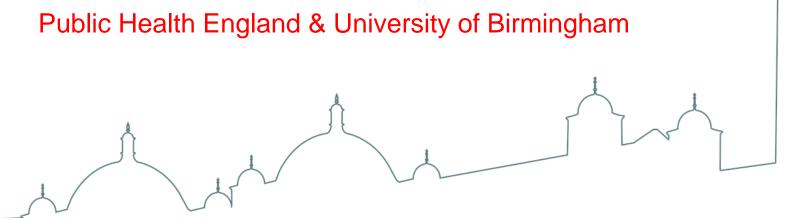
A Preliminary Appraisal of Health Risk Exposure and Proposed Interventions to Reduce Noxious (NO and NO2) Air Pollution at Birmingham New Street Station.

Professor John E Thornes

Principal Scientist: Climate Change and Air pollution



# **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?



**Keywords** 

Summary

# **RSD Internal Guidance**

DIESEL ENGINE EXHAUST EMISSIONS (DEEE) IN THE RAILWAY SECTOR

RIG-2014-04

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	
			Information	

Target audience	RSD

RPP

 $\times$  $\times$ 

Procedure Policy Inspectors\_\_\_\_

 $\times$ 

 $\times$ 

DEEE EXHAUST EMISSIONS DIESEL ENGINE

in respect of exposure to DEEE in the railway operating environment.

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)

Admin

# New Legislation

- New WEL values for NO2 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



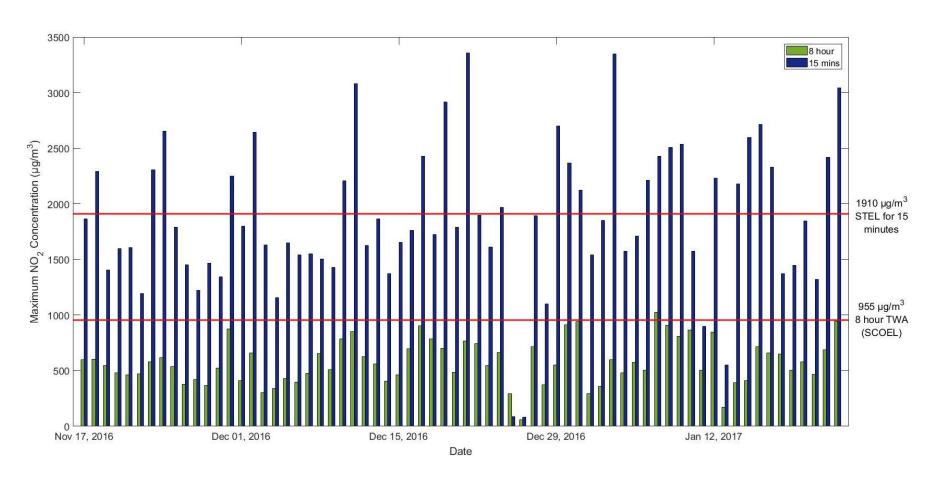
# New Legislation (Con)

- Nitrogen Dioxide NO2 WEL
- 8-hour TWA 0.5 ppm (955 ug/m3)
- 15-min STEL 1.0 ppm (1,910 ug/m3)

- Nitrogen Monoxide NO WEL
- 8-hour TWA 2.0 ppm (2,500 ug/m3)



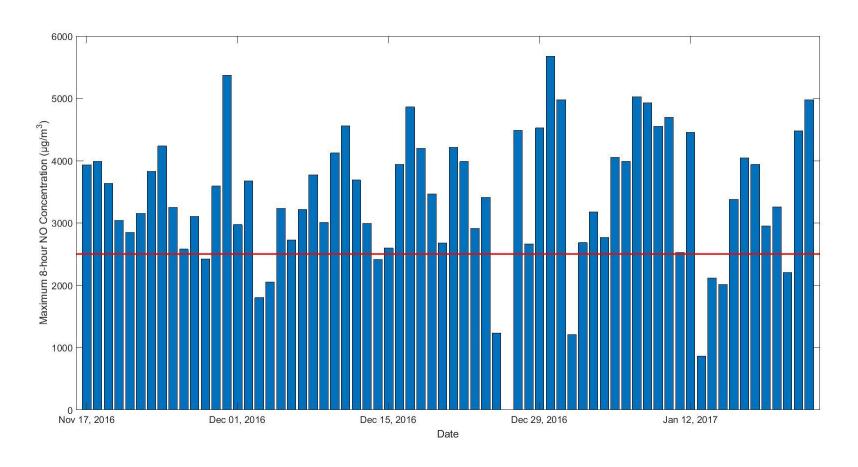
## Workplace Exposure Limits (WEL) NO2 15 min STEL Exceeded on 40% of days



