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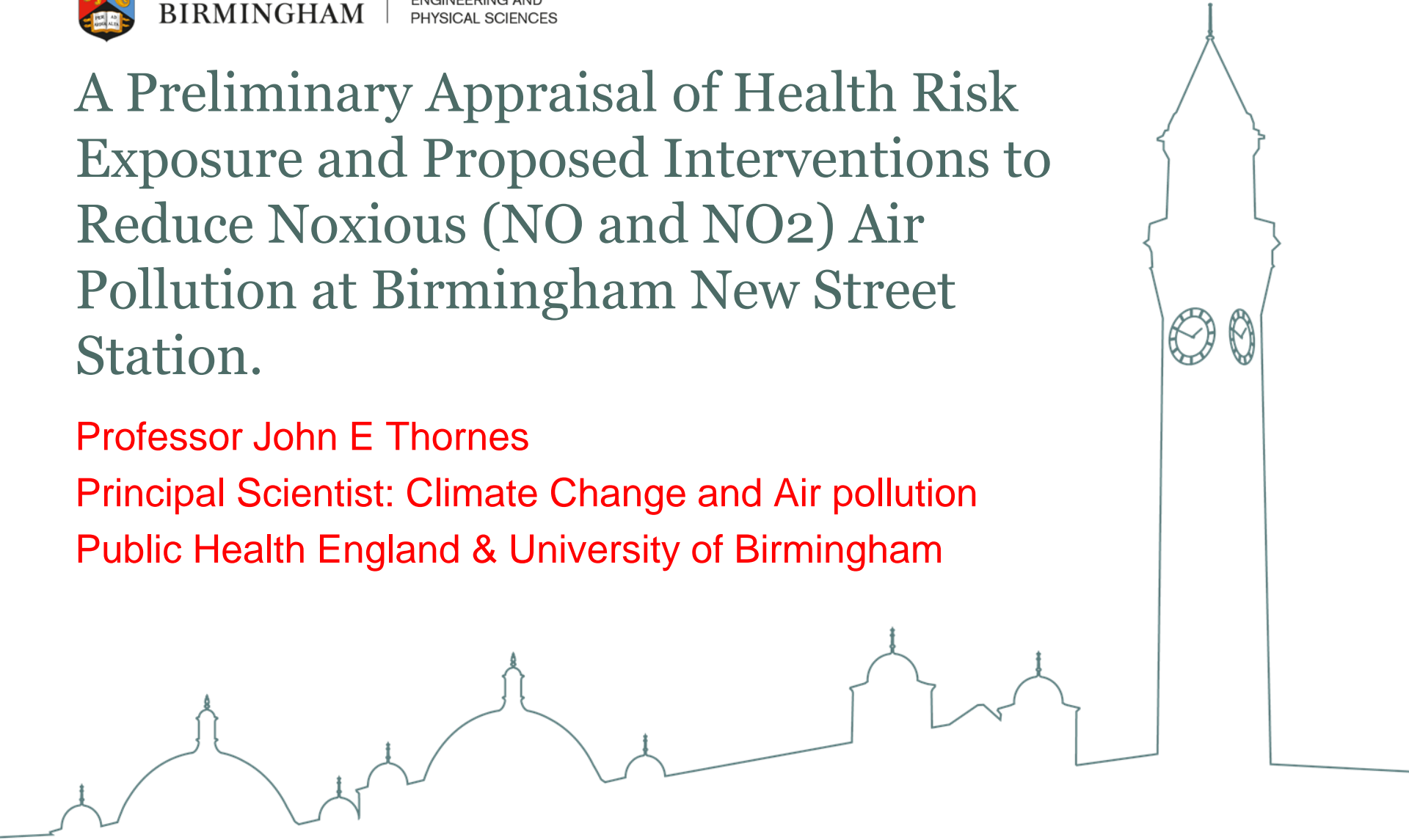
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# A Preliminary Appraisal of Health Risk Exposure and Proposed Interventions to Reduce Noxious (NO and NO<sub>2</sub>) Air Pollution at Birmingham New Street Station.

Professor John E Thornes

Principal Scientist: Climate Change and Air pollution

Public Health England & University of Birmingham





# Current Legislation

- The Office of Rail and Road (ORR) is the national independent health and safety regulator for the UK rail network.
- Network Rail and the Train Operators at New Street Station have a legal duty to manage the risks to employees **and passengers** from exposure to hazardous substances.
- Workplace Exposure Limits (WELs) are used as part of COSHH (Control of Substances Hazardous to Health) regulations.
- Occupational Health versus Public Health Limits?







## DIESEL ENGINE EXHAUST EMISSIONS (DEEE) IN THE RAILWAY SECTOR

Date of issue/ last review	June 2018	Date of next review	June 2021	
RIG postholder/owner		Sharon Mawhood		
RIG cleared by		Claire Dickinson Jen Ablitt		
RIG type		Policy_____	<input checked="" type="checkbox"/>	
		Information_____	<input checked="" type="checkbox"/>	
		Procedure_____	<input type="checkbox"/>	
Target audience	RSD_____	<input checked="" type="checkbox"/>	Policy_____	<input checked="" type="checkbox"/>
	RPP_____	<input checked="" type="checkbox"/>	Inspectors_____	<input checked="" type="checkbox"/>
			Admin_____	<input type="checkbox"/>

**Keywords**

DEEE EXHAUST EMISSIONS DIESEL ENGINE

**Summary**

This RIG summarises the current evidence base on health risks associated with exposure to diesel engine exhaust emissions (DEEE) and advises inspectors about action to take in securing compliance with the Control of Substances Hazardous to Health Regulations 2002 (COSHH) (as amended) in respect of exposure to DEEE in the railway operating environment.



