Our ref: P5357/Report D

FES Ltd
Forth House
Pirnhall Business Park
STIRLING
FK7 8HW

Attention: Mr Brian Gilchrist,
Commercial Manager

26 November 2012

Dear Brian

ENVIRONMENTAL AIR QUALITY MONITORING ASSESSMENT:
WAVERLEY STATION, EDINBURGH

I refer to the recent air quality monitoring exercise carried out at Waverley Station, Edinburgh, and present results below.

1.0 Background

1.1 In June 2012 the IARC re-classified Diesel engine exhaust emissions (DEEE) from Group 2A carcinogen category ("probably carcinogenic") to Group 1 category ("carcinogenic").

1.2 Due to on-going alterations to the physical layout of the station as part of the redevelopment project at Waverley station, Edinburgh, Network Rail was already carrying out air monitoring for DEEE (May 2012).

1.3 Unlike many occupational /environmental pollutants, there is however currently no definitive monitoring technique nor workplace exposure limit for DEEE specifically. There are nevertheless related parameters which can be usefully used in order to try and establish some measure of likely risk, and FES commissioned additional monitoring (Oct-Nov 2012) which is reported here.

2.0 Method

2.1 Strategy

Discussions with the client confirmed that occupancy of the station would be more significant for employees of NWR and sub-contractors, rather than passengers. For this reason the study addressed occupational exposure primarily. In particular, it was felt from anecdotal evidence and confirmed by preliminary walkover with site representatives that the ticket barriers at the west side of the main concourse are an area with significant duration of occupancy by significant numbers of staff, and where the perception of poor air quality can be relatively high, on the basis of odour and visual observation of engine smoke emissions.

2.2 Monitoring Type

2.2.1 Monitoring was carried out at fixed locations rather than on personnel. It was felt that given the location of the particulate sources (engine exhausts) results obtained from the monitoring locations used were not likely to be significantly different from exposure levels of staff at the assumed worst-case location (ticket gates to west of main concourse), and if anything were likely to be greater. Results presented at Section 3 would tend to confirm this.

2.2.2 Similarly for avoidance of damage the monitor was located at approximate height of 3.0m above platform level, which is considered to be likely to result in elevated levels compared to head-height (1.8m). (The NOx monitors are small and unobtrusive, while the particulate monitoring equipment is more obvious and therefore prone to damage [eg vandalism]).

2.2.3 The main benefit in utilising a fixed location was considered to far outweigh these disadvantages, in that it allowed a long monitoring period (21 days), which provided some control for what was considered to be easily the greatest factor impacting on measurements, that of external wind speed and direction. The results obtained cover conditions during which external wind conditions would be variously favourable and not favourable to particulate dispersion.

2.3 Monitoring Period

Monitoring was carried out from 1500 on Monday 15th October to 1200 on Tuesday 6th November. Monitoring locations are identified in Table 1 and also detailed on Fig 1 (Appendix 1).

2.4 Monitoring Techniques

2.4.1 Monitoring was carried out for particulates at one location (Location A), and for Nitrogen Dioxide at all four locations (A-D)

2.4.2 Monitoring for particulates was undertaken by two techniques in tandem. Air was sampled at 1.3 l/min flow rate, via a Casella Microdust air quality sampler with infra-red direct-reading detection of particulates. The same air stream was then collected onto a 30mm GFA filter for subsequent gravimetric analysis, providing a gravimetric average result for the sampling period. Gravimetric analysis was undertaken at the Ethos Environmental Ltd Edinburgh laboratory.

2.4.3 This particulate sample was also despatched for analysis by sub-contract laboratory (UKAS-accredited) for polycyclic aromatic hydrocarbons (PAH). The test result for this sample is provided at appendix 2. PAHs are the most prevalent and significant carcinogenic components of DEEE. Additionally there is a robust air quality standard for these pollutants (expressed as one individual component, benzo[a]pyrene), for reference purposes.

