**Supplementary Material (SM) for:**

# Particle number emission for periodic technical inspection in a Bus Rapid Transit system

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## 1. Statistical analysis results and discussion

### *1.1. Total PN emission baseline: emission technology (Figure 2)*

Euro II buses were not included due to insufficient data. Kruskal-Wallis test gives a $p$ value = 2.2x10$^{-16}$, which implies the rejection of null hypothesis, hence there is at least one mean PN emission that is significantly different to others. Figure S1 shows the statistically significant differences between pairs of groups. It can be concluded that:

- There is no statistically significant difference between PN emission of Euro II, Euro IV and Euro V buses ($p$ value : 0.99)
- There is a statistically significant difference of PN emission between buses without DPF (Euro II, IV an V) and low-emission technology buses (Euro V+DPF, Euro VI diesel and CNG). All pairs of groups have $p$ value <0.001.
- There is a statistically significant difference between low-emission technology buses. Euro V+DPF present higher emissions than Euro VI CNG ($p$ value = 3.16x10$^{-43}$), and Euro VI CNG buses have higher PN emission than Euro VI diesel ($p$ value = 0.000373).

### *1.2. Total PN emission baseline: fuel and DPF effect (Figure 3)*

Kruskal-Wallis test gives a $p$ value = 2.2x10$^{-16}$, which implies the rejection of null hypothesis, hence there is at least one mean PN emission that is significantly different to others. Figure S2 shows the statistically significant differences between pairs of groups. It can be concluded that:

- There is a statistically significant difference between PN emission of diesel vehicles without and with DPF ($p$ value = 3.35x10$^{-45}$).
- There is a statistically significant difference of PN emission between CNG and diesel buses (Euro V+DPF and Euro VI) ($p$ value = 7.14x10$^{-34}$).
- The statistical evidence shows that the PN emissions of diesel vehicles without DPF are higher than those of diesel vehicles with DPF, and the later are higher than those of CNG buses.

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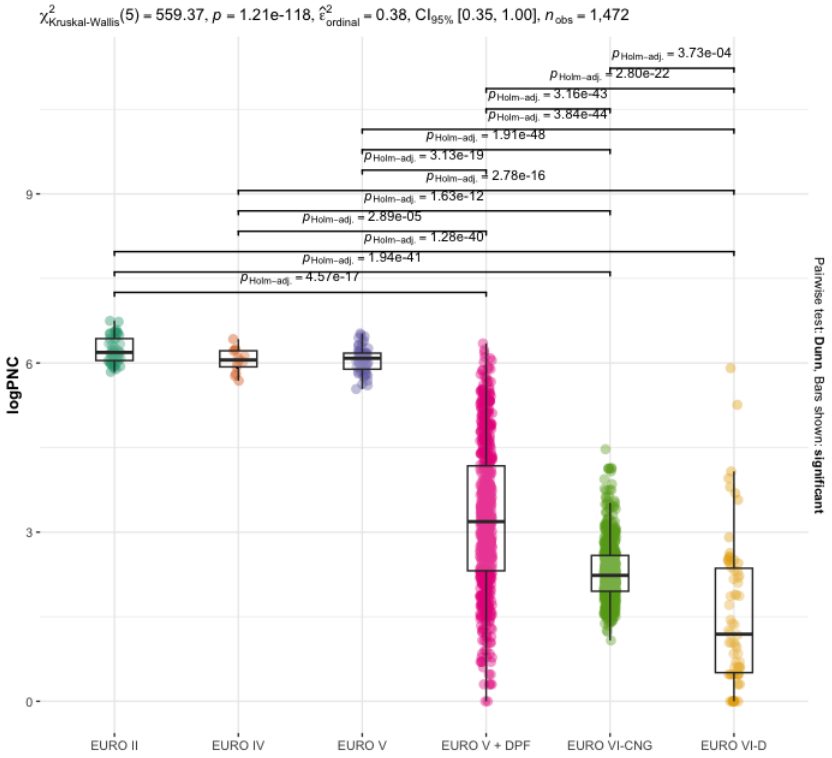


Figure S1: Results of ANOVA test for PN emission across all emission standards (Figure 2).