# New Legislation

- New WEL values for NO<sub>2</sub> and NO were introduced on August 25th 2018 as recommended by the European Commission SCOEL (Scientific Committee on Occupational Exposure Limits)
- These are included in the latest HSE publication 'EH40/2005 WELs' following the EU Commission Directive 2017/164





# New Legislation (Con)

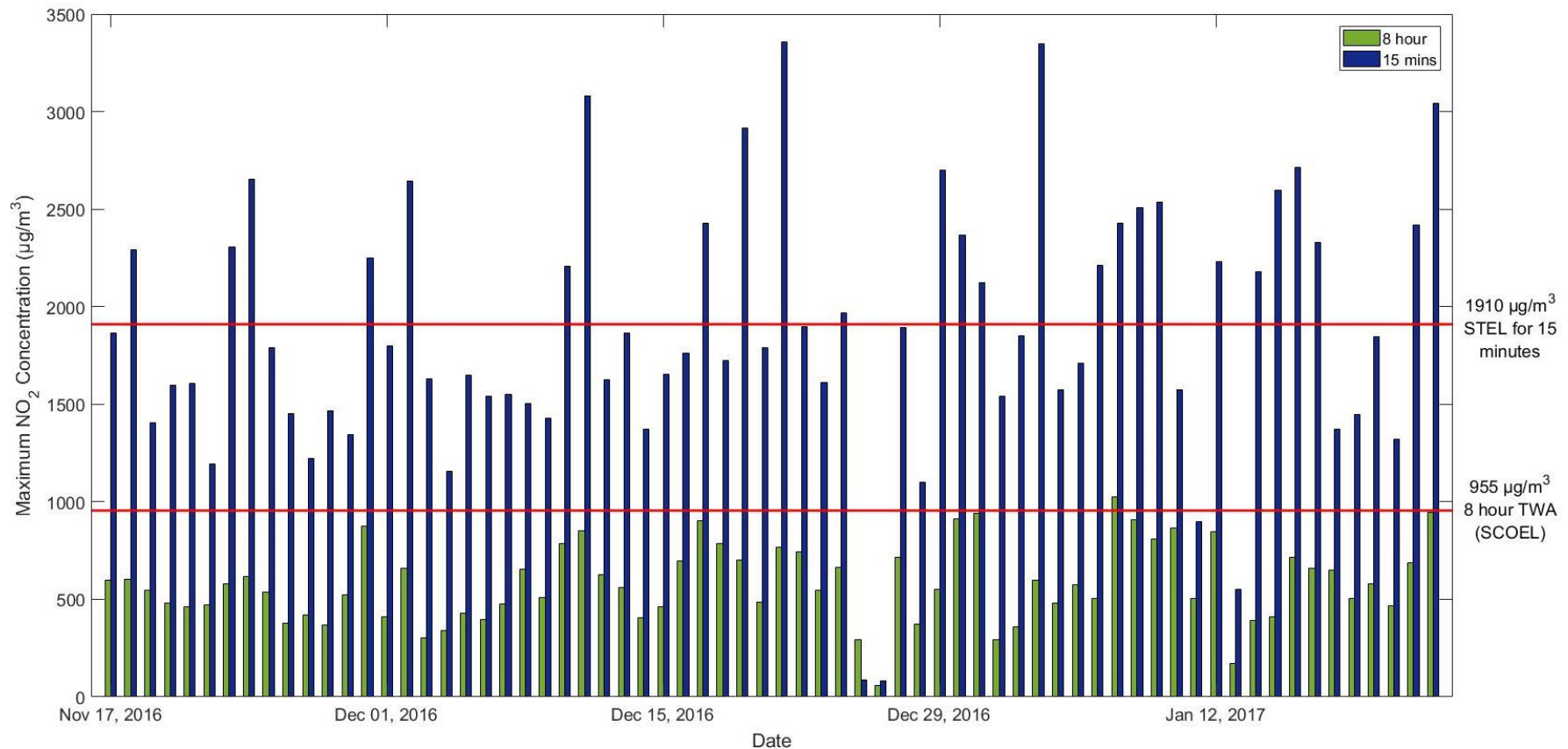
- Nitrogen Dioxide NO<sub>2</sub> WEL
- 8-hour TWA 0.5 ppm (955 µg/m<sup>3</sup>)
- 15-min STEL 1.0 ppm (1,910 µg/m<sup>3</sup>)
- Nitrogen Monoxide NO WEL
- 8-hour TWA 2.0 ppm (2,500 µg/m<sup>3</sup>)