2.4.4 Nitrogen Dioxide was sampled by means of standard air quality diffusion tubes supplied and analysed by City of Edinburgh Council Scientific Services Laboratory (UKAS-accredited). (See certificate of analysis at Appendix 3)

3.0 Results

3.1 Results are presented in Table 1.

Table 1. Air Quality Results

Location	Particulate, mg/m3 (infra-red, average)	Particulate, mg/m3 (gravimetric, average)	PAH (benzo[a]pyrene), ng/m3	NO2 ug/m3
A. East end of platform 16, 4m west of ticket barrier	0.073	0.092	1.07	303.8
B. At ticket barrier, height 2m	-	-	-	258.2
C. Central column on west concourse, height 2.5m	-	-	-	204.9
D. South side of concourse at WH Smith retail unit façade, height 3.0m	-	-	-	231.7

3.2 Nitrogen dioxide results would appear to confirm the assumption (see section 2.2) that the "A" monitoring location probably experiences higher levels of exhaust emission pollutants than at the ticket barrier itself

4.0 Interpretation

4.1 Particulates

4.1.1 Particulate concentrations were measured in the range 0.073 – 0.092 mg/m3 and are approximately 2% of the HSE workplace exposure limit (HSE Guidance Note EH40) for this material. It is acknowledged however that the particulate material within the station cannot necessarily be directly compared against this standard (which is meant to be applied to general particulate materials with no obvious toxic component), nevertheless this provides some degree of reassurance as to the extent of the exposure risk of employees occupying this location, as well as passengers occupying the concourse for any significant period of time.

4.1.2 These results can also be compared against external air quality data for Edinburgh City Centre (Queen St) which suggests PM10 levels (which are comparable to the parameter monitored at Waverley) of 9 ug/m3, suggesting that levels within Waverley are 8-10 times higher than external (www.scottishairquality.co.uk). The air quality standard for this parameter is 50ug/m3, however this relates to continual exposure (ie 7 days x 24 hours) as opposed to occupational exposure. Weighting the Waverley result for occupational exposure period (40 hours per week) at 90ug/m3 and the remainder (128 hours per week) at 9ug/m3, corresponds to an average" round-the clock" time-weighted exposure of 28ug/m3, which is still well within the air quality standard (although the caveat at 4.1 above regarding applicability of this criteria for particulate material with a significant DEEE component is still relevant here).

4.1.3 In order to "benchmark" the Waverley particulate results, reference can be made to a review of particulate air quality and employee exposures in a range of work environments not dissimilar to Waverley. The HSE's Health and Safety Laboratory undertook a monitoring assessment across 40 sites subject to DEEE sources including bus garages, ro-ro ferries, tollbooths, tunnels, railway depots etc. The findings of this comprehensive study were that air concentrations of respirable dusts (background air and personal exposures) were typically in the range 100-400 ug/m3. (Groves and Cain, A Survey of Exposure to Diesel Engine Exhaust Emissions in the Workplace *Ann. occup. Hyg.,* Vol. 44, No. 6, pp. 435^147, 2000). While this study is 12 years old this would suggest that the levels measured at Waverley are 20-90% of – and typical of - those encountered in these work environments.

4.2 Polycyclic Aromatic Hydrocarbons (PAHs)

4.2.1 In order to assess the particulate exposure with respect to the specific carcinogenic concerns of DEEE, the gravimetric particulate sample was analysed for PAHs. The "target" PAH of benzo[a]pyrene is used as the reference air quality standard (EPAQS) for all PAHs, and is 0.25ng/m3.

4.2.2 The air quality level measured over the three-week period at Waverley Station of 1.07 ng/m3 (see Table 1) is therefore approximately four times higher than the air quality standard. It should be borne in mind that this standard relates to 24 x 7 exposure, while employee exposures will be at most 24% of this (40 hours per week).

4.2.3 The closest air quality monitoring station for PAHs is at St Leonards monitoring station, Edinburgh. Ambient (ie external) level of PAHs in air exhibit some seasonal cycling (peaking in winter), with levels ranging between 0.015-0.25ng/m3, and averaging approximately 0.09 ng/m3 (www.uk-air.defra.gov.uk, 2011 data). Nevertheless it can be seen that the benzo[a]pyrene level measured within the station is approximately 10 times the average external "ambient" urban level.

4.2.4 There is no occupational exposure standard in the UK (WEL) for PAH or Benzo[a]pyrene. The most recent relevant exposure standard is contained within German regulations (Deutsche Forschungsgemeinschaft, 2004), which stipulate a level of 2000ng/m3.