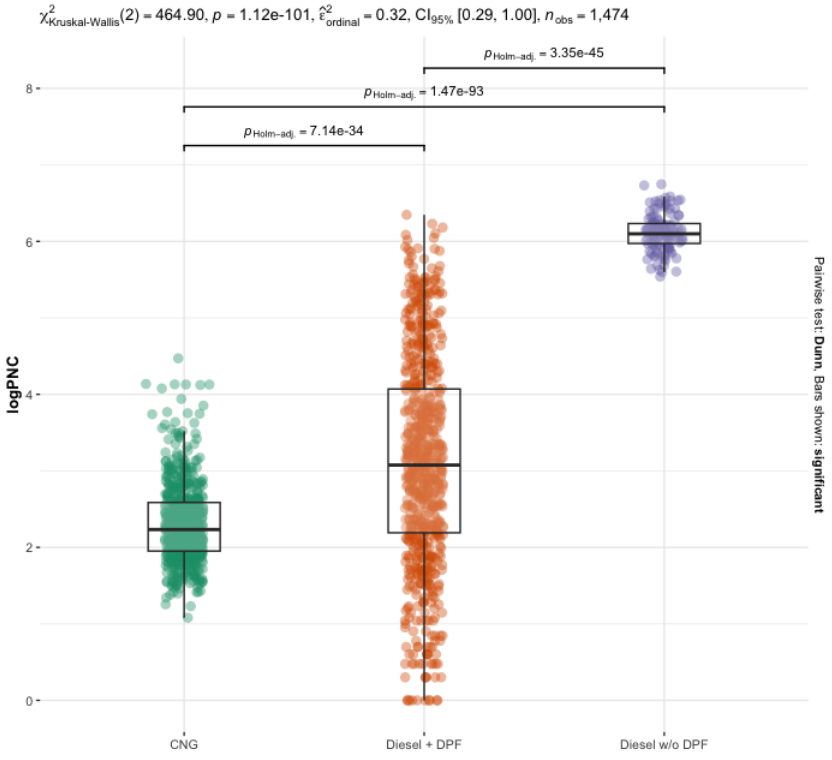


Figure S2: Results of ANOVA test for PN emission of buses with different fuel and with/without DPF (Figure 3).

*1.3. Diesel buses with DPF: impact of model year (Figure 4a)*

We first analyzed model years 2020 and 2021 because there are measurements of PN emission for Euro V+DPF and Euro VI buses. Kruskal-Wallis test gives a $p$ value = $2.2\text{x}10^{-16}$, which implies the rejection of null hypothesis, hence there is at least one mean PN emission that is significantly different to others. Figure S3 shows the statistically significant differences between pairs of groups. It can be concluded that:

- For model year 2020 there are significant differences in PN emission between the two technologies ($p$ value =$1.8\text{x}10^{-16}$), being lower those of Euro VI buses. However, there are not significant differences between these technologies for buses model year 2021 ($p$ value=0.3193).
- The PN emission of Euro V+DPF buses are statistically significantly lower for model year 2021 than 2020 ($p$ value =$4.23\text{x}10^{-9}$).
- Euro VI buses show no statistically significant differences between model year 2020 and 2021. ($p$ value =0.25).

