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**AIR QUALITY MONITORING FOR RESPIRABLE DUST :
LUL TRAIN OPERATORS AND PLATFORM STAFF**

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Air Quality Monitoring for Respirable Dust : LUL Train Operators and Platform Staff

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1. Introduction

- 1.1 LUL Procedure No. 3-05106-601 (Issue 1 Cat 5) contains requirements for dust monitoring on the Underground.
- 1.2 At the request of Chris Beach, LU Occupational Hygiene Specialist, personal monitoring for respirable dust exposure was to be undertaken on Station Staff conducting platform duties (Station Assistant Trains, SATS) and Train Operators whilst driving. In addition, one sample from each Line, collected whilst monitoring Train Operator exposure, was to be analysed for crystalline silica.
- 1.3 The specific stations and locations where monitoring was requested were:

Stations	Platform Locations
Aldgate East	District Line
Baker Street	Jubilee, Bakerloo and Circle Lines
Elephant and Castle	Bakerloo and Northern Lines
Euston Square	Circle and Hammersmith Lines
Hampstead	Northern Line
Kings Cross	Northern, Piccadilly, Metropolitan and Victoria Lines
Piccadilly Circus	Bakerloo Line
Tottenham Court road	Central and Northern Lines
Vauxhall	Victoria Line
Hampstead Station	Northern Line

- 1.4 Train operator monitoring was to be carried out on the Central, Bakerloo, Piccadilly, Jubilee, Northern, Circle and Hammersmith and Victoria Lines. It is known that the highest levels of airborne dust are found in tunnel and cut and cover sections of the track. Therefore monitoring was not scheduled for the Metropolitan or District Lines. Train operators driving trains on the Circle and Hammersmith Line were to be monitored.

2. Technical Background

- 2.1 The health effects concerning inhalation exposure to dust are dependent upon the size, shape and composition of the particles. In occupational health general dust is classified in terms of particle size, termed either inhalable or respirable. The inhalable fraction of dust is defined as particles that can be inhaled and deposited throughout the respiratory tract, i.e. from the nasal to the alveolar region in the lungs. Respirable dust is the term given to dust particles that are small enough to penetrate and therefore largely deposit in the alveolar region.

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- 2.2 Respirable and inhalable dusts are currently assessed against the respective Workplace Exposure Limits (WEL's) of 4 mg/m³ and 10 mg/m³ averaged over an 8-hour reference period (*Health and Safety Executive Document EH40/05*).
- 2.3 Prolonged exposure to respirable quartz may result in silicosis a progressive and irreversible condition in which healthy lung tissue becomes replaced with areas of fibrosis. The HSE Workplace Exposure Limit (WEL) for respirable crystalline silica has been set at a level of 0.3mg/m³ averaged over an 8-hour reference period (*HSE Document EH40/05*).

3. Method

- 3.1 Respirable dust levels were measured following the guidance set out in the Health & Safety Executive Document *MDHS 14/3: General methods for sampling and gravimetric analysis of respirable and inhalable dust*, and in house test procedure 4R-E206 Issue 4.
- 3.2 Sampling pumps equipped with respirable dust cyclone dust heads were worn by the Train Operators and Station Staff. An example of a cyclone dust head is shown in Figure 1. Monitoring was carried out at each of the stations for one shift timed to include the peak hours. Monitoring of the Train Operators was carried out over three shifts on each Line again timed to include peak hours.
- 3.3 One of the primary aims was to obtain monitoring data for a shift on each occasion. This was either achieved by a sequence of individuals wearing the same sampling head or each wearing a separate sampling head. Where separate sampling heads are used each must be run for sufficient time for the filter to make a measurable weight gain.
- 3.4 The samples were collected on glass fibre type A/E filters for gravimetric analysis or GLA 5000 PVC filters to allow both gravimetric analysis and then subsequent analysis for respirable quartz by infra red spectroscopy.
- 3.5 In locations where there would be little or no duties on the platforms static sampling pumps were set up in strategic locations where possible. It should however be noted that static results are not the same as personal sampling results although can be indicative in some circumstances.

4. Analysis

- 4.1 The samples taken on site were returned to the laboratory and gravimetric analysis undertaken in accordance with *MDHS 14/3*.
- 4.2 Following gravimetric analysis the personal respirable dust samples and selected static respirable dust samples together with blanks were submitted to the Institute of Occupational Medicine (IOM) for quartz analysis.

5. Results

5.1 Train Operators

5.1.1 Central Line

The respirable dust exposure levels measured are given in Table 1. The levels measured on the 21st, 22nd and 23rd November 2006 were from 0.26 to 1.16 mg/m³.