# Workplace Exposure Limits (WEL) NO<sub>2</sub>

## 15 min STEL Exceeded on 40% of days



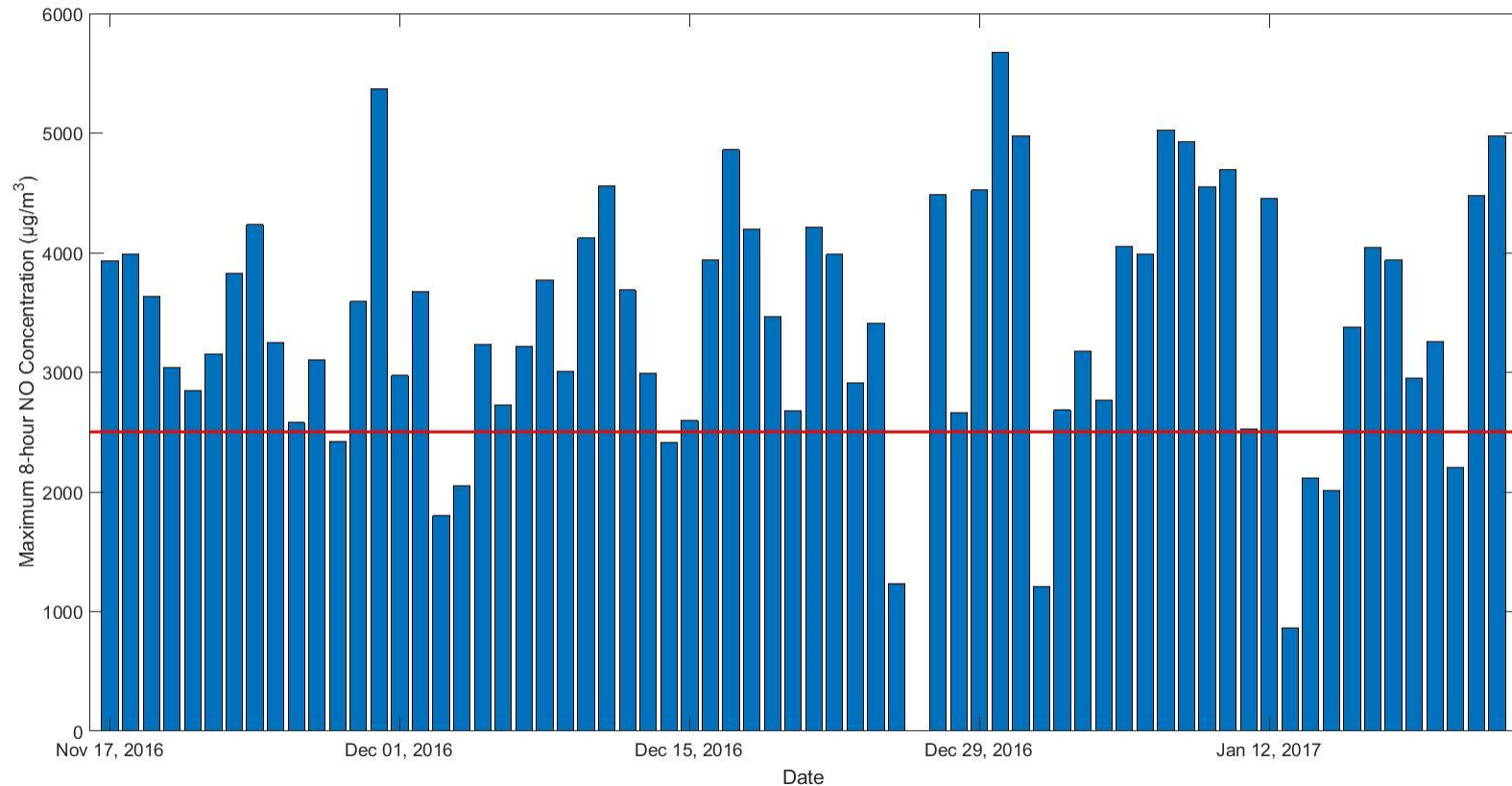
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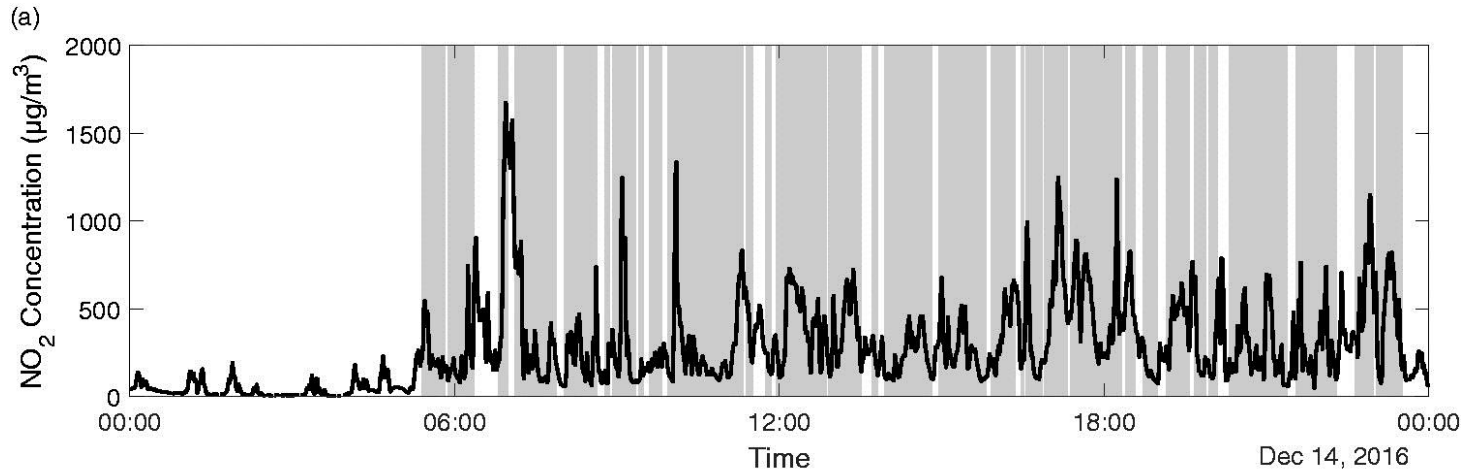