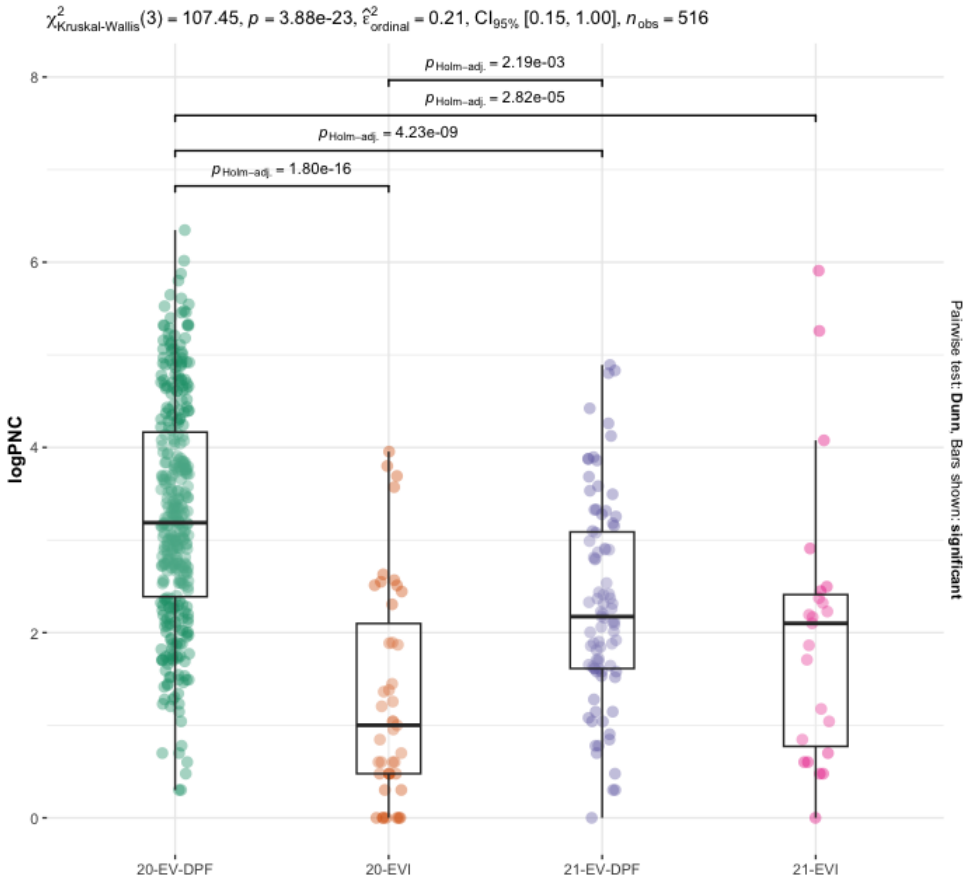


Figure S3: Results of ANOVA test for PN emission for buses with DPF (Euro V and Euro VI) grouped by model years (Figure 4a).

We also analyzed the impact of model year in Euro V+DPF vehicles from 2019 to 2021. Kruskal-Wallis test gives a $p$ value = $7.644\text{x}10^{-15}$, which implies the rejection of null hypothesis, hence there is at least one mean PN emission that is significantly different to other. Figure S4 shows the statistically significant differences between pairs of groups. It can be concluded that:

- For Euro V+DPF (retrofitted DPF) buses, the model year has a significant impact over the PN emissions. PN emission for buses model year 2019 are higher than for buses 2020 ($p$ value =0.000973), and the later are higher than for buses of model year 2021 ($p$ value =$1.03\text{x}10^{-9}$).

