# RealEngine v1.1

## *Disclaimer – What RealEngine Does Not Do*

This set of gauges is not intended to exactly replicate how real engine or aircraft systems operate, are damaged, or fail during operation; so please forgive the misleading name… ;-)
This gauge will fail an engine or system, where in the Real World™ these may not be affected at all, or only after hours and hours of abuse, due to safety factors.
So, with that out of the way...

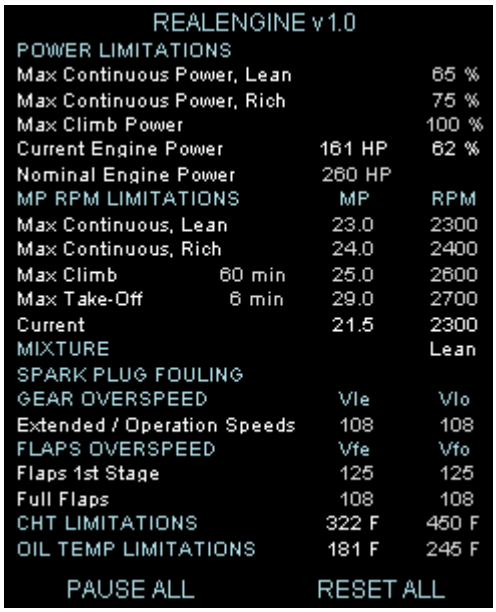
## *What RealEngine Does*

RealEngine will fail aircraft engines and systems if operating limitations/recommendations are exceeded.

I have designed this gauge with the objective in mind to (severely) penalize flying an aircraft under conditions outside of those recommended by the POH. Think of it as a strong incentive to respect the limitations and operating procedures recommended in the POH.
In the real world there is the fear of dying, and the "high cost in hard earned cash" if the aircraft is operated outside of the recommended operating conditions.
I hope to replace these driving forces in the sim by the fear of a failure of the engine or aircraft systems.

### Watch your gauges!

## RealEngine modules




- Engine Power Limitations
  - Simulates damage (first roughness, then failure) to the engine if % power limitations are exceeded.
- Engine MP RPM Limitations
  - Simulates damage (first roughness, then failure) to the engine if MP or RPM limitations are exceeded.
- Mixture State
  - Engine runs rough if mixture is too lean or too rich.
  - Engine can be damaged if mixture is too lean at higher power. High power operations like take-off or climb require rich/full rich mixture to avoid damage to the engine due to overheating or detonation.
- Spark Plug Fouling
  - Simulates power loss due to spark plug fouling if engine is idled for too long. Do a proper run-up!
- Gear Overspeed Failure
  - Generates gear failure if gear speeds are exceeded.
- Flaps Overspeed Failure
  - Generates flaps failure if flaps speeds are exceeded. Asymmetric failure of flaps is modelled.
- Cylinder Head Temperature (CHT) Limitations
  - Generates engine failure if CHT limitations are exceeded.
- Oil Temperature Limitations
  - Generates engine failure if oil temperature limitations are exceeded.

The individual modules will be described in detail later.

## RealEngine can be fully tailored to individual preferences

The modules consist in .xml gauges that are added to the aircraft via the panel.cfg.

- Each module can be installed into an aircraft individually. This allows to only add the modules/failure effects wished for.
- Modules can be turned on/off (paused) from the status panel (temporarily), or in the module's .xml (permanently)
- Operating limitations can be adapted to the aircraft either permanently in the module's .xml gauge, or temporarily through the status panel by click spots.

## *Typical operating procedures for GA piston engine aircraft*

These should keep you flying safe and avoid failures with RealEngine.

Adapted from http://aviationinspection.com/engine-inspections/aircraft-engine-operation/

Starting and Warm-Up

- To minimize spark plug fouling, idle engine at 1000 to 1200 rpm.
- Make a complete run-up, (but keep as brief as possible).
- (Avoid overheating by keeping ground operations to a minimum. Complete run-up into the wind.)
- (Cowl flaps should be open for all ground operations.)

Take-off

- Use full throttle (with few exceptions).
- Mixture full rich, except at high density altitude airports where you should lean as appropriate.
- Retract gear when clear of the ground.
- Retract flaps when clear of obstacles.

Climb

- Reduce to climb power.
- Lean the mixture during climb for smooth operation and increased power above a density altitude of 5000 feet.

Cruise

- Set 65 to 75 percent power for best performance.
- 55 percent power would be typical for good economy and range.
- For best power lean to maximum RPM.
- For best economy lean till engine runs rough, and then enrich slightly.
  Return mixture slowly to full before increasing power setting.

Descent and Landing

- (Reduce power gradually and maintain sufficient power to keep engine temps in the green arc range.)
- (Keep cowl flaps closed.)
- Gradually enrich the mixture for smooth engine operation during descent.
- Extend gear and flaps below Vlo and Vfo speeds only.
- Set mixture to full rich before landing, unless you are landing at a high density altitude airport.

Assure all engine temperatures (CHT, TIT, Oil…) are within the green arc range of engine instruments at all times.

(Bracketed items are not properly implemented due to FS's limited engine temperature simulation.)

## *Installation:*

It is highly likely that the gauge parameters have to be adapted to the aircraft, so it is recommended that the RealEngine folder be placed into the panel folder of the aircraft, and not in the fs gauges folder.

1. **Copy the whole "RealEngine" folder (that contains all RE_ .xml modules) into the "panel" folder of the aircraft.**
   (Example default Beech Baron: fs9folder..\Aircraft\beech_baron_58**panel\RealEngine***.xml files)

   Btw, it does not matter if a "RealEngine" folder is placed in the "gauges" folder as well. When looking for a gauge, the sim will first look in the panel folder of the aircraft for the gauge file, and only if it does not find it there in the main gauges folder.
   Also, no need for cabbing the folder.