# Nitric Oxide WEL 8hr 2,500ug/m<sup>3</sup> 8-hour TWA Exceeded 86% of days





# - Vortragstar



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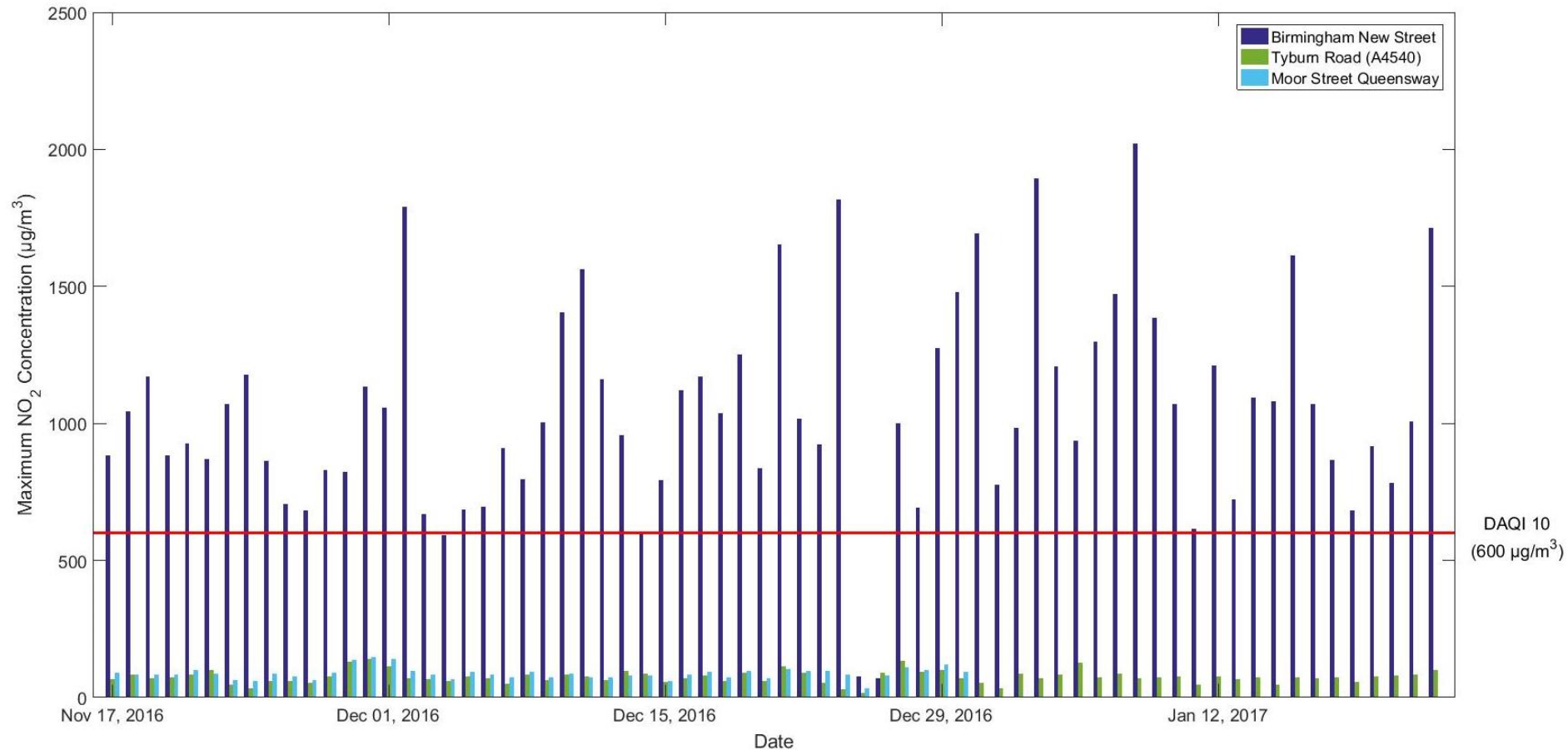
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	Ratio of concentration when platforms occupied to average concentration
Platform 10, 220/221	1.24
Platform 10, 158/170	1.03
Platform 11, 220/221	1.33
Platform 11, 158/170	1.17
Platform 10, 220/221, Platform 11, 158/170	1.33
Platform 10, 158/170, Platform 11, 220/221	1.17
Platform 10, 220/221, Platform 11, 220/221	2.46
Platform 10, 158/170, Platform 11, 158/170	1.11



# DAQI: BNS vs A4540 & Moor Street



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# New Street Station Air Quality Action Plan - Update



Azhar Quaiyoom  
Simon Evans  
Pat Power

13<sup>th</sup> Dec 2018





Network Rail presented an Action Plan in March 2018 following the work by the University of Birmingham post Jan 2017.

This presentation shall provide a progress update from the action plan and interventions taking place to improve Air Quality at New Street.



- Report / Preliminary Analysis focuses upon NO<sub>2</sub> and Particulate Matter based on EU Guidelines.
- Analysis acknowledges factors such as train idling and wind speeds create a variance in the results.
- Fume extract system / Impulse fans design assumes CO<sub>2</sub> is a good indicator for other pollutants such as NO<sub>2</sub> / NO (as in HSE HSG187), but report states no correlation between CO<sub>2</sub> and NO<sub>2</sub> / NO
- Clear correlation between spikes and train idling.
- UofB stated '*considerable week-by-week variation in pollutant levels and thus care must thus be taken in the interpretation of the results*'.