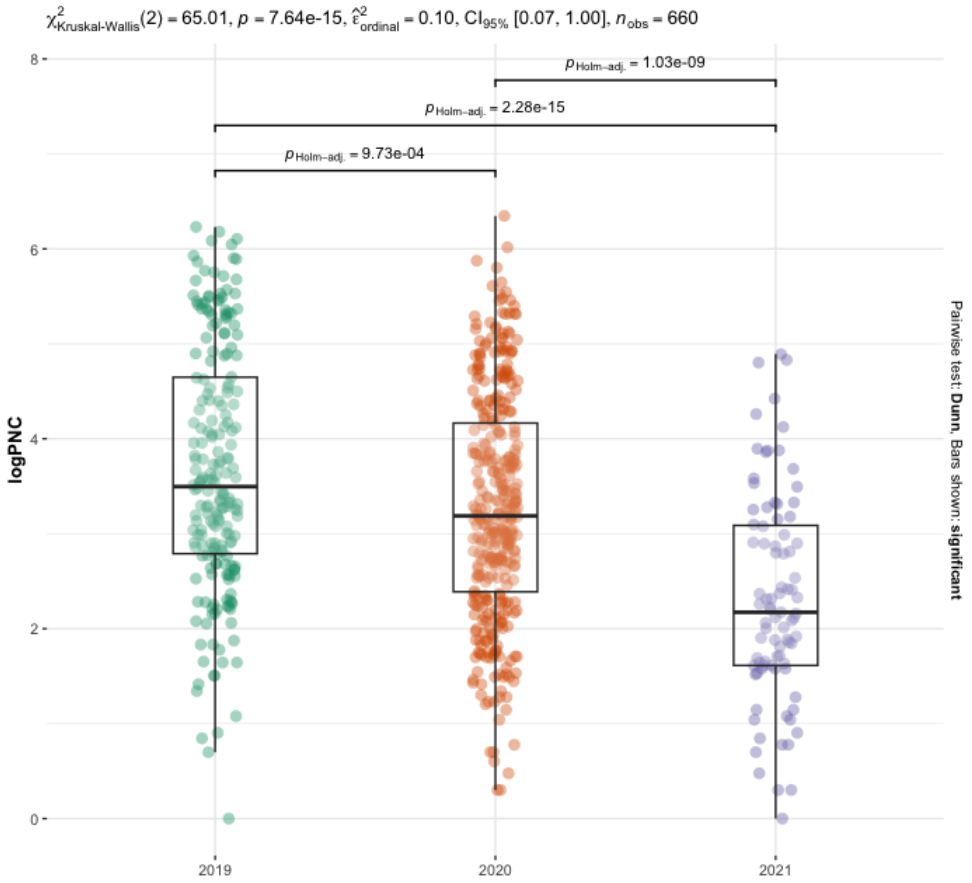


Figure S4: Results of ANOVA test for PN emission for Euro V+DPF buses grouped by model years (Figure 4a).

### *1.4. Diesel buses with DPF: impact of mileage (Figure 4b)*

Given that we only have data for Euro VI buses with mileage below 50,000 km, we analyzed first the differences of vehicle technology for buses with mileage in this range. Kruskal-Wallis test gives a $p$ value = 0.04203, which is slightly lower than the significance level of 0.05. This indicates that the values are significantly different in a 95% confidence level. Hence, for buses with mileage under 50,000 km, the PN emission of Euro VI buses are statistically significantly lower than those of Euro V buses with retrofitted DPF.

Next we tested the impact of mileage for Euro V+DPF buses. Kruskal-Wallis test gives a $p$ value = $2.2\text{x}10^{-16}$, which implies the rejection of null hypothesis, hence there is at least one mean PN emission that is significantly different to others. Figure S5 shows the statistically significant differences between pairs of groups. It can be concluded that:

- Euro V+DPF buses show no statistically significant differences in the PN emission of buses with mileage range of 0-50,000 km with respect to 50,000-100,000 km ($p$ value = 0.85) and 100,000-150,000 km ($p$ value =0.17).
- The PN emission of Euro V+DPF buses in the mileage range of 0-50,000 km are statistically significantly lower than those in the mileage range of 150,000-200,000 km ($p$ value = 0.00414).
- From the mileage range of 50,000-100,000 km there are statistically significantly differences in the PN emission. In that range the emissions are lower than those in the range of 100,000-150,000 km ($p$ value = $8.58\text{x}10^{-6}$), and the later are lower than those in the range of 150,000-200,000 km ($p$ value = $3.19\text{x}10^{-7}$).