4.2.5 A recent (2006) study was undertaken by HSE measuring personal exposures of over 200 employees in 25 different industries across the UK with higher-than–average likelihood of PAH exposures (eg tar distillation, coke ovens, asphalt, oil refinery, power stations, aluminium smelting). (*An Assessment of Occupational Exposure to Polycyclic Aromatic Hydrocarbons in the UK*, Ann. Occup. Hyg. (June 2006) 50(4): 395-403.doi: 10.1093/ annhyg/mel010). In this study the personal exposure levels of workers to benzo[a]pyrene ranged from <10 to 6210 ng m^{-3} 8 h TWA with a median of 10 ng m^{-3} (when weighted for 8 hours per day exposure). By way of comparison the level of benzo[a]pyrene measured at Waverley was 1.07 ng. m^{-3} , well below the median or mean, as would be expected. (It should be noted however that employees in the highest-risk industry in that study (coke ovens) would normally be expected to be using RPE to assist in control of exposure)

4.3 Oxides of Nitrogen (NOx)

4.3.1 Results (see Table 1) from analysis of the NO_2 diffusion tubes indicate that average levels around the concourse are in the range 200-300ug/m^3. Air quality monitoring programmes (City of Edinburgh Council) in the vicinity of Waverley Station (eg Princes Street, Cowgate, South Clerk Street) indicate levels in the broad range 30-80 ug/m^3, and averaging at approximately 50 ug/m^3. The Air Quality Standard for ambient air for NO_2 is 40ug/m^3, and results obtained from within the station are therefore significantly above this level and ambient levels in the vicinity.

4.3.2 The air quality standard is meant to be interpreted against round-the-clock exposure however. For occupational exposure there is no current robust standard (HSE Guidance Note EH40), however a level of 5.6 mg/m^3 (based on assumed exposure period of 40-hours per week) has been used previously and is still informally utilised as a useful reference. It can be concluded therefore that exposure of NMR staff (and sub-contract staff) within the station to NO_2 is unlikely to exceed 10% of this guide level.

5.0 Conclusions

5.1 Results are in line with expectations for such a work environment: levels of particulates, PAHs and NO_2 are elevated above background (ie urban) air quality levels.

5.2 Even assuming worst-case exposure patterns (ie average of 40 hours located at ticket barrier per week), the exposure levels are:

- Approximately 2% of HSE guidance (EH40) for respirable particulate
- 0.05% of the German occupational exposure standard for benzo[a]pyrene (a major carcinogenic component of DEEE and a target substance indicative of PAHs in general).
- approximately 10% of the median exposure for benzo[a]pyrene obtained in those UK industries with highest-risk of PAH exposure (see section 4.2.5)
- less than 10% of informal guidance levels for occupational exposure to NO_2

5.3 It is concluded therefore that the results suggest that levels at Waverley of particulate, benzo[a]pyrene and NO_2 are typical of such work environments and – in the absence of access to comparable measurements prior to the refurbishment development – it can be concluded the monitoring results do not suggest that station refurbishment alterations have obviously impacted negatively on air quality in general, or employee exposures specifically.

6.0 Recommendations

6.1 Respiratory Protection

6.1.1 It is concluded that use of respiratory protection for those employees engaged for significant periods at the ticket barriers is not warranted. Respiratory protection is a control measure that places significant demands on the user, and also in terms of management control.

6.1.2 Use of RPE by staff would also present a negative – indeed, probably alarming - image to passengers and others using the station. Whilst such perceptions are not in themselves sufficient grounds for not utilising RPE, it is felt that the airborne levels of the various pollutants measured are insufficiently high in comparison to occupational exposure standards to warrant such an intrusive and visible control measure.

6.1.3 Use of respiratory protection should always be seen as a last resort in any case, and it is felt that the client's resources could be more usefully directed towards review of at-source control options (see section 6.2) and possibly other exposure monitoring strategies (see sections 6.3 and 6.4)

6.2 Control

6.2.1 While the above results should provide some assurance that levels are typical of such environments, in the absence of definitive methodology or reference standards for occupational/environmental exposure assessment, HSE guidance indicates that emphasis should be placed on *control* rather than *monitoring*. Under the *Control of Substances Hazardous to Health (COSHH) Regulations 2002* there is in any case a general duty on the employer not just to comply with any specific exposure standards (where they exist) but - regardless of findings from air monitoring – to comply with the general duty to eliminate or reduce exposure risk "*so far as is reasonably practicable*".

6.2.2 To assist with this the HSE has published guidance (recently revised) HSG187 (Control of diesel engine exhaust emissions in the workplace), which details typical control measures available in a range of workplace environments impacted by DEEE.

6.2.3 Under the COSHH Regulations, assessments should in any case be reviewed where there may be significant change. Given the recent re-classification of DEEE and the development alterations to Waverley station, it may be prudent therefore to formally review the extent to which the existing controls in place at Waverley meet "*reasonably practicable*" criteria.