5.1.2 Jubilee Line

The respirable dust exposure levels measured are given in Table 2. The levels measured on the 18th, 19th and 20th December 2006 were from 0.13 to 0.19 mg/m³.

5.1.3 Circle and Hammersmith Lines

The respirable dust exposure levels measured are given in Table 3. The levels measured between the 27th, 28th and 29th November 2006 were from 0.17 to 0.26mg/m³.

5.1.4 Northern Line

The respirable dust exposure levels measured are given in Table 4. The levels measured on the 5th, 6th and 7th December 2006 were from 0.25 to 0.32 mg/m³.

5.1.5 Piccadilly Line

The respirable dust exposure levels measured are given in Table 5. The levels measured on the 30th November, the 1st and 4th December 2006 were from 0.34 to 0.41mg/m³.

5.1.6 Victoria Line

The respirable dust exposure levels measured are given in Table 6. The levels measured on the 13th, 14th and 15th December 2006 were from 0.50 to 0.58 mg/m³.

5.1.7 Bakerloo Line

The respirable dust exposure levels measured are given in Table 7. The levels measured on the 8th, 11th and 12th December 2006 were from 0.59 to 1.44 mg/m³.

5.2 Station Staff

The monitoring was primarily aimed at assessing the exposure of staff carrying out platform duties to respirable dust by means of personal sampling. Where no platform duties were carried out static samples were taken, these however cannot directly replace personal samples. In the following results summary the focus is on the personal samples where possible.

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5.2.1 Hampstead Station

The results for the monitoring at Hampstead Station are given in Table 8. The monitoring was carried out on the 8th March 2007. Only limited time was spent on the platforms with the majority of the time spent at the Gate line.

The results of the personal samples for the staff were between 0.52 and 0.77 mg/m³.

5.2.2 Baker Street Station

The results for the monitoring at Baker Street Station are given in Table 9. The monitoring was carried out on the 13th March 2007. Each duty monitored included 2 hours SATS duty on the platforms. The range of the results was 0.45 – 0.51mg/m³.

5.2.3 Euston Square Station

The results for the monitoring at Euston Square Station are given in Table 10. The monitoring was carried out on the 8th January 2007. The results for the personal samples on the Gate line were 0.17 and 0.23 mg/m³. On the day of the visit SATS duties were not scheduled, therefore in order to gain some guidance a static sample was taken on the platforms. The result of the static sample was 0.18 mg/m³.

5.2.4 Aldgate East

The results for the monitoring at Aldgate East Station are given in Table 11. The monitoring was carried out on the 21st December 2006. The results were in the range 0.21 to 0.97 mg/m³. On the day of sampling, due to staff absence; SATS duties were not carried out and the Station Supervisor closed one exit of the station.

5.2.5 Elephant and Castle

The results for the monitoring at Elephant and Castle Station are given in Table 12. The monitoring was carried out on the 9th March 2007. No SATS duties were undertaken on the day of the visit. The results of the personal samples were 0.06 and 0.07mg/m³ which reflect attendance at the Gate line.

5.2.6 Piccadilly Circus Station

The results for the monitoring at Piccadilly Circus Station are given in Table 13. The monitoring was carried out on the 10th January 2007. Personal samples were taken for staff working for SATS duties on both eastbound and westbound platforms of Piccadilly Line; the results were from 0.65 to 0.73 mg/m³. No staff duties were carried out on the Bakerloo Line platform, therefore, a static sample was equipped on the ramp at the arrival end of southbound platform and the result was 0.66 mg/m³.

5.2.7 Tottenham Court Road Station

The results for the monitoring at Tottenham Court Road Station are given in Table 14. The monitoring was carried out on the 11th January 2007. A personal sample was taken for one person working carrying out SATS duties on the eastbound platform of Central Line, the results was 0.24 mg/m³. Two static samples were taken from the Northern Line platforms in order to provide indicative dust levels, the results were 0.54 and 0.62 mg/m³.

5.2.8 Vauxhall Station

The results for the monitoring at Vauxhall Station are given in Table 15. The monitoring was carried out on the 12th January 2007. Platform duties took place for 1 hour 30 minutes on the northbound platform, the result for the personal sample collected was 0.57 mg/m³. The static samples located on the SB and NB platforms indicated levels of 0.74 and 0.98mg/m³ respectively.

5.2.9 Kings Cross Station

The results for the monitoring at Kings Cross Station are given in Table 16. The monitoring was carried out on the 7th March 2007. SATS duties were undertaken on platforms 4, 5 and 8 for 2 hours. The results were in the range 0.30 – 0.59mg/m³.

5.3 The IOM certificates for the analysis of quartz on the samples No's 060755/21, 23, 25, 27, 29, 53 and 55 are included in Appendix 1. The results for each of the Lines are given in Table 17.