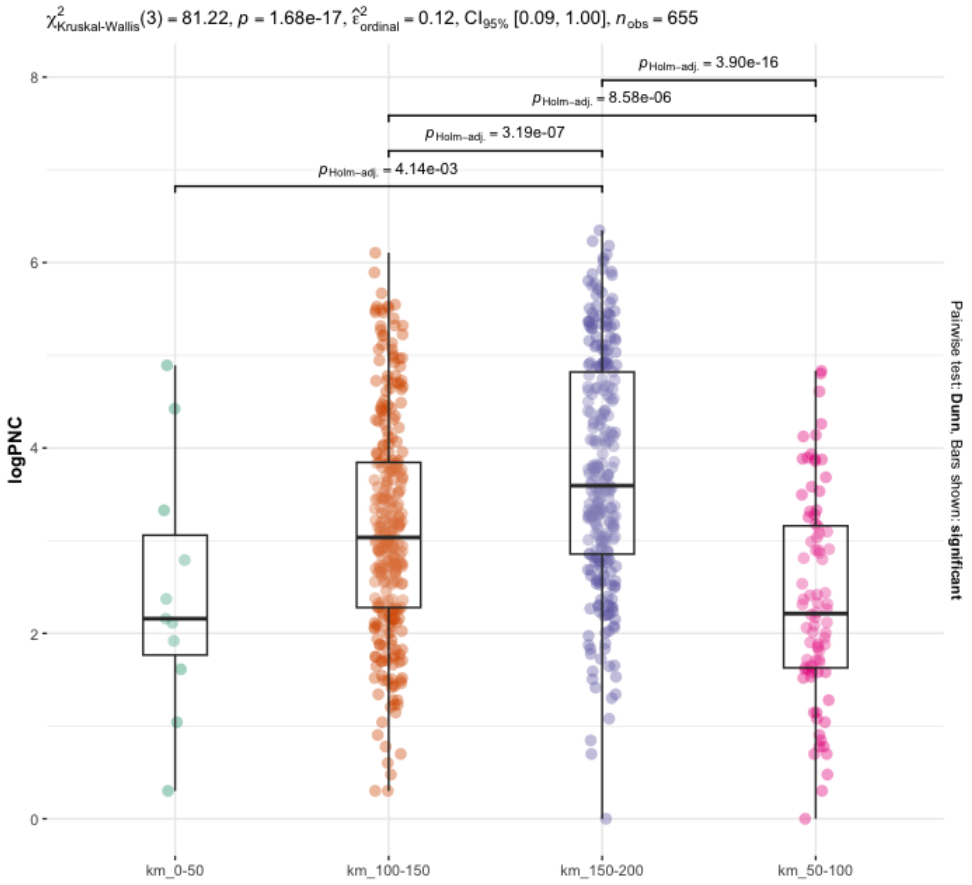


Figure S5: Results of ANOVA test for PN emission for Euro V+DPF buses grouped by mileage (Figure 4b).

### *1.5. Diesel buses without DPF: impact of model year (Figure 6a)*

Data from Euro III buses, Euro IV model year 2011 and Euro V model year 2019 and 2020 are omitted as they are insufficient. ANOVA test gives a $p$ value = 0.0131, which implies the rejection of null hypothesis, hence there is at least one mean PN emission that is significantly different to other. Figure S6 shows the statistically significant differences between pairs of groups. It can be concluded that:

- There are practically no statistically significant differences among the mean PN emission in the groups of data. The exception are Euro II buses model year 2004 and Euro V buses model year 2013 ($p$ value =0.032) and model year 2015 ($p$ value =0.0287). However, when rounding the numbers they can reach the significance level of 0.05. This entails that there is no significant differences between the PN emission of buses without DPF with different model year.

### *1.6. Diesel buses without DPF: impact of mileage (Figure 6b)*

Mileage groups with insufficient data are discarded for this analysis. ANOVA test gives a $p$ value = 0.0207, hence the null hypothesis is rejected, implying that there is at least one group which is statistically significantly different from the others. Figure S7 shows that there are no statistically significant differences between pairs of groups, implying that there is no effect of mileage in the PN emission of buses without DPF:

### *1.7. Euro VI CNG buses: impact of model year (Figure 7a)*

Buses with model year 2021 are discarded as there is only one measurement. Kruskal-Wallis test gives a $p$ value = 0.4092, hence the null hypothesis is accepted, implying that there are no statistically significant differences for the PN emission of CNG buses model year 2019 and 2021.