2. **Add the following entries in the "panel.cfg" of the aircraft in question:**
   (Example default Beech Baron: fs9folder..\Aircraft\beech_baron_58**panel\panel.cfg**)

   a. At the end of the [**Window Titles]** section at the top of the panel.cfg, as last entry:

      **WindowYY=RealEngine**

      Example: If Window05=... is the last entry in the [Window Titles] section, add Window06=RealEngine .

   b. In the **[Views]** section, add the whole following (long) entry just after the last [Window..] entry:
      i. YY = same number as used in the [Window Titles] section.
      ii. You may want to copy this entry from the RealEngine - Readme v11.txt to avoid issues with line breaks in the pdf document.

```
// ************** RealEngine v1.1 ************

[WindowYY]              // YY= same number as used in the [Window Titles] section.
window_size=0.2 // Panel width in % of screen
size_mm=200,290
position=0
visible=1

// Delete unwanted Failure Modules as needed, or deactivate line by "// ". For multiengine aircraft, delete/inactivate these modules for all active engines.
// Entries for engines not existing should be deleted from the panel.cfg. E.g. for a Twin engine plane delete the Failure Modules and Effects for Engine 3 and 4 from the panel.cfg.
//      No need to remove the .xml files from the RealEngine folder though.
// Verify that all _active_ gauges are sequentially numbered.

// *** Status Panel ***
//      Displays status for engine 1. Beware: Other engines may be less healthy and fail before engine 1!

gauge00=RealEngine!RE1_StatusPanel_v10, 0, 0, 200, 290

// *** Non-Engine Failure Modules ***
```

```
gauge01=RealEngine!RE1_GearOverspeed_Failure_v10, 0, 0, 1, 1
gauge02=RealEngine!RE1_FlapsOverspeed_Failure_v10, 0, 0, 1, 1

// Non-Engine Effects

gauge03=RealEngine!RE1_Effect_AsymmetricFlapsFailure_v10, 0, 0, 1, 1
gauge04=RealEngine!RE1_Effect_HydraulicElectricalFailure_v10, 0, 0, 1, 1

// Sound Effects (currently only flaps and gear failure)

gauge05=dsd_xml_sound3!dsd_xml_sound3, 0, 0, 1, 1, ./Gauges/dsd_xml_sound3_RealEngine_v10.ini

// *** Engine Failure Modules ***

// Engine Time-to-Fail modifier: Makes Engine 2 - 4 fail at different speed - Simulates different health level of the engines.

gauge06=RealEngine!RE2_4_EngineTTFModifier_v10, 0, 0, 1, 1

// Engine 1 Failure Modules
//        Aircraft parameters (limitations, activation of modules, ect) need only to be adjusted for Engine 1. Engine 2 - 4 will pull the Aircraft parameters from Engine 1.

gauge07=RealEngine!RE1_EnginePowerLimitations_EngineRoughnessFailure_v10, 0, 0, 1, 1
gauge08=RealEngine!RE1_EngineMPRPMLimitations_EngineRoughnessFailure_v10, 0, 0, 1, 1
gauge09=RealEngine!RE1_MixtureLeanLimit_EngineRoughness_v10, 0, 0, 1, 1
gauge10=RealEngine!RE1_MixtureRichLimit_EngineRoughness_v10, 0, 0, 1, 1
gauge11=RealEngine!RE1_SparkPlugFouling_PowerLoss_v10, 0, 0, 1, 1
gauge12=RealEngine!RE1_CHTLimitations_EngineFailure_v10, 0, 0, 1, 1
gauge13=RealEngine!RE1_OilTemperatureLimitations_EngineFailure_v10, 0, 0, 1, 1

// Engine 1 Effects

gauge14=RealEngine!RE1_Effect_RandomNumber_v10, 0, 0, 1, 1
gauge15=RealEngine!RE1_Effect_MixtureState_v10, 0, 0, 1, 1
gauge16=RealEngine!RE1_Effect_EngineRoughness_v10, 0, 0, 1, 1
gauge17=RealEngine!RE1_Effect_EngineMaxPowerLoss_v10, 0, 0, 1, 1

// Engine 2 Failure Modules

gauge18=RealEngine!RE2_EnginePowerLimitations_EngineRoughnessFailure_v10, 0, 0, 1, 1
gauge19=RealEngine!RE2_EngineMPRPMLimitations_EngineRoughnessFailure_v10, 0, 0, 1, 1
gauge20=RealEngine!RE2_MixtureLeanLimit_EngineRoughness_v10, 0, 0, 1, 1
gauge21=RealEngine!RE2_MixtureRichLimit_EngineRoughness_v10, 0, 0, 1, 1
gauge22=RealEngine!RE2_SparkPlugFouling_PowerLoss_v10, 0, 0, 1, 1
gauge23=RealEngine!RE2_CHTLimitations_EngineFailure_v10, 0, 0, 1, 1
gauge24=RealEngine!RE2_OilTemperatureLimitations_EngineFailure_v10, 0, 0, 1, 1

// Engine 2 Effects

gauge25=RealEngine!RE2_Effect_RandomNumber_v10, 0, 0, 1, 1
gauge26=RealEngine!RE2_Effect_MixtureState_v10, 0, 0, 1, 1
gauge27=RealEngine!RE2_Effect_EngineRoughness_v10, 0, 0, 1, 1
gauge28=RealEngine!RE2_Effect_EngineMaxPowerLoss_v10, 0, 0, 1, 1
```

```
// Engine 3 Failure Modules

gauge29=RealEngine!RE3_EnginePowerLimitations_EngineRoughnessFailure_v10, 0, 0, 1, 1
gauge30=RealEngine!RE3_EngineMPRPMLimitations_EngineRoughnessFailure_v10, 0, 0, 1, 1
gauge31=RealEngine!RE3_MixtureLeanLimit_EngineRoughness_v10, 0, 0, 1, 1
gauge32=RealEngine!RE3_MixtureRichLimit_EngineRoughness_v10, 0, 0, 1, 1
gauge33=RealEngine!RE3_SparkPlugFouling_PowerLoss_v10, 0, 0, 1, 1
gauge34=RealEngine!RE3_CHTLimitations_EngineFailure_v10, 0, 0, 1, 1
gauge35=RealEngine!RE3_OilTemperatureLimitations_EngineFailure_v10, 0, 0, 1, 1

// Engine 3 Effects

gauge36=RealEngine!RE3_Effect_RandomNumber_v10, 0, 0, 1, 1
gauge37=RealEngine!RE3_Effect_MixtureState_v10, 0, 0, 1, 1
gauge38=RealEngine!RE3_Effect_EngineRoughness_v10, 0, 0, 1, 1
gauge39=RealEngine!RE3_Effect_EngineMaxPowerLoss_v10, 0, 0, 1, 1

// Engine 4 Failure Modules

gauge40=RealEngine!RE4_EnginePowerLimitations_EngineRoughnessFailure_v10, 0, 0, 1, 1
gauge41=RealEngine!RE4_EngineMPRPMLimitations_EngineRoughnessFailure_v10, 0, 0, 1, 1
gauge42=RealEngine!RE4_MixtureLeanLimit_EngineRoughness_v10, 0, 0, 1, 1
gauge43=RealEngine!RE4_MixtureRichLimit_EngineRoughness_v10, 0, 0, 1, 1
gauge44=RealEngine!RE4_SparkPlugFouling_PowerLoss_v10, 0, 0, 1, 1
gauge45=RealEngine!RE4_CHTLimitations_EngineFailure_v10, 0, 0, 1, 1
gauge46=RealEngine!RE4_OilTemperatureLimitations_EngineFailure_v10, 0, 0, 1, 1

// Engine 4 Effects

gauge47=RealEngine!RE4_Effect_RandomNumber_v10, 0, 0, 1, 1
gauge48=RealEngine!RE4_Effect_MixtureState_v10, 0, 0, 1, 1
gauge49=RealEngine!RE4_Effect_EngineRoughness_v10, 0, 0, 1, 1
gauge50=RealEngine!RE4_Effect_EngineMaxPowerLoss_v10, 0, 0, 1, 1

// **************************************
```