6. Discussions and Conclusions

6.1 The levels of airborne respirable dust measured for personal samples on Train Operators on the following lines: Central, Jubilee, Circle and Hammersmith, Northern, Piccadilly, Victoria and Bakerloo were all below the Workplace exposure limit for respirable dust of 4 mg/m³ (long term 8 hour time weighted average).

6.2 The levels of respirable quartz (crystalline silica) were all significantly below the Workplace exposure limit of 0.3 mg/m³ (long term 8 hour time weighted average). In most cases crystalline silica was not detected.

6.3 The levels of airborne respirable dust measured for personal samples taken on staff carrying out platform duties as part of their shifts at the following stations: Hampstead, Baker Street, Kings Cross, Piccadilly Circus, Tottenham Court Road and Vauxhall were all below the Workplace exposure limit for respirable dust of 4 mg/m³ (long term 8 hour time weighted average).

6.4 Platform duties were not scheduled at all of the stations. However, the results of the static samples on the platforms and personal samples worn by personnel on the gate lines suggest that personal exposure to respirable dust on the platforms would be below the Workplace exposure limit for respirable dust of 4 mg/m³ (long term 8 hour time weighted average).

Air Quality Monitoring for Respirable Dust: Train Operators and Platform Staff

Table 1: Central Line Train Operators

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/1	RD	Ravi Sooriah, TO, Driving train	21/11/06	06.14	07.45	2.2	200.2	1.16	West Ruislip Depot → Hanger Lane → North Acton → Notting Hill Gate → Bond Street → Stratford → Epping → Bethnal Green → White City → West Ruislip → West Ruislip Depot → Hanger Lane → Liverpool Street → White City → West Ruislip
		S. Sheltor, TO, checking CCTV in Cab	21/11/06	07.50	09.18	2.2	193.6		
		Steve O'Neil, TO, Driving train	21/11/06	11.15	12.59	2.2	228.8		

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/3	RD	Paul Andrews , TO, Driving train	22/11/06	06.31	07.40	2.2	151.8	0.26	Hainault → Wanstead → Ealing Broadway → Stratford → Hainault → Stratford → Lancaster Gate → North Acton → Ealing Broadway → Hainault → Woodford → Hainault
			22/11/06	07.45	08.54	2.2	151.8		
		Martin Struthers, staff no. 8682243 TO, Driving train.	22/11/06	09.15	10.26	2.2	156.2		
			22/11/06	10.31	11.36	2.2	143		
		Paul Drew, staff no. 9093659, TO, Driving	22/11/06	12.23	13.41	2.2	171.6		

Air Quality Monitoring for Respirable Dust: Train Operators and Platform Staff

Table 1: Central Line Train Operators (Continued)

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/21	RD	Tim Smith, staff no. 3090128 TO, Driving train	23/11/06	06.54	08.23	2.2	195.8	0.41	West Ruislip Depot → West Ruislip → North Acton → Epping → West Ruislip → Leytonstone → West Ruislip
			23/11/06	08.31	10.19	2.2	237.6		
		Mandy Faux, staff no. 7685521 TO, Driving train	23/11/06	11.17	12.17	2.2	132		
		Rakesh Kumar, staff no. 4673299 TO, Driving train	23/11/06	12.25	13.31	2.2	145.2		

Air Quality Monitoring for Respirable Dust: Train Operators and Platform Staff

Table 2: Jubilee Line Train Operators

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/35	RD	Fyns Sydney, TO, staff no. 1699374, Driving train	18/12/06	08.14	09.12	2.2	127.6	0.17	Wembley Park → Stratford → Wembley Park → Stratford → Wembley Park → Stratford → Canada Water → Wembley Park
			18/12/06	08.21	10.08	2.2	103.4		
			18/12/06	12.13	13.15	2.2	114.4		
			18/12/06	13.12	14.03	2.2	112.2		

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/37	RD	Robert Wilkin, Train operator, staff no. 3879342, Driving train	19/12/06	07.28	10.05	2.2	345.4	0.13	North Greenwich → Willesden Green → North Greenwich → Wembley Park → Stanmore → Wembley Park → North Greenwich → Wembley Park → North Greenwich
			19/12/06	11.36	12.07	2.2	68.2		
			19/12/06	12.11	12.57	2.2	101.2		
			19/12/06	13.07	14.40	2.2	204.6		

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Table 2: Jubilee Line Train Operators (Continued)