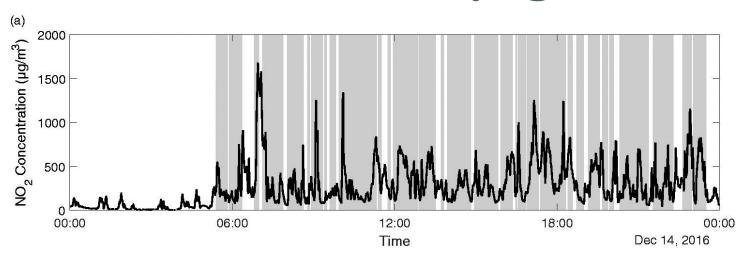




## Nitric Oxide WEL 8hr 2,500ug/m3 8-hour TWA Exceeded 86% of days



# - Voylagetar





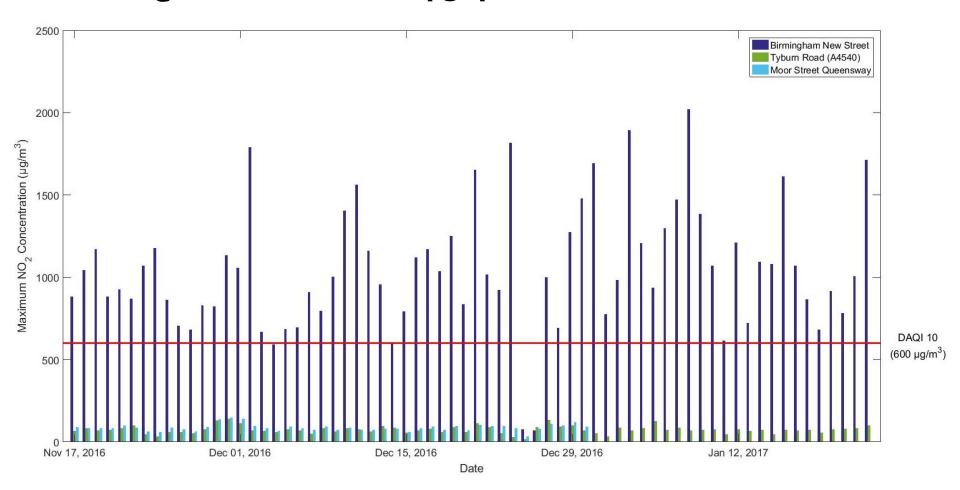


COLLEGE OF ENGINEERING AND PHYSICAL SCIENCES



	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





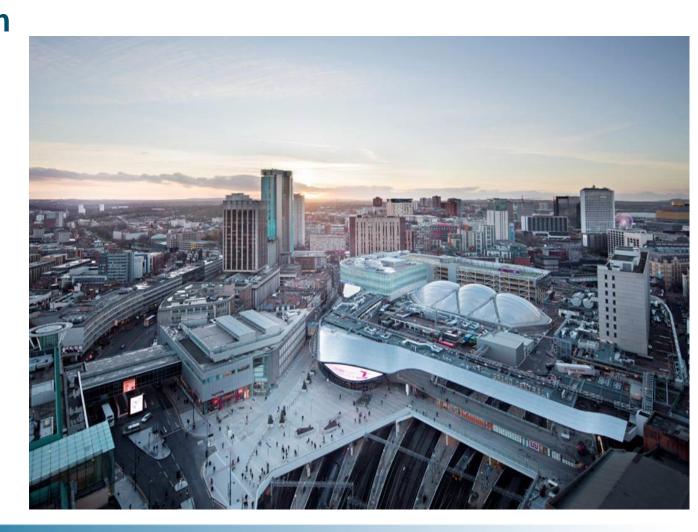


# New Street Station Air Quality Action Plan - Update



Azhar Quaiyoom Simon Evans Pat Power

13<sup>th</sup> Dec 2018



#### Introduction



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.