3. **For single engine aircraft delete all the lines referring to engine 2 – 4** from the entry just copied into the panel.cfg (see step 2, delete // Failure Modules and // Effects sections for the modules starting with “RE2_” to “RE4_”).
   For multiengine aircraft leave the entries for the respective engines 2, 3 or 4.
   If you want, you can also leave the complete entry from step 2, but that makes FS just execute the additional unnecessary code.

4. **Move the files**
   **”dsd_xml_sound3.gau” and**
   **“dsd_xml_sound3_RealEngine_v10.ini”**
   **from the RealEngine folder into the main fs./Gauges folder** if you want to have sound effects active (gear/flaps failure sounds only). No need to overwrite if you already have dsd_xml_sound3.gau in the gauges folder.

5. Eventually **delete/deactivate modules/effects** that you don't want. See below.

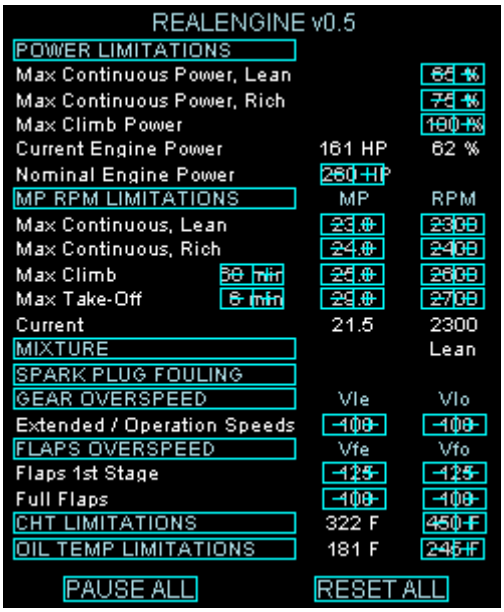
6. You can then **edit the individual modules' .xml files** in the RealEngine folder to reflect the limitations of the particular aircraft. See below.

   The following modules typically need adjustment:
   - Engine Power Limitations (Engine Power HP is critical!)
     RE1_EnginePowerLimitations_EngineRoughnessFailure.xml
   - Engine MP RPM Limitations
     RE1_EngineMPRPMLimitations_EngineRoughnessFailure.xml
   - Gear Overspeed
     RE1_GearOverspeed_Failure.xml
   - Flaps Overspeed
     RE1_FlapsOverspeed_Failure.xml

7. Start the sim…
   **Cycle to the 2D panel** after loading the aircraft.
   After loading the aircraft the failure effects will only become active after the failure module gauges have been open in the active window. By default the failure modules and the status panel are open in the 2D panel, so if you fly with the 3D panel, cycle to the 2D panel at least once after loading the aircraft.

Note: Default parameters in the gauges are optimized for the default FS2004 Beechcraft Baron 58, so if you just want to check out RealEngine, follow the installation steps 1 to 4 above, and start a flight with the Baron. No need for parameter adjustment.

## *How to adjust the limitations/parameters*




1. Values can be increased/decreased directly in the status panel (click spots). These adjustments are lost if the gauge is reloaded.
   This allows for easy testing of different values when setting up a new aircraft.
   The modules can also be paused by click spots.

2. To adjust values permanently:
   a. **Open the module's .xml file** in the RealEngine folder in your aircraft's panel folder with Notepad or any simple text editing program (select "Open" dialog from the program_remember to set the file type to "All"). Word is probably not ideal, as it may format according to the xml instructions.

      Note: You need to edit the parameters in the xml modules for Engine 1 only: RE1_...xml. The parameters for engine 1 will be used by the modules for engine 2 to engine 4 for multiengine aircraft.

   b. The relevant parameters are in the upper part of the code.
      Example: "RE1_EnginePowerLimitations_EngineRoughnessFailure.xml"

```
<!-- ////////////////////////////////////////// Aircraft Operation Limitations -

<Element>
      <Select>
      <Value>

            <!-- ///////// Module On/Off /////// -->
                  <!-- Engine Power Limitations ON by default ? -->     1      (L:RI
            <!-- /////// Nominal Engine Power HP - for calculation of % power - **
                  <!-- Rated Engine Power (HP) -->                    260     (L:RI
            <!-- /////// Maximum Cruise Parameters - Continuous Operation /////// -
                  <!-- Max Continuous Power with Lean Mixture (%) -->  65     (L:RI
                  <!-- Max Continuous Power with Rich Mixture (%) -->  75     (L:RI
            <!-- /////// Cruise Climb Parameters - Continuous Operation during Clir
                  <!-- Maximum Climb Power (%) -->                    100     (L:RI
                        <!-- No damage occurs as long as the aircraft is climbing.
```

   c. **Change the parameter to the values appropriate for your aircraft.**
      Depending on your preferences and aircraft, not all parameters have to be changed.

   d. **Save into the RealEngine folder, overwrite.**
      Verify that the extension is .xml; otherwise manually change the extension of the file to .xml.

   e. That's it…

## *What parameters to set*

The POH, if you can find one, should list the limitations and recommended procedures.
Based on the POH you can decide which of the engine failure modules (power/ MP/RPM) best suits the recommendations of the POH.

