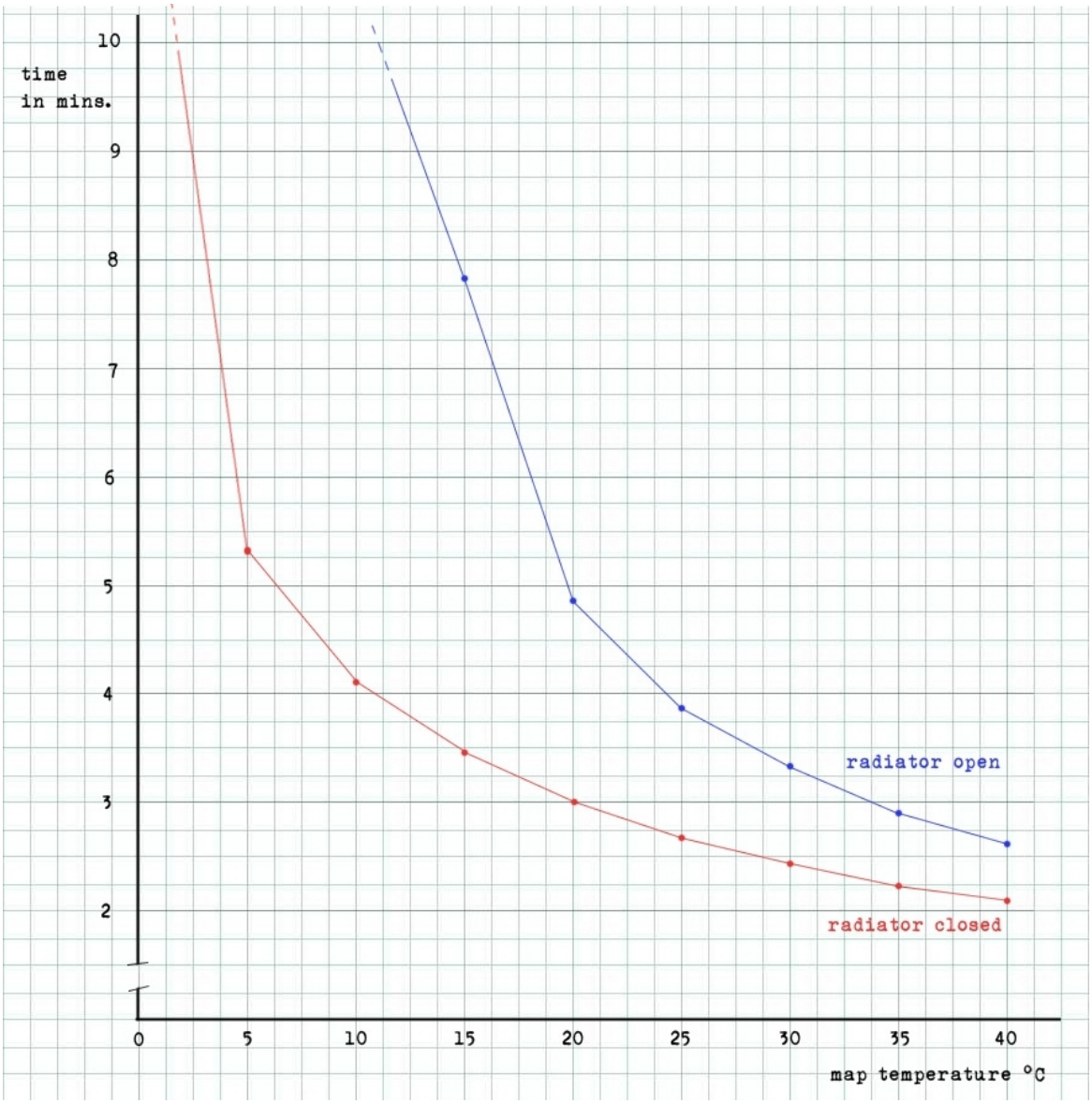
Others

Avia B.534	115°C / 105°C
B-239	250°C / 95°C
CW-21	250°C / 90°C
D.XXI	240°C / 90°C
IAE. 80-81	120°C

III. Appendix A

Graph showing dependency of the map temperature to the time needed to reach limit oil temperature. Aircraft shown is F4U-1A Corsair with Pratt & Whitney R-2800-8W radial engine. Limits for this engine are 230°C CHT and 100°C oil. Oil inlet temperature is displayed on the cockpit gauge meaning that hot oil leaving engine at this point is around 125°C.

Starting on the ground, chocks in. MFP of ‘’41.5 (50% throttle in game) and 2110RPM (100% prop. pitch in game). This way, oil limit temperature was reached sooner than CHT limit temperature. One test performed with cowling flaps (radiator) fully closed, one with flaps fully open. Time from ignition to overheat situation measured and transferred in the chart:



As you can see, aircraft overheats quicker as the outside temperature is rising. Comparing maps with temperature of 10°C and 20°C, you can see that you’re overheating your

engine 25% quicker on the hotter map even with radiator closed. The difference is even more pronounced with radiator fully open as the outside air is helping to cool your engine and moreover, the heat produced by your engine is being let out. Mind you my plane was doing an engine run sitting static on the ground - the cooling effect is obviously depending on your airspeed (the air around my engine is moving faster through my radiator, or as in this case, through my engine cowling) and on your altitude. The higher you fly, the lower the outside temperature.

We hope you'll find this guide helpful and that you'll enjoy more realistic (and therefore more challenging) engine management brought into the sim.

Team Daidalos