This is a progress report for Virtual Engine Test Bench v0.5. It builds upon the v0.1 where the baseline pipeline check has been completed. It has become more than just a calculator. Major efforts were to increase the fidelity of the model. To emulate the real-world engine calibration workflows, this version is mainly dedicated to steady state testing. For this purpose significant improvements from v0.1 follows as:

* AFR Target: User can decide AFR targets for RPM ranges, model can interpolate for the given input data. Not only this will be a crucial aspect of calibration process but will be useful for v2.0 where testing for different fuels will be introduced.
* Friction Mean Effective Pressure & Pumping Mean Effective Pressure: To showcase the losses occurring within the engine, empirical loss models have been integrated.
* Volumetric Efficiency Map: In v0.1 constant VE was utilized to showcase the dataflow. V0.5 improves upon this by using VE map. User can input their own VE map or use the default Nissan’s 3.5 Liter Naturally Aspirated VQ35DE(Nissan 350Z) engine’s map.
* Emissions Model: To make this project not only about performance but overall car performance, empirical emissions model has been integrated. Improvements on this module is expected in v2.0.
* Plotting: In v0.1, model was only able to report the results as a CSV file. v0.5 adds on to this by plotting the torque & power curves against RPM. In WOT testing, these are plotted together and in Full Sweep, user can select which throttle positions to be plotted and torque and power curves will be plotted separately. Additionally, emissions are also plotted to give the user the ability to get a grasp of the full picture.

**Improvement of Fidelity**

To demonstrate the fidelity improvement of the model, results after each upgrade has been recorded which is presented in *Figure 1*:

Figure 1: WOT torque results for a 2 Liter NA engine

Each upgrade not only showcase the improvement of fidelity but also the main principles in engine design. From how running richer can increase the torque output to how FMEP & PMEP deteriorates the performance at higher RPMs.

**Validation**

To bring some realness to the project, WOT torque and power curves of the model for 3.5L NA engine has been compared to a dyno results of a Nissan VQ35DE engine. As the VE map has been taken from this engine, it is the closest model can get to validation as possible with the current available dataset. Results are shown in *Figure 2* and *Figure 3*. Model provides high accuracy compared to the dyno results, with low and high RPMs being the main discrepancies. This stems from