For the case no POH can be found, I have added typical values to the description of the individual modules that can act as starting values.
These recommendations are mainly based on the following documents:

Lycoming Key Reprints – Operation: Very interesting collection of articles on engine management.
http://www.lycoming.textron.com/support/tips-advice/key-reprints/index.html

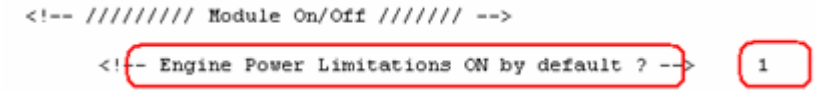
Pilot's Notes General A.P 2095: General aircraft handling notes, required supplement to many WWII POH.

But these are only suggestions, just set the limitations any way you wish and feel comfortable with.
You'll probably have to tweak the values a little to obtain the desired behaviour anyway.

## *How to deactivate modules*

Failure modules can be deactivated in several ways:

1. The module can be paused and unpaused by clicking the hotspot in the status panel.
2. Inactive by default, but possibility to activate from within the status panel:
   Open the .xml file for the failure module (e.g. RE1_EnginePowerLimitations_EngineRoughnessFailure.xml) in the panel/Realengine folder.
   Change parameter "Module ON/OFF" to "0".




3. Complete removal: Delete the entry in the panel.cfg, or transform into a comment with the "// " tag.
   Example: If you want to have only MP and RPM based engine failure, and no failure based on engine power:
   …
   // gauge**01**=RealEngine!RE1_Engine Power Limitations_Engine Roughness Failure_v10, 0, 0, 1, 1
   gauge**01**=RealEngine!RE1_Engine MP RPM Limitations_Engine Roughness Failure_v10, 0, 0, 1, 1
   gauge**02**=RealEngine!RE1_Mixture Lean Limit_Engine Roughness_v10, 0, 0, 1, 1
   gauge**03**=RealEngine!RE1_Mixture Rich Limit_Engine Roughness_v10, 0, 0, 1, 1
   …
   "// " transforms the line into a comment. It will not be read.
   You can also just delete this line.
   **Important:** The following gauges have to be renumbered so that all active gauges are numbered consecutively, starting with "gauge00".

Note: If you only occasionally want to fly with RealEngine, just set the "Module ON/OFF" parameter in all module .xml files to "0" (#2.). You can then activate failure effects by pressing the "Pause All" button.

The following failure effects are implemented by individual .xml modules, and can thus be individually deactivated in the panel.cfg as described above (#3.). You may not like a certain effect, or it may not work satisfactorily – just deactivate it.

- Asymmetric flaps failure (RE1_Effect_Asymmetric Flaps Failure_v10.xml)
- Engine running rough (RE1_Effect_Engine Roughness_v10.xml)
- Lean/Rich/Full Rich effect on engine failure (RE1_Effect_Mixture State_v10.xml)

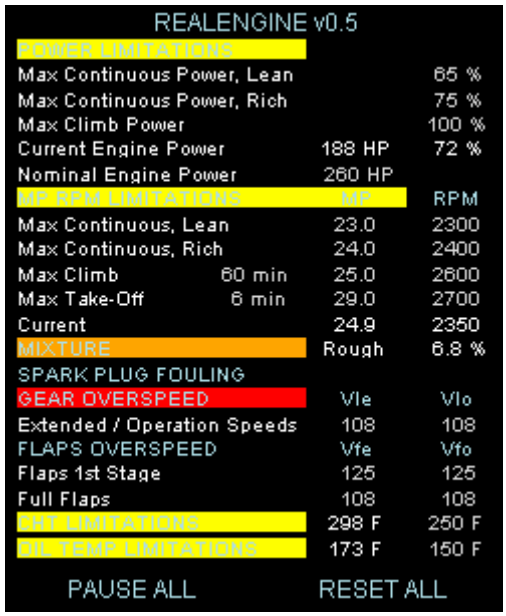
## *Module: Status Panel*

RE1_Status Panel_v10.xml

- Displays limitations and current operating parameters.
- Displays information on the current state of the modules: Failures, warnings, engine damage ect.
- Adjust limitations by click spots (temporarily: parameters will be reset after panel or aircraft reload).
- Pause/unpause execution of individual or all modules (click spots).
- Reset failures for all modules.

However, the goal is to fly the aircraft without the status panel, without failure, according to the POH recommendations…

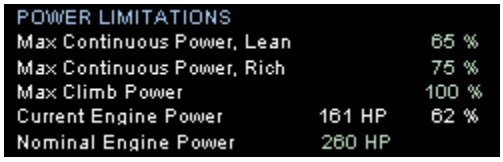
Btw: You don't want to have the panel look like this →…




Notes:

- Displays operating parameters/warnings/failures for engine 1 only. Beware: Other engines may be less healthy and fail before engine 1!
- Pause and Reset actions act on all engines.
- The status panel is not required for execution of the failure modules. If you don't need/want the display it can be deactivated/removed in the panel.cfg.
- You can also access the status panel from the Views menu.

## *Module: Engine Power Limitations*




RE_Engine Power Limitations_Engine Roughness Failure.xml

Simulates damage (first roughness, then failure) to the engine if power limitations are exceeded.

Full Rich Mixture/ Rich Mixture are needed at high power settings (Take-off, Climb, High cruise) to avoid damage to the engine.
* For leaning procedures see separate paragraph on leaning.

Power limitations:

- Maximum Cruise Power Lean: Unlimited operation with best economy mixture.
- Maximum Cruise Power Rich: Unlimited operation with rich/best power mixture, will fail with best economy mixture.
- Maximum Climb Power: Allowed during climb only, requires full rich mixture.
- Take-off: Full power is allowed up to 1000 ft AGL (default) only, then power has to be reduced to climb power. Requires full rich mixture.

The damage model is gradual: If power or mixture limitations are only slightly exceeded, time-to-fail will be longer than if limitations are considerably exceeded.
If the engine is strained for too long, the engine will first run rough/skip, later fail.
If power is brought back within limitations in time the engine (overstress timer) will slowly recover.

Needs the following Modules:

- "RE_Effect_EngineRoughness" to simulate engine running rough if severely strained.
- "RE_Effect_Mixture State" to model lean/rich/full rich limitations.
- "RE_Effect_RandomNumber"

### IMPORTANT PARAMETERS

Nominal Engine Power HP: For calculation of % power

- <!-- Rated Engine Power (HP) --> 230
  - !!! It is essential for correct operation of module that this parameter is adjusted to the Acft engine power !!!