## **Initial Findings**



- Report / Preliminary Analysis focuses upon NO2 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 CO2 is a good indicator for other pollutants such as NO2 / NO (as in HSE HSG187), but report states no correlation between CO2 and NO2 / 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)



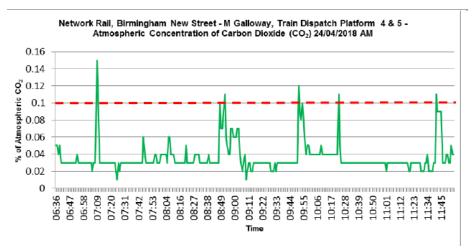
## Further Monitoring – April 2018

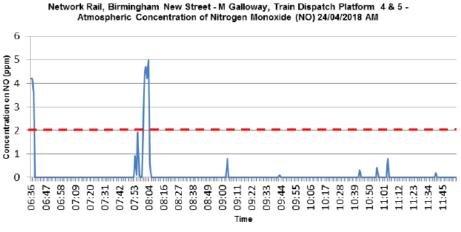


## Personal and Static Monitoring – 24th / 25th April 18'

#### 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 / CO2 / NO2 below WELs (COSHH Regulations) & PM



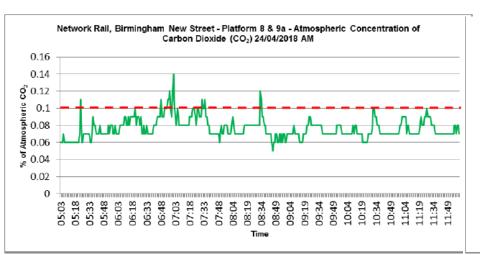


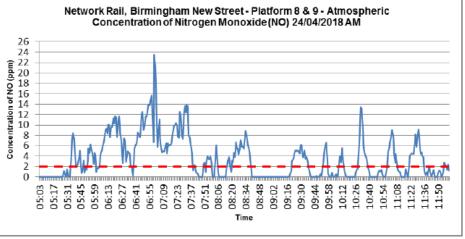
## Further Monitoring – April 2018



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

Average levels of CO2, CO, NO2 / PM were below exposure limits / guidance values.



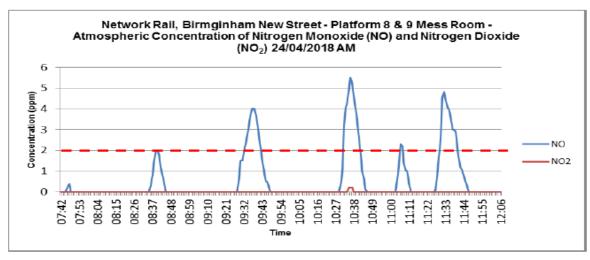


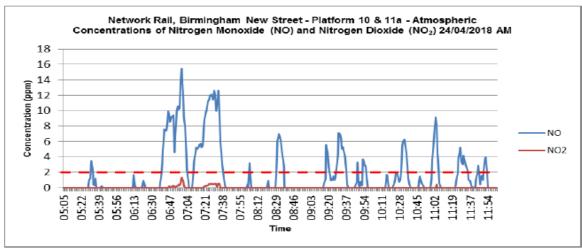
- High peaks in NO identified linked with train idling
- Correlation with CO2 and NO levels
- High peaks is CO2 / NO2 linked to train idling

## Further Monitoring – April 2018



### Personal and Static Monitoring – 24th/25th 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 (CO2)

- 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	CO2 range (PPM)
Standby	0%	<1000
Low Pollution	25%	1000-2000
High Pollution	50%	2000-3500
Emergency Pollution	100%	>3500

- 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. CO2 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.