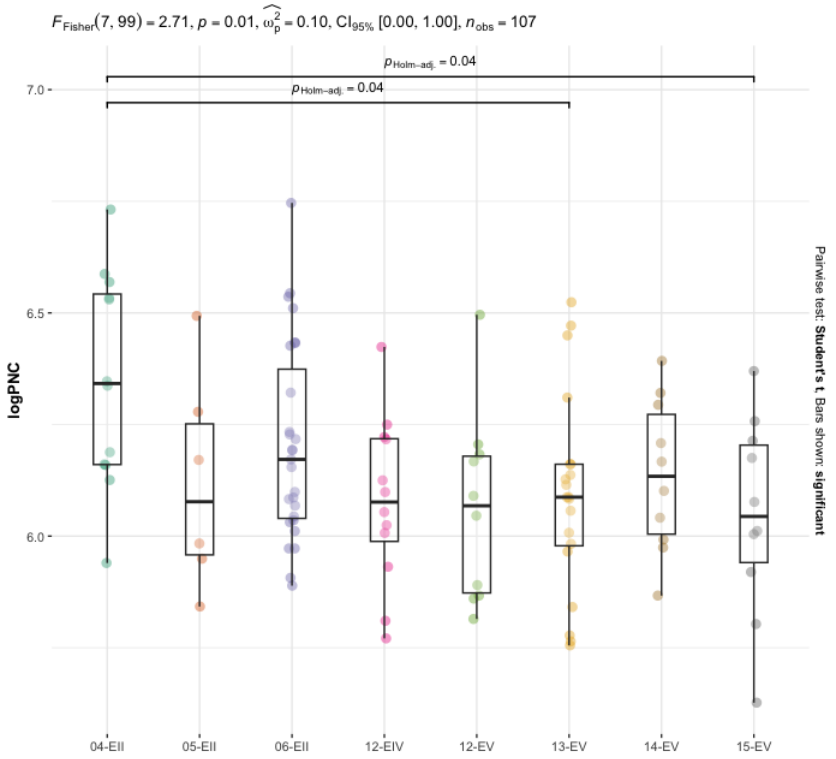


Figure S6: Results of ANOVA test for PN emission for diesel buses without DPF grouped by model year (Figure 6a).

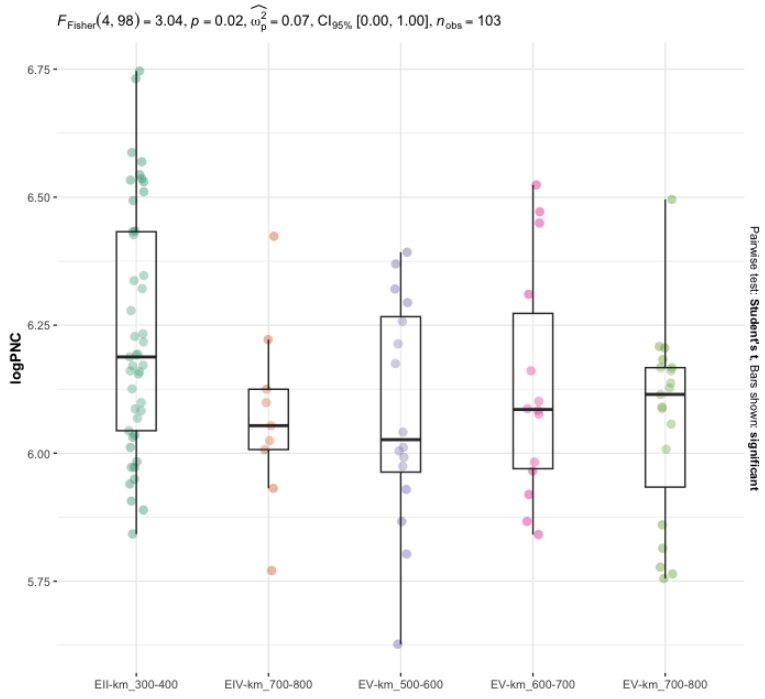


Figure S7: Results of ANOVA test for PN emission for diesel buses without DPF grouped by mileage (Figure 6b).