Maximum Cruise Parameters: Continuous Operation

- <!-- Max Continuous Power with Lean Mixture (%) --> 65
- <!-- Max Continuous Power with Rich Mixture (%) --> 75

Cruise Climb Parameters: Continuous Operation during Climb only

- <!-- Maximum Climb Power (%) --> 85
  - No damage occurs as long as the aircraft is climbing.
  - Requires Full Rich Mixture below 5000 ft density altitude or 3000 ft true altitude (whichever is lower), can be leaned to Rich Mixture above.
  - Warning: If the aircraft is not climbing (not gaining altitude), the engine may be damaged at power settings above Max Continuous Power settings!

Take-Off: Full Power is allowed to 1000 ft AGL (default).

  - No damage will be generated up to this altitude during Take-Off.
  - At higher altitude AGL power has to be reduced to climb or cruise power, or damage to the engine may occur.
  - Set Full Rich Mixture below 5000 ft density altitude or 3000 ft true altitude (whichever is lower), can be leaned to Rich Mixture before take-off above.

Time-to-fail if power limitation considerably exceeded, beyond progressive damage range

- <!-- Time-to-fail (min) --> 5

## TYPICAL MAXIMUM POWER SETTINGS

General guidelines from Lycoming technical notes
http://www.lycoming.textron.com/support/tips-advice/key-reprints/pdfs/Key%20Operations.pdf

| | **Normally Aspirated** Fixed Pitch Prop | Variable Pitch Prop | **Supercharged or Turbocharged** |
|---|---|---|---|
| Take-off | Full power | Full power | Full power (max 5 minutes) |
| Climb | 100 % | 85 % | 85 % |
| Cruise Best power | 75 % | 75 % | 75 % |
| Cruise Best Economy | 75 % | 75 % | 65 % |

- For GA piston engine aircraft cruise settings are generally considered to be 55% - 75% of maximum rated engine power.
- Assure that all engine temperatures (CHT, TIT, Oil…) are within the green arc range of engine instruments at all times.

### Cruise power settings chart:

Operating the engine according to power may require you have (make?) a Cruise Power Settings chart – MP/RPM to achieve 55%, 65% and 75% power at different altitudes.

- For a given power several MP/RPM combinations will be possible at a given altitude – use the setting which gives the least vibration and lowest noise.
- Lower RPM may give slightly better fuel economy.
- Every MP value has a minimum allowed RPM setting. Typically lowest RPM recommended for cruise is 2100 – 2200 RPM. Even lower RPM can lead to detonation (not modelled).

LYCOMING MODEL IO-540-K, -L, -M SERIES, 300 HP ENGINE

| Press. Alt. Feet | Std. Temp F | 165 HP - 55% Rated RPM and MAN. Press. | | | | 195 HP - 65% Rated RPM and MAN. Press. | | | | 225 HP - 75% Rated RPM and MAN. Press. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2100 | 2200 | 2300 | 2400 | 2100 | 2200 | 2300 | 2400 | 2200 | 2300 | 2400 |
| SL | 59 | 22.5 | 21.8 | 21.2 | 20.7 | 25.6 | 24.7 | 23.8 | 23.2 | 27.6 | 26.6 | 25.8 |
| 1,000 | 55 | 22.3 | 21.6 | 21.0 | 20.5 | 25.3 | 24.4 | 23.5 | 22.9 | 27.3 | 26.3 | 25.5 |
| 2,000 | 52 | 22.1 | 21.4 | 20.7 | 20.2 | 25.1 | 24.2 | 23.3 | 22.7 | 27.1 | 26.1 | 25.2 |
| 3,000 | 48 | 21.9 | 21.2 | 20.5 | 20.0 | 24.8 | 23.9 | 23.0 | 22.5 | 26.8 | 25.8 | 24.9 |
| 4,000 | 45 | 21.7 | 21.0 | 20.3 | 19.8 | 24.6 | 23.7 | 22.8 | 22.2 | 26.5 | 25.6 | 24.6 |
| 5,000 | 41 | 21.5 | 20.8 | 20.1 | 19.6 | 24.3 | 23.5 | 22.5 | 22.0 | - | 25.3 | 24.4 |
| 6,000 | 38 | 21.3 | 20.6 | 19.8 | 19.3 | 24.0 | 23.2 | 22.3 | 21.7 | - | 25.0 | 24.1 |
| 7,000 | 34 | 21.0 | 20.4 | 19.6 | 19.1 | 23.7 | 22.9 | 22.0 | 21.5 | - | - | 23.8 |
| 8,000 | 31 | 20.8 | 20.2 | 19.4 | 18.9 | - | 22.5 | 21.8 | 21.2 | | | |
| 9,000 | 27 | 20.6 | 20.0 | 19.2 | 18.6 | - | - | 21.5 | 21.0 | | | |
| 10,000 | 23 | 20.4 | 19.8 | 19.0 | 18.4 | - | - | 21.2 | 20.7 | | | |
| 11,000 | 19 | 20.2 | 19.6 | 18.7 | 18.2 | - | - | - | 20.4 | | | |
| 12,000 | 16 | 20.0 | 19.4 | 18.5 | 18.0 | | | | | | | |
| 13,000 | 12 | - | 19.2 | 18.3 | 17.7 | | | | | | | |
| 14,000 | 9 | - | - | 18.0 | 17.3 | | | | | | | |
| 15,000 | 5 | - | - | - | 16.9 | | | | | | | |

## *Module: Engine MP / RPM Limitations*

RE_Engine MP RPM Limitations_Engine Roughness Failure.xml

| MP RPM LIMITATIONS | | MP | RPM |
|---|---|---|---|
| Max Continuous, Lean | | 23.0 | 2300 |
| Max Continuous, Rich | | 24.0 | 2400 |
| Max Climb | 60 min | 25.0 | 2600 |
| Max Take-Off | 6 min | 29.0 | 2700 |
| Current | | 21.5 | 2300 |

Simulates damage to the engine if MP or RPM limitations are exceeded.

The module has MP and RPM limitations for

- Maximum Cruise (Lean/Rich) – Continuous operation
- Climb – time-limited operation
- Take-Off – time-limited operation

Any MP or RPM setting above cruise levels will eventually damage/fail the engine.
Engine runs rough/skips before complete failure.