# Train Operations- reminder

- During a regular weekday there are currently **364 trains that have a dwell time of > 5 minutes** at New Street. These can be broken down as follows:

5-9 minutes	179 trains
10-14 minutes	82 trains
15+ minutes	103 trains

- TOC's have operational guidelines to turn off engines and prevent engine idling. The TOC's operating diesel trains at the station are:-
  - Virgin Trains
  - Cross Country
  - Transport for Wales (formerly Arriva Trains Wales)
  - WM trains (former London Midland)

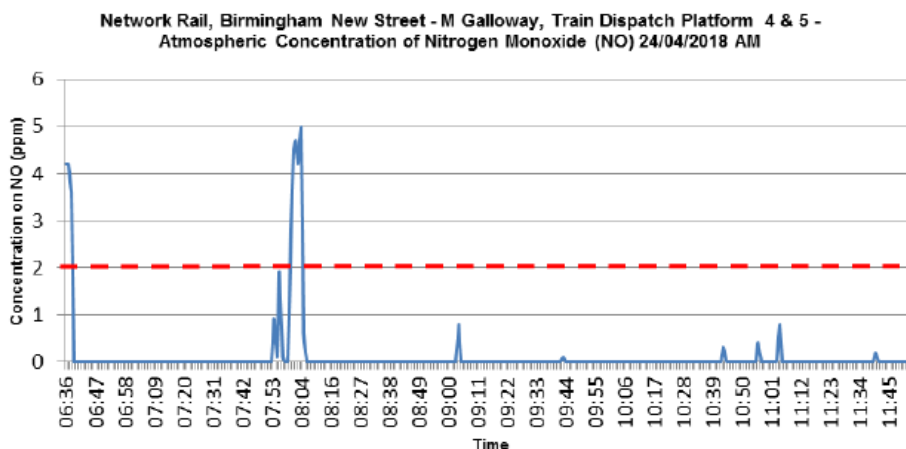
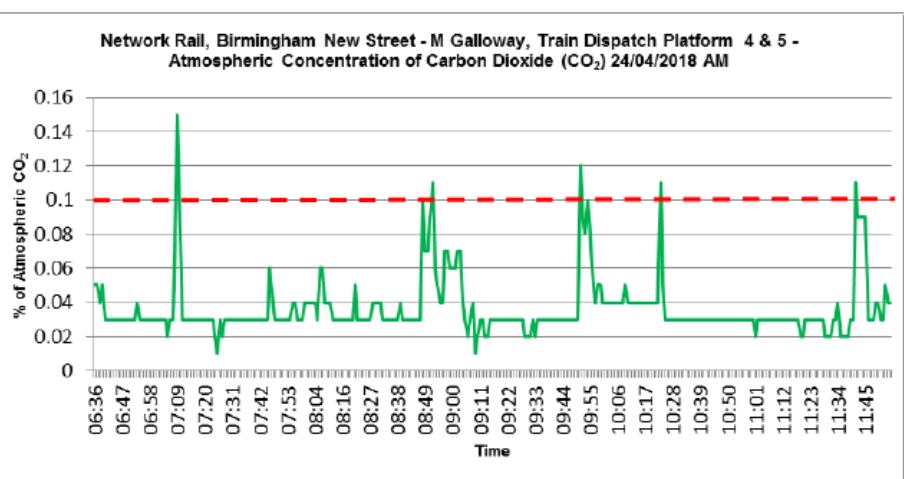




## Personal and Static Monitoring – 24<sup>th</sup> / 25<sup>th</sup> April 18'

### Personal:

- Platform 4 & 5 train dispatchers tested
- Results showed average concentrations of NO below guidance values but some elevated concentrations for short periods
- PM / CO / CO<sub>2</sub> / NO<sub>2</sub> below WELs (COSHH Regulations) & PM

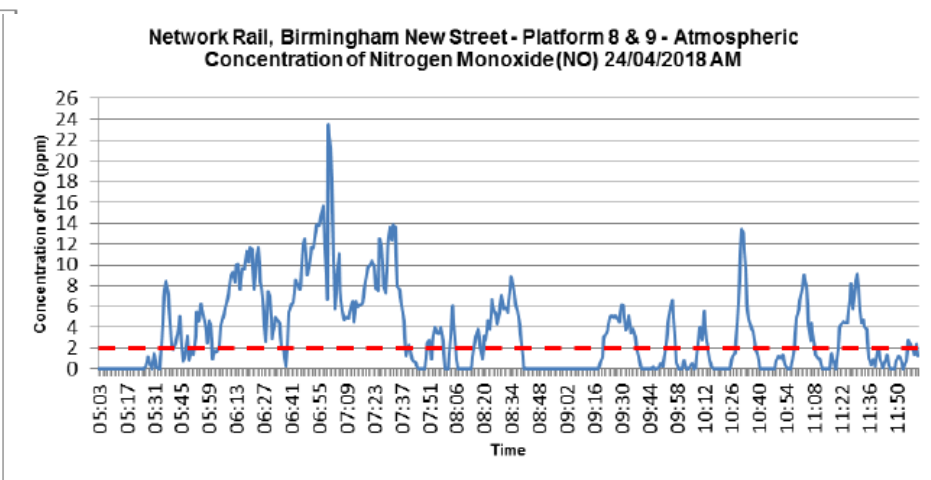
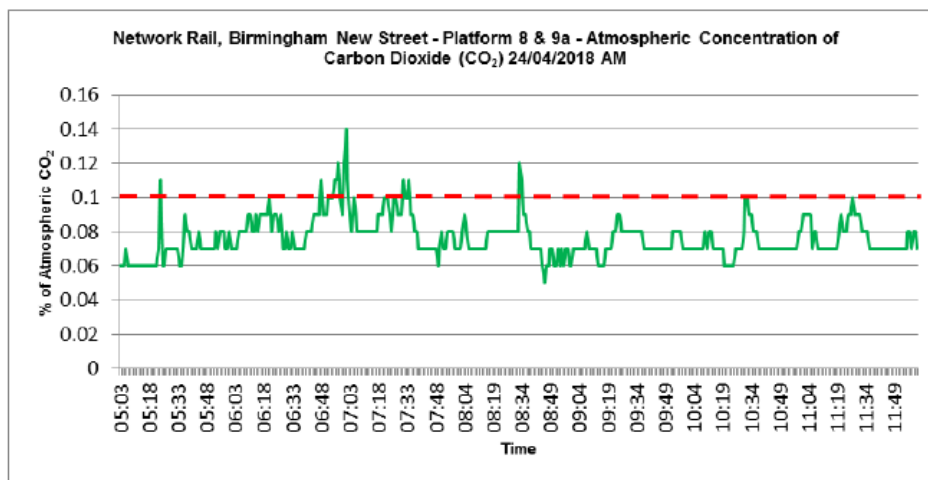




## Personal and Static Monitoring – 24<sup>th</sup> /25<sup>th</sup> April 18'

### Static:

- Average levels of CO<sub>2</sub>, CO, NO<sub>2</sub> / PM were below exposure limits / guidance values.