6.3 Health surveillance

For benzo[a]pyrene there is an option for health surveillance (monitoring of employee urine), which may be considered as a useful and non-invasive reassurance measure, and which may in the circumstances constitute a "reasonably practicable" measure to help confirm the conclusions from monitoring and other client risk assessment measures (ie that existing control measures meet *reasonable practicability* criteria)

6.4 Personal Exposure Monitoring

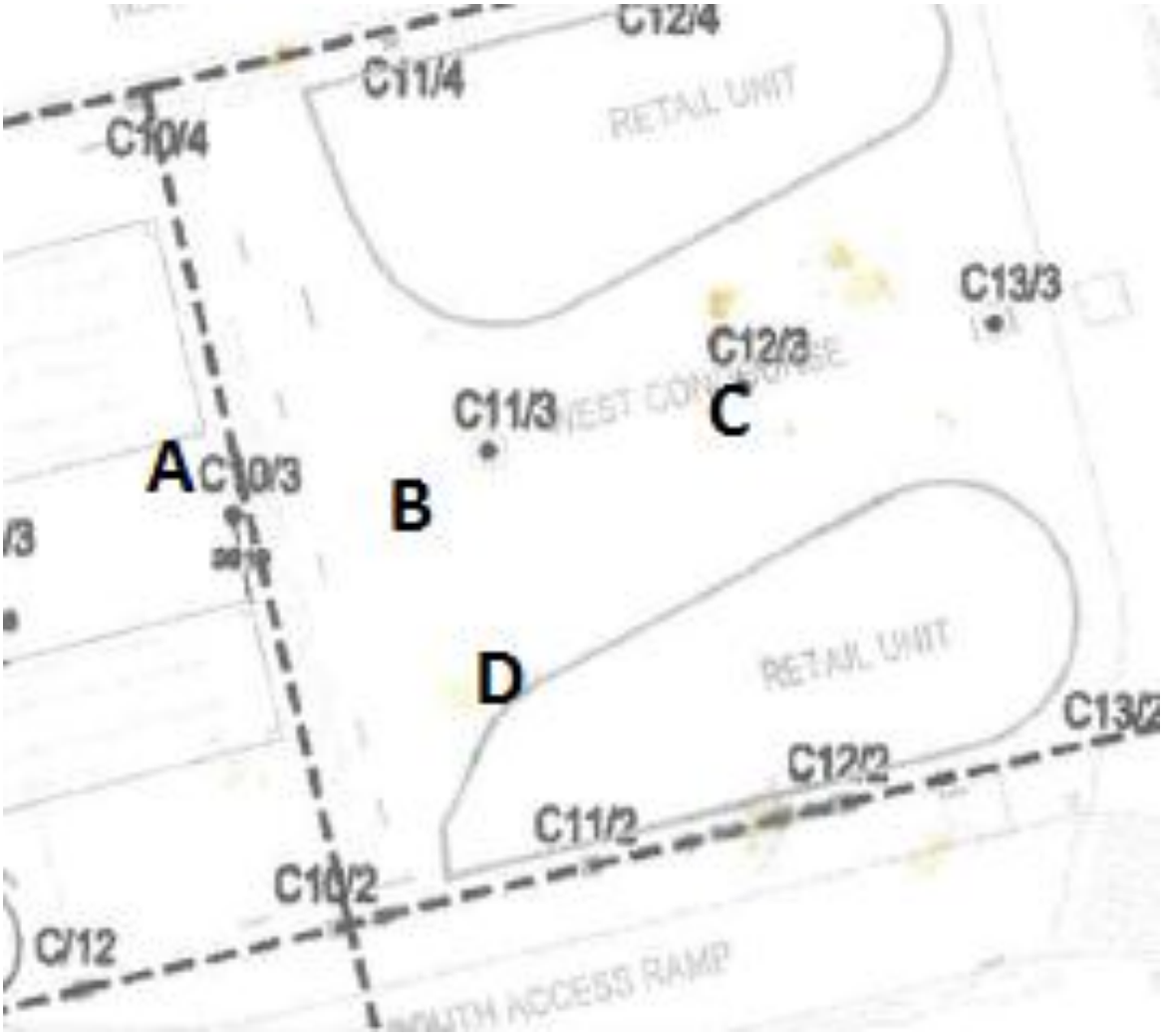
The client may wish to consider personal exposure monitoring to confirm the findings from this study. It is however our opinion that while this may provide concrete reassurance to staff (eg at ticket barriers), this is unlikely to provide significantly different results from that reported above, and that any such resources would be better deployed on options 6.2 or 6.3.

Please do not hesitate to get back to me with any queries you may have.