The gauge has a gradual failure model. Time to fail is dependent on how much the cruise limitations (continuous operation) have been exceeded.

- Engine will fail almost immediately if Max Take-Off MP or RPM are considerably exceeded.
- At Maximum Climb MP/RPM the engine will run for 30 min (default).
- Engine will run for a very long time if cruise settings are only slightly exceeded.

Damage due to too lean mixture is also gradual.

Note: Strain generated on the engine accumulates over time, and does not reset if MP and RPM are returned to cruise parameters, i.e. it is normal that during the flight some “strain” is accumulated.

Needs the following modules:

- "RE_Effect_EngineRoughness" to simulate engine running rough if severely strained.
- "RE_Effect_RandomNumber" required by "RE_Effect_EngineRoughness"
- "RE_Effect_Mixture State" to model lean/rich/full rich limitations.

## IMPORTANT PARAMETERS

Maximum Cruise Parameters: Continuous Operation Limitations

Lean (weak, best economy) mixture limit: Any mixture can be set at MP/RPM below these limitations.

- <!-- Maximum Continuous MP with Lean Mixture (in Hg) --> 22
- <!-- Maximum Continuous RPM with Lean Mixture (rpm) --> 2300

Rich (best power) mixture limit: Engine will be damaged if mixture is Lean.

- <!-- Maximum Continuous MP with Rich Mixture (in Hg) --> 23
- <!-- Maximum Continuous RPM with Rich Mixture (rpm) --> 2400

Maximum Cruise Climb Parameters: Time-limited Operation

- <!-- Climb MP (in Hg) --> 27
- <!-- Climb RPM (rpm) --> 2400
- <!-- Climb Time-to-fail (min) --> 30
    - Requires Full Rich mixture below 3000 ft AMSL/5000 ft dens alt, Rich mixture above.
    - Engine will fail faster if mixture is too lean.

Maximum Take-Off Parameters: Time-limited Operation

1. <!-- Take-Off MP (in Hg) --> 29
2. <!-- Take-Off RPM (rpm) --> 2400
3. <!-- Take-Off Time-to-fail (min) --> 3
    - Requires Full Rich mixture below 3000 ft AMSL/5000 ft dens alt, Rich mixture above.
    - Engine will fail faster if mixture is too lean.

## Suggestions for setting the MP/RPM limitations:

1. Use data from the POH
   Example:
   American P51D Mustang pilot training manual ( http://avialogs.com/ )

**TABLE OF MANIFOLD PRESSURE AND RPM LIMITS FOR FLIGHT**

| | TAKEOFF MAXIMUM | WAR EMERGENCY | MILITARY POWER | MAXIMUM CONTINUOUS | MAXIMUM CRUISE |
|---|---|---|---|---|---|
| MANIFOLD PRESSURE | 61" | 67" | 61" | 46" | 42" |
| RPM | 3000 | 3000 | 3000 | 2700 | 2400 |

- <!-- Maximum Continuous MP with Lean Mixture (in Hg) --> 42
- <!-- Maximum Continuous RPM with Lean Mixture (rpm) --> 2400

- <!-- Maximum Continuous MP with Rich Mixture (in Hg) --> 46
- <!-- Maximum Continuous RPM with Rich Mixture (rpm) --> 2700

- <!-- Climb MP (in Hg) --> 46
- <!-- Climb RPM (rpm) --> 2700

  Climb = Continuous -> no climb limitation

- <!-- Take-Off MP (in Hg) --> 61
- <!-- Take-Off RPM (rpm) --> 3000
- <!-- Take-Off Time-to-fail (min) --> 5

The aircraft will only stand about 5 minutes at take-off power, so you should quickly throttle back to climb.
This also means that there will be some "strain" accumulated on every flight. This is normal, just keep the times straining the engine short.

2. If no POH/information is available on the aircraft a starting point would be to select likely MP/RPM values for continuous/climb/take-off which achieve the engine power % as listed in the table “Typical maximum power settings” in the power limitations section above.
   Or use the “Engine Power Limitations” module right away.

Note: Typically either module “Engine Power Limitations” or “Engine MP / RPM Limitations” will be used for engine limitations, depending on which best suits the operating recommendations for the aircraft, or personal preference.
However, these modules can also both be active, i.e. requiring respecting both power and MP / RPM limitations at the same time.

## *Fuel-Air Mixture Control / Leaning*


### Module: Mixture Lean Limit

RE_Mixture Lean Limit_Engine Roughness.xml

### Module: Mixture Rich Limit

RE_Mixture Rich Limit_Engine Roughness.xml

Engine will run rough/skip if mixture is too lean, or too rich. No damage is generated though. If mixture is returned into the correct range the engine will resume smooth operation.
Lean limit is the mixture setting for best fuel economy (and should be close to peak EGT by default).

Needs the following modules:

- "RE_Effect_EngineRoughness" to simulate engine running rough.
- "RE_Effect_RandomNumber" required by "RE_Effect_EngineRoughness"

Typically the parameters of these modules do not need adjustment.
If you wish to change the performance of these modules though, have a look into the .xml files.

### Module: Full Rich / Rich / Lean (Weak) Mixture State

RE_Effect_Mixture State.xml

This module is needed by other modules to model mixture-dependent engine damage.
Determines whether mixture is Full Rich, Rich or Lean.
If this module is not loaded the mixture will be considered to be “Full Rich”.

Typically the parameters of this module do not need adjustment.

### LEANING INSTRUCTIONS

For Full Rich / Rich mixture, best power:

- Below 5000 ft* density altitude set the mixture lever to full rich (100%) for take-off and climb.
- Above 5000 ft* density altitude, and at any altitude for cruise power settings, the mixture can be leaned until the engine runs smooth.
    - At most, mixture should be leaned to best power
- Leaning for best power:
    - Fixed pitch props: Lean for maximum RPM.
    - Lean for maximum EGT (below lean cont. power), and then enrich for 50 – 100 °F EGT drop.
    - Often you can determine best power by engine sound.
    - Fuel flow meter can help in setting the right mixture as well.
    - May need experimenting. Power is indicated in the Status Panel (Engine Power module).
- FS2004: “Auto-rich” in the realism setting automatically adjusts the mixture for best power.
    - Nevertheless, the mixture lever has to be advanced to 100% (“Full Rich”) for take-off and climb.

For Lean (Weak) mixture, best economy:

- Lean till engine runs rough, then slightly enrich to smooth operation.
- Lean to peak EGT.
- Lean to fuel flow specified in the POH.