Store	PPM	Fan Speed
Stage	CO2	(%)
1	0	25
2	1000	50
3	2250	100

Fan/Sensor settings during January 2018 assessment

### Short term Action Plan - complete



#### Action / Intervention

Completion of UoB Air Quality report & Study V

Further emission tests carried out post University of Birmingham Study V

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

Status review of current & historic maintenance V

Performance Review of existing fume extract system V

#### Further wins since March 2018 - Action Plan



#### Action / Intervention

TOC Focus Group - Train idling / stopping positions V

Further adjustment of CO2 thresholds for fan speed V

Staff Occupational Health Tests and screening V

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

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

### Medium - Long term plan



#### **Action / Intervention**

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

Engine / emission improvement (Auto Shutdown System V / 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

## Live Action Plan - multi-faceted approach



13														Netwo	orkk	aıı
14	Ref.	Title	Action	Action Ov	Other Owner				Action	s / Updates		Priority	Open <i>l</i> Closed			7
15	1	Train Idling reduction	Auto-shutdown software intervention to tested and implemented onto Diesel roll stock alongside training / behaviour change.		gill	09/11/2018	upgrade on the first across 50% of the fit test results to enforce share with train operational. One is 50% of the fit operational. One is 50% of the fit of the fit operational of the fit operational of the fit operational operations of the fit operations of the f	Litain - wed 23 leet following it be following to leet following the fol	and May 187. Followin in first week. Further first week. Further first week. Further first week. Further first was due to Hum de across the wholk of a constant who was the format of the first	g successful to refocus and oc platform super su	s plan to test the Auto Shutdown software ial, the software upgrade shall be implemented mmitment on reducing train idling following Jan rvisors to record and log train idling times and nutdown software successfully installed and not the technology. ACTION: VT target 31st 0 trains) and provide feedback on reduced fuel on class 220 but going through verification update informed there are capacity issues on et for Cross Country consist of 58 trains. Further nent with Bombardier.  Latform supervisors but reported positive in for auto shutdown to Network Rail.  ession. WM rep to attend the next Focus Group of Shut down to three of their trains, mid engine rogramme for implementation across the fleet, ented. ACTION: complete across fleet by 7th	н	OPEN			
	2	Train Coupling - de- coupling	There is evidence of train coupling / de- coupling can create high level of emissions in the morning.	Ref.	Title	Nov 2018 Action		track that mak		allenging but h	g / de-coupling at New Street, possibly due to nappy to assist in observing associated idling	Actions / Up	dates		Priority	Open i
16				5 Er	nissions testing		iion testing to check ainst COSHH regs.		AQ∤Kevin FBlacktop1Patrick Power	Oate	15.03.18: 10. Another round of monitoring took September and November 2017. Although the I monoxide (CDI), and phick have seen a considerable increase in nitrogen November 2017 tests, Analysis shows there is a 23.05.18: NR carried out personal and statio m results show relative compliance but some elevistatio monitoring shows average concentration 50% of the guidance in three instances. CO, Cl for all samples. Closed.  28.06.18: VT carried out static monitoring at N VT reported small increases in NDx around the some small increases in emissions when driver-ACTION: Any future planned monitoring 11.09.2018. Cross Country carried out personal 18' over one day.  15.11.2018: ACTION: Russell to provide results by VT. ACTION: Cross Country to share results of monitoring and the control of the country to share results of monitoring the country to share results of monitoring the control of the country to share results of monitoring the country to share the country to share results of monitoring the country to share results of the country to share the	results in Jan 1 page disolder (I) monoxide fNC distinct link will control tink will be seen the control tink will be seen to seen tink will be seen the control tink will be seen to see the control tink will be seen the control tink will be seen to seen the control tink will be seen to see the control tink will be seen to seen to see the control tink will be seen to see the control tink will be seen	18" showed this NOZ) are below NOZ) are below to that with train idling in the train idling in NOZ are below the NOZ are below to the NOZ are the NOZ	at the average concentrations for carbon workplace exposure limits (WEL), we compared to September and and NO levels.  24th & 25th April. Personal monitoring eriods.  value in two instances, and exceed concremained within compliance values as at concourse level for NOx and CO2, inglimobile) carried out also that showed ing from the training from the training from the values.  or Services staff at New Street in August course and driver monitoring carried out at 18'.	м	OPEN
				- B - I	Stakeholder engagement		keholders to the TOC oup Meeting	A. Quaiyoom		Ongoing	1109.18: OPR attended Focus Group session w message that all need to be done to improve air.  11.09.18: University of Birmingham, led by Prof. T. Exposure and Proposed Interventions to Reduc Railway Station* paper. This has been commen. 15.11.18: Birmingham City Council Scrutiny Comgroups attend also - ACTION: AQ to share invite the page of the proper section of the proper section.	quality at the st hornes are ke <i>e Nowious (NC</i> ted by ORR an nittee meeting	en to issue ' <i>A'</i> J <i>and NO2/Ai</i> nd Network Ra pplanned 13th	Frakiminary Appraisal of Health Risk Folkution at Birmingham New Street il and yet to be finalised. Dec 18', NR request reps from TOC	М	OPEN
			_	7	Diodiesei		that may create further	A. Quaiyoom	R. Dickerson (NR)	15/11/2018	28.06.18': ACTION: NR STE team to investigate	e issue of Biodi	liesel creating	further NOx.	L	
					Air Sheet?	Sheet3	<b>(</b>							[a]		