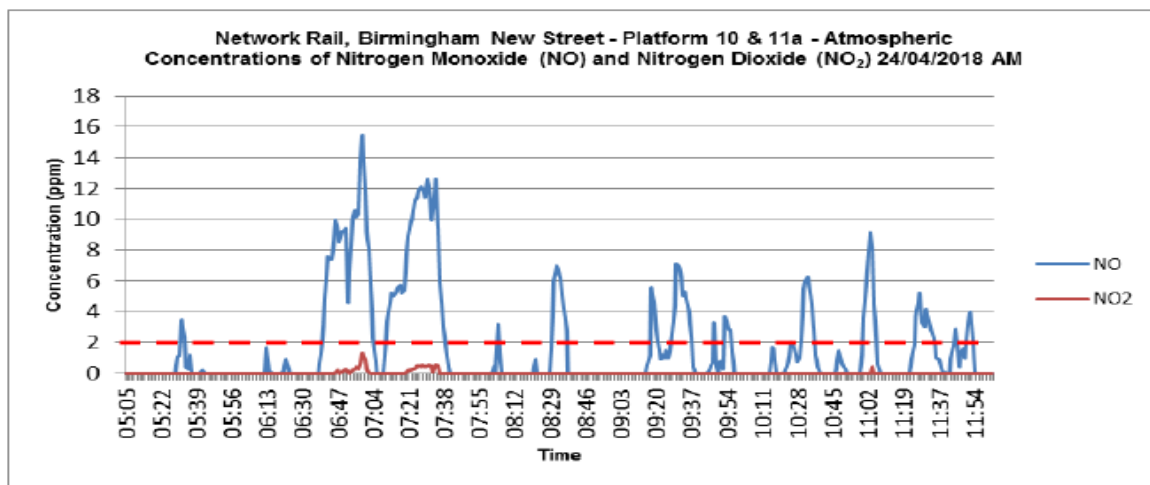
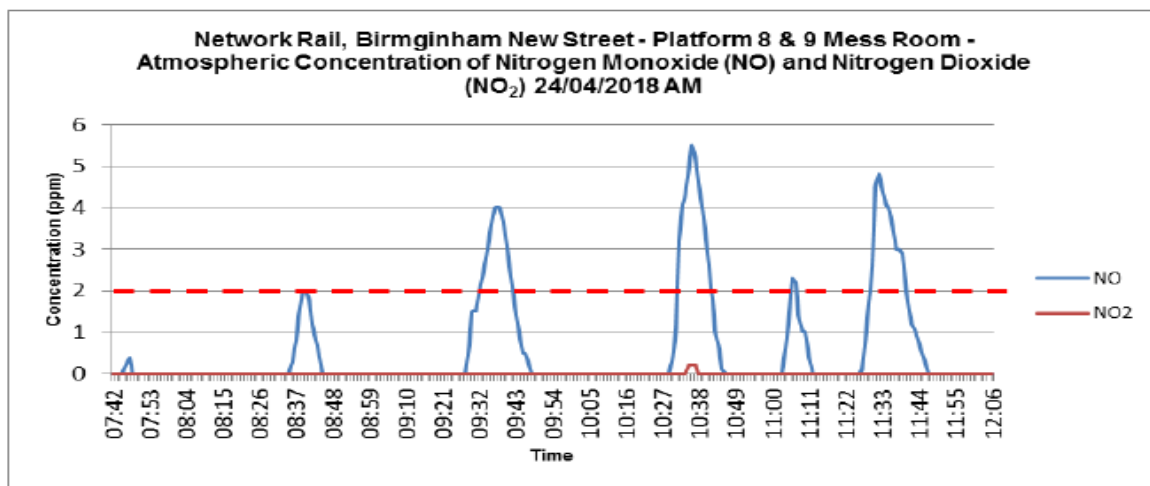


- High peaks in NO identified linked with train idling
- Correlation with CO<sub>2</sub> and NO levels
- High peaks in CO<sub>2</sub> / NO<sub>2</sub> linked to train idling



# Further Monitoring – April 2018

## Personal and Static Monitoring – 24<sup>th</sup>/25<sup>th</sup> April 18'





# Fume Extract System at New Street



- 98 jet fans across 12 platforms
- Fans are bi-directional depending upon wind direction
- Remove fumes towards end of platforms into open space
- Array of CO2 sensors that control 4 speeds of each fan over 2 zones



# Diesel Fume Extract Settings (Workplace Exposure Limits)

## Carbon Dioxide (CO<sub>2</sub>)

- 5000ppm (8hour \*TWA)
- 15000ppm (15min \*TWA)

## Carbon Monoxide (CO)

- 30ppm (8hour \*TWA)
- 200ppm (15min \*TWA)

Based upon: EH40-2005 Workplace Exposure Limits

\*TWA = Time Weighted Average

Mode	Fan Speed	CO <sub>2</sub> range (PPM)
Standby	0%	<1000
Low Pollution	25%	1000-2000
High Pollution	50%	2000-3500
Emergency Pollution	100%	>3500

1. HSE guidance (HSG 187) & EH:40 states the workplace exposure limit (WEL) is 5000PPM over an 8-hour time weighted average (TWA) with a 15 minute peak exposure of 15000PPM
2. CO<sub>2</sub> range sits well within the HSE guidance and is targeted to reduce the emergency pollution mode operation and also target the fans to shutdown at low pollution times.