* Actually, RealEngine requires full rich mixture for high power operations below 5000 ft density altitude or 3000 ft true altitude AMSL, whichever is lower.
High ambient temperatures increase density altitude.
As a rough guide you can use the following equivalences (for dry air):

>5000 ft density altitude is reached at
> 45 °C at 1000 ft AMSL
> 38 °C at 2000 ft AMSL
> 27 °C at 3000 ft AMSL

Note: The engine may have lower than expected performance if density altitude is higher than true altitude (i.e. air density is lower than expected).

GENERAL RECOMMENDATIONS FOR LEANING

http://aviationinspection.com/engine-inspections/aircraft-engine-operation/
http://www.lycoming.textron.com/support/tips-advice/key-reprints/pdfs/Key%20Operations.pdf
General guidelines from Lycoming technical notes:

| | **Normally Aspirated** | | **Supercharged** | **Turbocharged** |
|---|---|---|---|---|
| | Fixed Pitch Prop | Variable Pitch Prop | | |
| Start and Taxi | Full Rich* | Full Rich* | Full rich | Full rich |
| Take-off | Full Rich* | Full Rich* | Full rich | Full rich |
| Climb | Full Rich* | Full Rich* | As per POH | Full rich |
| Cruise Best power | Lean to maximum RPM | Lean to 100 °F rich of peak EGT | Lean to 100 °F rich of peak EGT | 125 °C rich of peak TIT |
| Cruise Best Economy | Lean till roughness, then enrich till smooth | Lean to peak EGT | Peak EGT, Below 65% | Peak TIT |
| Descent | Lean, rich enough so engine runs smooth | | | |
| Landing | Full Rich* | Full Rich* | Full Rich | Full Rich |

Why Lean?

- Improved engine efficiency.
- Greater fuel economy (i.e., minimum specific fuel consumption) and longer range.
- Smoother engine operation – saves engine accessories and engine mounts.
- Longer spark plug life, less fouling.
- Reduced maintenance costs, reduced operating costs.
- More desirable engine temperatures while operating at cruise altitudes.

When to Lean?

- Lean anytime the power setting is 75 percent or less at any altitude. Damage to the engine will not occur from leaning at these power settings.
- Maximum leaning at higher than cruise power settings can lead to detonation and/or preignition and possible engine failure.
- Return mixture slowly to full before increasing power setting.
- Leaning past peak EGT is not recommended.
- Use of carburettor heat enriches the mixture. Re-lean the mixture after application of carb heat.
- For landings at airports below 5000 feet density altitude, adjust the mixture for descent, but only as required. You can’t go wrong if you keep the engine running smoothly!
- Before entering the traffic pattern, go to full rich.

* Above 5000 ft density altitude, for non-Super/Turbocharged engines:

- At high altitude airports, lean for taxi, take-off, traffic pattern entry and landing.
- Startup and Taxi: Lean at 1000 RPM until RPM peaks, then enrich slightly.
- Before Takeoff: Go to full throttle and lean mixture for smooth operation and increased power.
- Climb:
    - Fixed pitch prop: lean to maximum RPM and then enrich slightly.
    - Variable pitch prop: lean to engine smoothness.
    - With EGT gauge: lean to +100 degrees F. on the rich side of peak (may not be accurate in FS).
- Super/Turbocharged engines typically require Full Rich mixture during take-off and climb.

## *Module: SPARK PLUG FOULING*

SPARK PLUG FOULING

Spark plugs may foul due to carbon or lead deposits if engine is idled for too long (a few minutes).
Leads to loss in maximum power of the engine.

Idle the engine at 1000 – 1200 rpm.
Before take-off perform a proper run-up! This will also clear the spark plugs if they have fouled.

Run-up:

- 1700 rpm, or as recommended by the POH
- Check both magnetos for appropriate RPM drop
- Check prop governor for proper operation (if constant speed prop)
- Check carburettor heat (RPM drop)

Needs the following module:

- " RE_Effect_Engine Max Power Loss_v10.xml"

Typically the parameters of this module do not need adjustment.
However, if the plane can not be idled at 1000 – 1200 rpm, or if the run-up can not be performed at > 1300 rpm, e.g. if brakes are not strong enough, you may want to change the parameters in the .xml.

## AVOIDING SPARK PLUG FOULING

http://www.lycoming.textron.com/support/tips-advice/key-reprints/pdfs/Key%20Operations.pdf

- It is not good practice to idle an engine below 1000 RPM at any time.
- Engines should be idled between 1000 and 1200 RPM. This will also allow for efficient engine warm-up
- Avoid prolonged idling on the ground
- Avoid power-off descents
- Lean out during cruise

If in doubt about the power output, a brief, smooth full throttle check is recommended.

Notes on shock cooling of cylinder heads (not implemented in RealEngine due to poor CHT model, but listed for info).

- Power off let-downs should be avoided to avoid shock-cooling of the cylinder heads.
- CHT change should not exceed 50 °F per minute.
- Shock cooling can lead to spark plug fouling and damage to the engine.
- To avoid shock cooling:
    - Accomplish descent power reduction in several steps
    - Maintain at least 15" MP
    - Set RPM at the lowest cruise position
    - Keep descent to below 1000 fpm
    - Leave mixture lean during descent, and enrich just enough to keep engine running smooth

## *Module: Cylinder Head Temperature (CHT) Limitations*

RE_CHT Limitations_Failure.xml


Simulates engine failure if CHT limitations are exceeded for too long.

Note: The effect of operating conditions (power, cowl flaps, airspeed, mixture, ambient temperature ect.) on CHT seems to be poorly implemented by FS, so this module will probably not help in managing the engine in a very realistic way.
You may test, and if you don't like it, just turn it off.

### IMPORTANT PARAMETERS

- <!-- Max Allowed Cylinder Head Temperature F --> 450
- <!-- Time-to-fail (min) --> 5
  Note: Timer slowly counts down if CHT is within limitations.

http://www.lycoming.textron.com/support/tips-advice/key-reprints/pdfs/Key%20Operations.pdf

### Heat is enemy #1 of the engine

Keep CHT within the green band, typically 150 °F to 500 °F.
Keeping CHT below 400 °F is recommended for best service life.
Control CHT:

- Enrich the mixture
- Adjust cowl flaps
- Reduce power

During climb:

- Climb at higher speed (lower fpm)

On the ground:

- Make runups thorough, but as brief as possible.
- Avoid overheating by keeping ground operations to a minimum. Park and complete runup into the wind.
- Cowl flaps should be open for all ground operations.