Yours sincerely
For Ethos Environmental Ltd

(Dr) Brian Gardner
Technical Manager

APPENDIX 1. MONITORING LOCATIONS



APPENDIX 2. ANALYSIS CERTIFICATION (Polycyclic Aromatic Hydrocarbons)

Environmental Scientifics Group

Analysis of Filter Sample for PAHs

Customer:	Brian Gardner Ethos Environmental Unit 15 Dumbryden Industrial Estate Dumbryden Road Edinburgh EH14 2AB
Testing Facility:	Environmental Scientifics Group Etwall House Bretby Business Park Ashby Rd Staffordshire DE15 0YZ
Laboratory Reference:	ASC/07583
Customer Reference:	P5357
Job Number:	NA
Samples Received:	15th November 2012
Sample Condition:	Good
Analysis Completed:	20th November 2012
Approved by:	
Date:	21 Nov 12
Approver's name:	Joanne Baker
Job Title:	Senior Analyst
Report Date:	21st November 2012

UKAS TESTING 1015

Environmental Scientifics Group

Introduction

A filter sample was received for the analysis of PAHs. The analysis of the 16 EPA PAHs included in this suite is UKAS accredited.

Experimental

The filter was spiked with a cocktail of deuterated internal standards 1000ng each of D10-Fluorene, D12-Chrysene, D12 Benz(a)anthracene and 1000ng D12-Benzo(a)pyrene). The sample was Soxhlet extracted with dichloromethane and then reduced to a volume of approximately 1mL.

The sample extract was transferred to an auto sampler vial and measured by GC-MS for 16 PAHs after the addition of a syringe standard containing 1000ng of each of D10-Fluoranthene D12 Benzo(ghi)perylene and 1000ng D12 Perylene.

Measurement was achieved using a Agilent 6890/5973 GC-MS equipped with a 30m DB-5ms 0.25µm film capillary column. The mass spectrometer was operated in selective ion monitoring (SIM) mode the ions recorded being listed below.

The UKAS accredited methods used for the PAH sample preparation and measurement were ASC/SOP/204 – issue 1, and ASC/SOP/205 – issue 1 respectively.

ESG
Environmental Scientifics Group

Results

The results from the analysis are detailed in the following tables and are reported to two significant figures as total ng in the samples as received. The results have not been blank corrected. LoD is the limit of detection and has been calculated using twice the response of our internal blank.

Uncertainty for this analysis is estimated to be 20%.

Table 1 Results of PAH Analysis by GC-MS

	LoD	ASC/07583.001 Filter Sample (ng)
Naphthalene	10	<10
Acenaphthylene	10	<10
Acenaphthene	10	<10
Fluorene	10	<10
Phenanthrene	10	71
Anthracene	10	10
Fluoranthene	10	180
Pyrene	10	350
Benzo (A) Anthracene	10	65
Chrysene	10	96
Benzo (B) Fluoranthene	10	24
Benzo (K) Fluoranthene	10	17
Benzo (A) Pyrene	20	44
Indeno (1,2,3-CD) Pyrene	10	35
Dibenzo (A,H) Anthracene	10	<10
Benzo (GHI) Perylene	10	56

UKAS TESTING
1015

APPENDIX 3. ANALYSIS CERTIFICATION (Nitrogen Dioxides)

·EDINBVRGH·
THE CITY OF EDINBURGH COUNCIL

Ethos Environmental
Head Office
Units 15/16 & 19
Dumbryden Industrial Estate
Dumbryden Road
EH14 2AB

For the attention of: Date of Issue: 21 November 2012

The sampling tubes were not exposed by this laboratory and the concentration in air was caclulated using exposure times stated by the sampling officer.

REPORT OF NITROGEN DIOXIDE ANALYSIS OF PASSIVE DIFFUSION TUBES

Received from Head Office on 07/11/2012 Submitted by

Laboratory Reference	Client's Reference	Sampling point	Exposure start date	Exposure end date	Nitrogen dioxide in tube (mg/L)	* Nitrogen dioxide in air(µg/m3)
50302133	1	Centre Concourse	/ /	/ /	7.637	204.9
50302134	2	South Side by WH Smith	/ /	/ /	8.638	231.7
50302135	3	At Gates	/ /	/ /	9.624	258.2
50302136	4	Platform 16	/ /	/ /	11.326	303.8

Signed: Brian Cavens

Brian Cavens : Regulatory Testing Team Leader

The sample was examined under my direction, according to documented standard and in-house methods (Note 2) , details of which are available on request.

Notes:
1. No liability can be accepted for information given by customer
2. Non-accrediatied tests are indicated by "*"
3. Subcontracted tests are indicated by "#"
4. This report must not be reproduced except in full without written approval of the laboratory

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INVESTORS IN PEOPLE

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