Stage	PPM CO <sub>2</sub>	Fan Speed (%)
1	0	25
2	1000	50
3	2250	100

Fan/Sensor settings during January 2018 assessment



## Action / Intervention

Completion of UoB Air Quality report & Study ✓

Further emission tests carried out post University of Birmingham Study ✓

intervention of Impulse Fan system (25% over ride and adjust CO2 threshold) ✓

Status review of current & historic maintenance ✓

Performance Review of existing fume extract system ✓



## Action / Intervention

TOC Focus Group - Train idling / stopping positions ✓

Further adjustment of CO2 thresholds for fan speed ✓

Staff Occupational Health Tests and screening ✓

Comparison of SOCOTEC test results V's B'ham University ✓

DfT / ORR / RSSB / BCC EHO Meetings and updates for guidance ✓



## Action / Intervention

TOC Behaviour Change Programme for Drivers to turn off engines and overcome technical challenges ✓

Engine / emission improvement (Auto Shutdown System ✓ / Stop/Start/ Selective Catalytic Reduction (SCR))

Performance optimisation for impulse / jet fans fume extract system:

- BMS integration
- NOx Sensors
- Real time monitoring of NOx and CO2
- Real time performance monitoring of each jet fan

Regular PPM for Impulse fans system







## Reduce Train idling

- ✓ Platform supervisors monitoring
- ✓ Further toolbox talks & briefings from TOC's - promote behaviour change
- ✓ Discipline monitoring reports for station non compliance

## Auto-Shutdown (**Software upgrade**) to shutdown after 8-12 mins idling

- ✓ Virgin implemented upgrade onto 16 out of 20 trains
- ✓ Cross Country implemented on 3 trains

## Train Coupling / de-coupling

- ✓ Working group set up
- ✓ Check hot spots around the station

## Occupational Health Check

- ✓ Network Rail health screening for all train dispatch staff

## Engagement with DFT / ORR / RSSB

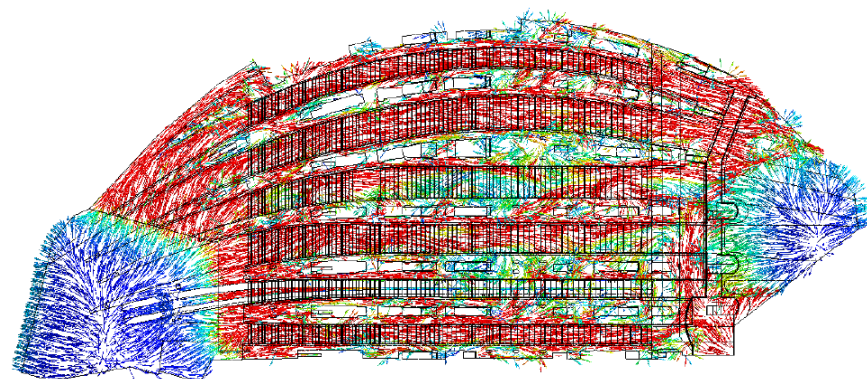
- ✓ Share best practices
- ✓ Steering Group for T1122 research at Kings Cross / Edinburgh Stations
- ✓ Feedback into DfT to influence change via Train operator franchise



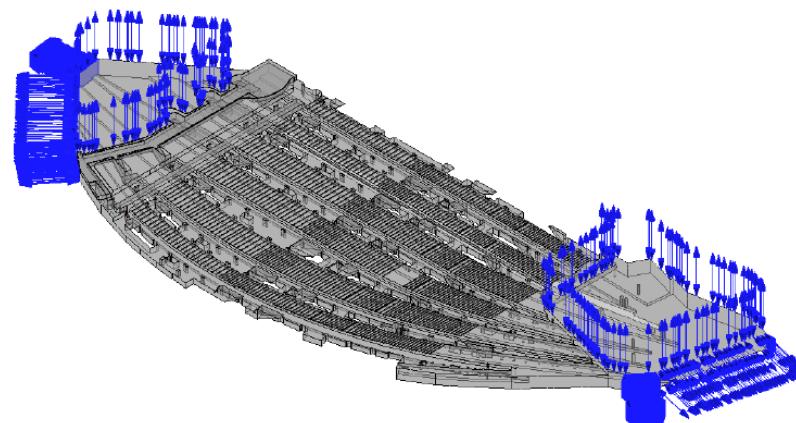
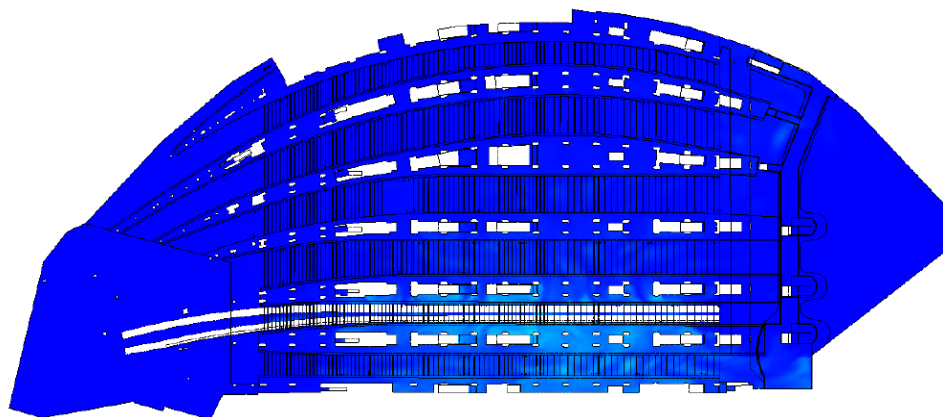
# Impulse Fan Enhancement - Project