## *Module: Oil Temperature Limitations*


RealEngine_Oil Temperature Limitations_Failure.xml

Simulates engine failure if Oil Temperature limitations are exceeded for too long.

### IMPORTANT PARAMETERS

- <!-- Max Allowed Oil Temperature deg F --> 245
- <!-- Time-to-fail if Oil Temp is exceeded (min) --> 5
  Note: Timer slowly counts down if Oil Temperature is within limitations.

http://www.lycoming.textron.com/support/tips-advice/key-reprints/pdfs/Key%20Operations.pdf

Typical green band 120_245 °F (recommended 165° F_220° F).

## *Module: Gear Overspeed*

| GEAR OVERSPEED | Vle | Vlo |
|---|---|---|
| Extended / Operation Speeds | 108 | 108 |

RE_Gear Overspeed_Failure.xml

Generates gear failure if Vle (gear extended) or Vlo (gear operating) speeds are exceeded.

The module actually generates a complete failure of the hydraulic and electric systems.
Unrealistic I know, but let's say the hydraulic lines rupture due to the gear stress, stuff starts to fly around, and creates a short in the electrical system.
Now, this should get the pilot's attention ;-)
Make sure you know how to extend that gear manually.
Note: The flaps will not be operational either…

Needs modules
"RE_Effect_HydraulicElectricalFailure".

### IMPORTANT PARAMETERS

Gear Limitations

- <!-- Maximum Gear Extended Speed Vle (KIAS) --> 108
- <!-- Maximum Gear Operation Speed Vlo (KIAS) --> 108

## *Module: Flaps Overspeed*

| FLAPS OVERSPEED | Vfe | Vfo |
|---|---|---|
| Flaps 1st Stage | 125 | 125 |
| Full Flaps | 108 | 108 |

RE_Flaps Overspeed_Failure.xml

Generates gear failure if Vfe or Vfo are exceeded.

The module actually generates a complete failure of the hydraulic and electric systems.
Note: The gear will not be operational either…

Flaps failure may also be asymmetric.

- You absolutely need pedals or at least a twist handle joystick to survive this. More a gimmick than realistic I believe. If you don't like it just deactivate the module Effect_Asymmetric Flaps Failure_v10 in the panel.cfg.

Needs modules
"RE_Effect HydraulicElectricalFailure"
"RE_Effect_Asymmetric Flaps Failure_v10.xml" Required for asymmetric flaps failure.

### IMPORTANT PARAMETERS

Flaps Limitations

- <!-- Maximum Flap Extended Speed: Stage 1 Vfe1 (KIAS) --> 140
- <!-- Maximum Flap Extended Speed: Full flaps Vfe2 (KIAS) --> 95

- <!-- Maximum Flap Operation Speed: Stage 1 Vfo1 (KIAS) --> 140
- <!-- Maximum Flap Operation Speed: Full flaps Vfo2 (KIAS) --> 95

## *Troubbleshooting*

1. Whole or parts of the status panel are blank.
   Verify the entries in the panel.cfg are exactly as they should be:
   a. Best is you copy the [Window Titles] and [Window**YY**] entries from the readme.
   b. Check that the numbering of [Window Titles] Window**YY**=RealEngine… and [Window**YY**] entries are the same and consecutive with other gauges.
   c. Check active gauges in the [Window**YY**] entry are numbered consecutively.
2. Plane starts with engines off when it should be on, or does not start.
   Try the following:
   a. Try an engine start
   b. At high (density) altitude airports pull back the mixture lever some before starting.
   c. Look in the aircraft Realism Settings/Failures (Alt – Menu Aircraft/Realism/Failures) if engine failure is turned on – turn off and restart. Sometimes that seems to happen.
   d. Reload the aircraft
   e. Reload the flight
3. Plane does continue to spin to the ground after an asymmetric flap failure, although you have hit the reset button in the status panel.
   That's the way it is. Tough world. Don't fail your flaps. ;-)

## *Miscellaneous*

- The modules have been developed and extensively tested with FS2004, but work in FSX as well.
- Most modules of RealEngine only work with piston engine aircraft.

## *Credits*

- Doug Dawson: Freeware Sound Gauge_dsd_xml_sound3.gau (dsdxmls3.zip at flightsim.com) for flaps and gear failure sounds.
- Asymmetric flaps failure: Idea by A2A Accusim.
- Power loss effect: TooLowGear http://www.fsdeveloper.com/forum/showthread.php?t=16339
- Roughness effect has been inspired by Warwick Carter's Gee Bee Model Z / effect by Robert Sanderson (http://www.flightsim.com/kdl.php?fid=99404).
- Brett Henderson for testing in FSX and for suggesting a way to implement individual failures for the engines of multiengine aircraft.
  http://www.sim-outhouse.com/sohforums/showthread.php?t=23054&p=400009&viewfull=1#post400009

## *License:*

I have spent a lot of time creating this package, so please respect the following rules:
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- www.flightsim.com

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These sites are my “home” on the net, or I have received great help or had a good time, and this is my way of supporting them.
Exceptionally, upload is allowed to sites whose main language is other than English.

## *Change log*

Version 0.3
Version 0.4
Version 0.5

### Version 1.0

Old version. Possibly not fully functional. Do not use!
The correct version is v1.1 (I hope…).
I simply picked the wrong zip archive during upload to flightsim and Sim-Outhouse.
Sorry to those who downloaded v1.0!

### Version 1.1

Upload of the correct version that should have been v1.0. The .xml modules are labelled _v10.

- Some cosmetic changes to all modules.
- Mixture State: During take-off and climb mixture can now be leaned to rich either above 5000 ft DENSITY altitude (added) or 3000 ft TRUE altitude (whichever is lower); At lower altitude the mixture lever has to be in full rich (100%) position for high power operations like take-off and climb.
- Power, MPRPM: Progressive sensitivity to Power/mixture and MPRPM/mixture limitation excess.
- Added separate failures of all engines of multiengine aircraft.

If you have questions/comments you can send me a PM at the flightsim.com forum board.
http://forums.flightsim.com/vbfs/member.php?u=29126

Hope you like it.
And keep an eye open for an emergency landing site at all times.

Gunter (teson1)