#### Action Plan - headlines



#### 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

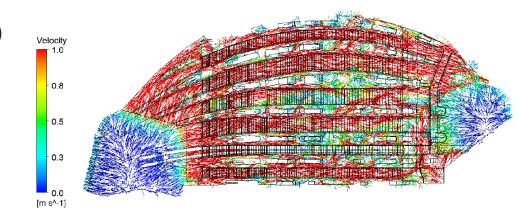
#### **Engagement with DFT / ORR / RSSB**

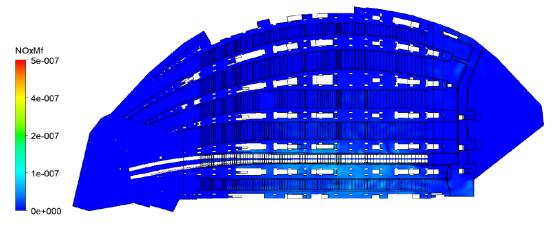
- ✓ Share best practices
- Steering Group for T1122 research at Kings Cross / Edinburgh Stations
- ✓ Feedback into DfT to influence change via Train operator franchise

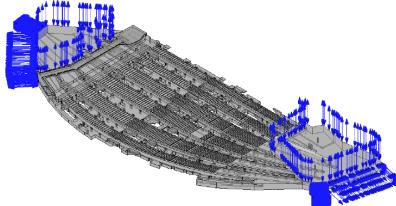
## Impulse Fan Enhancement - Project



- NO / NO2 clearance capability of the platform jet fan system has been analysed using complex Computational Fluid Dynamics (CFD).
- Analysis shows system can clear NOx 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 CO2 & NO / NO2 sensors
- Full BMS link for live emission data
- Complete target April 2019
- Challenge for noise control of fans
- Costs near £1M







## HybridFLEX project - Porterbrook

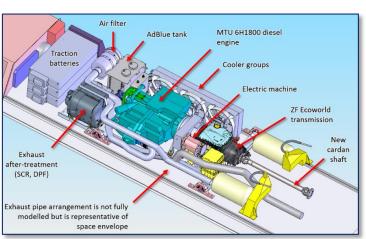


Project to convert class 168/170 Turbostar multiple units to parallel hybrid diesel and electric operation.

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.

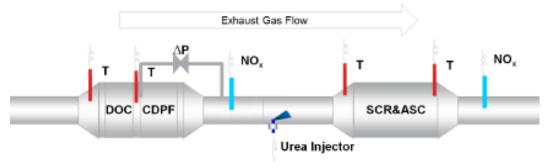




Feasibility and simulation work completed, entering detail design phase. Trial of two units, installation during 2020.

# Retrofit exhaust gas after treatment - Porterbrook

- Investigation of retrofitting full SCRT technology to DMUs which will reduce key exhaust gas pollutants (HC, CO, NOx, 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.



#### **Conclusion**



- 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.