- NO / NO<sub>2</sub> clearance capability of the platform jet fan system has been analysed using complex Computational Fluid Dynamics (CFD).
- Analysis shows system can clear NO<sub>x</sub> emissions within legislative limits in cold and warmer ambient conditions with 4 no. Voyager trains on P3 & 4
- CFD now complete
- Start Feb 2019 (platform by platform)
- 97 new CO<sub>2</sub> & NO / NO<sub>2</sub> sensors
- Full BMS link for live emission data
- Complete - target April 2019
- Challenge for noise control of fans
- Costs near £1M

Velocity  
1.0  
0.8  
0.5  
0.3  
0.0  
[m s<sup>-1</sup>]



NO<sub>x</sub>Mf  
5e-007  
4e-007  
2e-007  
1e-007  
0e+000

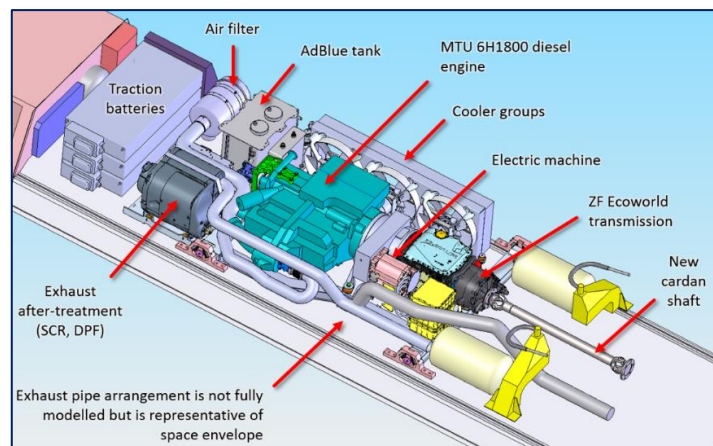
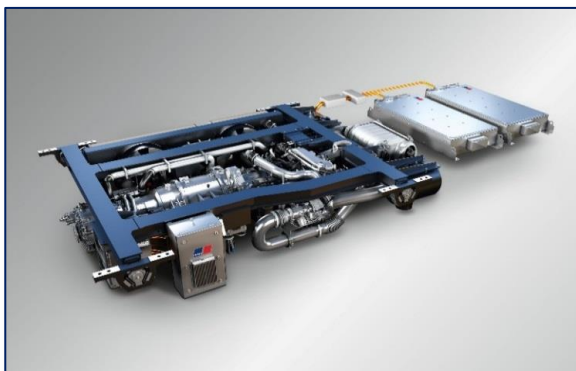




Project to convert class 168/170 Turbostar multiple units to parallel hybrid diesel and electric operation.

Hybridisation enables a unit to stop its diesel engines and call into stations under battery power; dwelling and departing with zero emissions, reduced noise and maximised fuel economy.

Replacement of engine & alternator raft with new MTU hybrid powerpack with stage V engine, energy packs (batteries) and associated control / ancillary components.

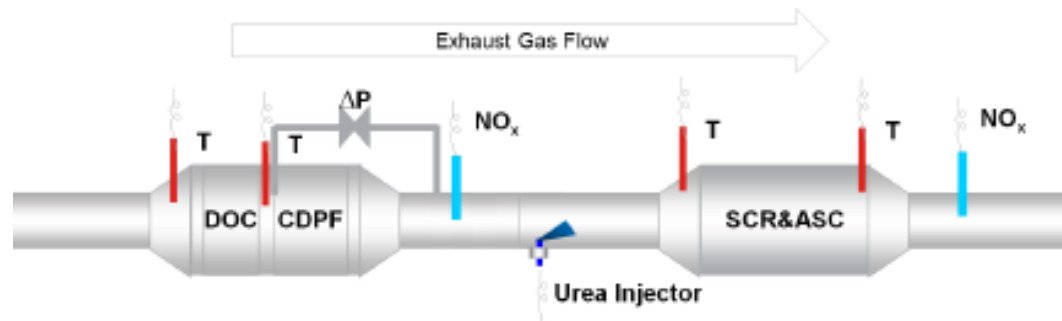


Feasibility and simulation work completed, entering detail design phase.

Trial of two units, installation during 2020.



- Investigation of retrofitting full SCRT technology to DMUs which will reduce key exhaust gas pollutants (HC, CO, NO<sub>x</sub>, PM).
- Key components include: Catalysts, Particulate filter, Urea injector to fit inline of existing exhaust. Urea tank and controller to fit to underframe.



Third party review undertaken into technical viability.

Vehicle underframe inspections undertaken on class 158 & 170.

Exhaust temperature logging and analysis undertaken on class 158 & 170.

Technical discussions, initial proposals and commercial aspects ongoing.



# HydroFLEX project – Long term

Project to convert class 319 into a hydrogen powered train.  
Ability to operate across electrified and non-electrified routes.  
Collaboration with University of Birmingham.  
Demonstration of 'fuel-of-the-future' off the network at low speed.  
Testing and demonstration during 2019.





- The Action Plan has been progressing well and improvements seen since Jan 2018 monitoring results reflect this.
- Network Rail shall continue to monitor the Air Quality at the station and hold regular focus group meetings.
- There are multiple factors creating 'spikes' in diesel emissions – multi faceted approach is required with support from train operators and other stakeholders.
- Network Rail does not have any enforcement powers to improve existing rolling stock emission levels. Misconception to Network Rail powers.



**Thank you.**



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