### *1.8. Euro VI CNG buses: impact of model year (Figure 7b)*

Vehicles with mileage above 200,000 km are discarded in the analysis due to insufficient data. Kruskal-Wallis test gives a $p$ value = $1.084 \text{x} 10^{-8}$, which implies the rejection of null hypothesis, hence there is at least

one mean PN emission that is significantly different to other. Figure S8 shows the statistically significant differences between pairs of groups. It can be concluded that:

- For Euro VI CNG buses with mileage below 50,000 km the PN emissions are statistically significantly higher than for all other mileage ranges: with respect to 50,000-100,000 km range the $p$ value= 0.0025, with respect to 100,000-150,000 km range the $p$ value = $3.33\text{x}10^{-7}$, and with respect to the 150,000-200,000 km range the $p$ value = $4.86\text{x}10^{-5}$.
- The PN emission of CNG buses in the mileage range of 50,000-100,000 km are higher than those with mileage range 100,000-150,000 km ($p$ value = $6.28\text{x}10^{-5}$).
- There are no statistically significant differences in the PN emission of CNG buses with mileage in the range of 150,000-200,000 km with respect to those in the mileage range of 100,000-150,000 km ($p$ value =0.069) or those in the mileage range of 50,000-100,000 km ($p$ value =0.055).

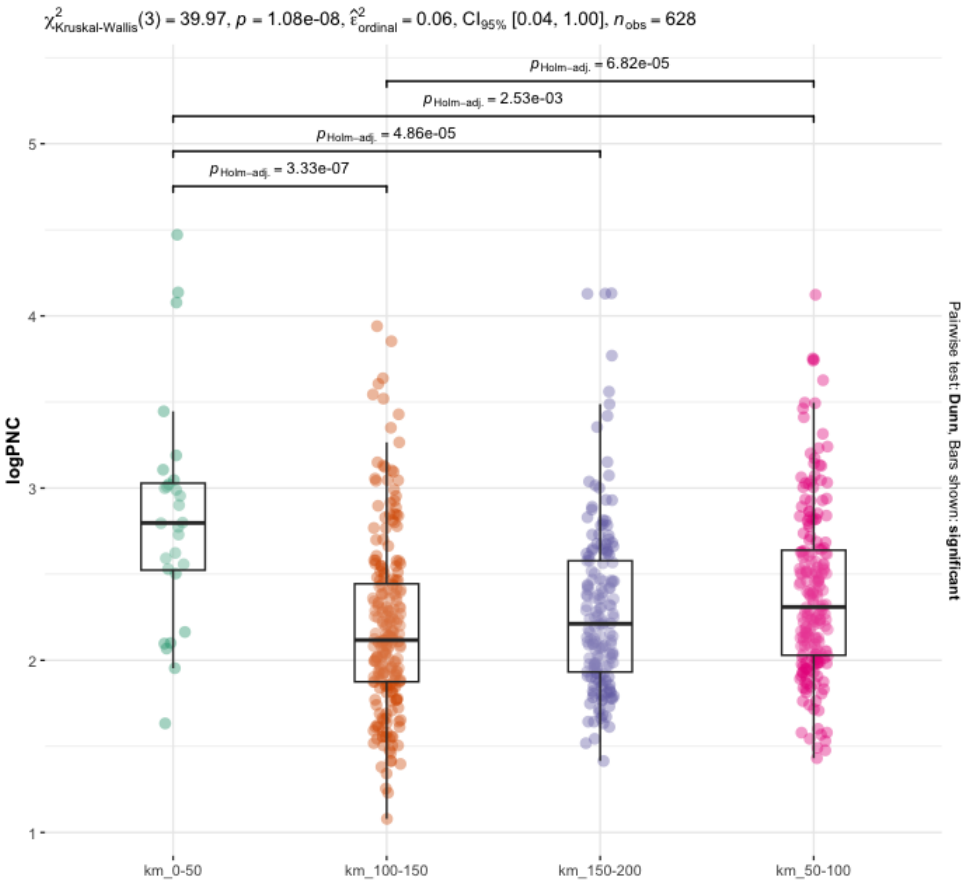


Figure S8: Results of ANOVA test for PN emission for CNG buses grouped by mileage (Figure 7b).