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)*	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/55	RD	Nialla Dawson, TO, staff no. 7684593, Driving train	20/12/06	09.08	09.57	2.2	105.1	0.19	Wembley Park → North Greenwich → Stanmore → Stratford → North Greenwich → Wembley Park → Stratford → Stanmore → Neasden
			20/12/06	10.16	11.14	2.2	124.4		
			20/12/06	11.21	12.20	2.2	126.5		
			20/12/06	12.28	12.35	2.2	15.0		
			20/12/06	13.37	15.23	2.2	227.3		
			20/12/06	15.32	16.38	2.2	141.5		

* Flow rate correction atmospheric pressure >1030mbar

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Table 3: Circle and Hammersmith Line Train Operators

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/5	RD	Robert Brown, IO, staff no. 7680757, Driving train	27/11/06	13.32	14.34	2.2	136.4	0.26	Barking → Hammersmith → Edgware Road → Hammersmith → Plaistow → Hammersmith → Barking
			27/11/06	14.38	14.55	2.2	37.4		
			27/11/06	16.09	16.20	2.2	24.2		
			27/11/06	16.28	17.28	2.2	132		
			27/11/06	17.31	18.30	2.2	129.8		
			27/11/06	18.32	19.46	2.2	160.6		

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/7	RD	Robert Brown, IO, staff no. 7680757, Driving train	28/11/06	13.47	14.47	2.2	132	0.19	Barking → Hammersmith → Barking → Hammersmith → Edgware Road train cancelled at Edgware Road
			28/11/06	14.50	15.53	2.2	138.6		
			28/11/06	15.58	17.07	2.2	151.8		
			28/11/06	17.10	17.23	2.2	28.6		

Air Quality Monitoring for Respirable Dust: Train Operators and Platform Staff

Table 3: Circle and Hammersmith Line Train Operators (Continued)

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/23	RD	Robert Brown, IO, staff no. 7680757, Driving train	29/11/06	14.41	17.38	2.2	389.4	0.17	Edgware Road → Edgware Road → Edgware Road → Hammersmith → Whitechapel → Hammersmith → West Ham
			29/11/06	18.38	18.50	2.2	26.4		
			29/11/06	18.52	19.48	2.2	123.2		
			29/11/06	19.50	20.29	2.2	85.8		
			29/11/06	20.36	21.28	2.2	114.4		

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Table 4: Northern Line Train Operators

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/13	RD	Keith Irvin, TO, staff no. 5685425, Driving train	05/12/06	09.20	09.34	2.2	30.8	0.25	East Finchley → High Barnet → East Finchley → High Barnet → Morden → East Finchley
			05/12/06	09.31	09.53	2.2	35.2		
			05/12/06	10.00	10.43	2.2	94.6		
			05/12/06	10.52	12.08	2.2	167.2		
			05/12/06	12.17	13.13	2.2	123.2		

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/16	RD	Keith Irvin, TO, staff no. 5685425, Driving train	06/12/06	08.29	10.07	2.2	215.6	0.29	East Finchley → Kennington → High Barnet → Kennington → High Barnet → East Finchley → High Barnet → Morden → Kings Cross
			06/12/06	10.15	11.52	2.2	213.4		
			06/12/06	11.57	12.09	2.2	26.4		
			06/12/06	13.00	13.13	2.2	28.6		
			06/12/06	13.19	14.36	2.2	169.4		
			06/12/06	14.44	15.22	2.2	83.6		

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Table 4: Northern Line Train Operators (Continued)

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/27	RD	Nicholas Fitzpatrick, TO, staff no. 7021993, Driving train	07/12/06	09.15	09.30	2.2	33	0.32	East Finchley → High Barnet → Kennington → High Barnet → Morden → High Barnet → Kennington → Waterloo
			07/12/06	09.35	11.24	2.2	239.8		
			07/12/06	11.30	12.52	2.2	180.4		
			07/12/06	13.38	14.58	2.2	176		
			07/12/06	15.04	16.04	2.2	132		

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Table 5: Piccadilly Line Train Operators

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/10	RD	Simon Jameson, IO, staff no. 5121829 Driving train	30/11/06	16.14	20.27	2.2	556.6	0.41	Acton Town → Cockfosters → Acton Town → Arnos Grove → Acton Town
			30/11/06	21.35	22.20	2.2	99		

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/12	RD	Gary Clark, TO, staff no. 9012480, Driving train	01/12/06	08.22	09.27	2.2	143	0.34	Acton → Cockfosters → Rayners Lane → Acton Town → Arnos Grove → Cockfosters → Rayners Lane → Acton Town
			01/12/06	09.32	10.58	2.2	189.2		
			01/12/06	11.12	11.32	2.2	44		
			01/12/06	12.24	13.26	2.2	136.4		
			01/12/06	13.29	13.40	2.2	24.2		
			01/12/06	13.43	14.09	2.2	57.2		

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/25	RD	Gary Clark, TO, staff no. 9012480, Driving train	04/12/06	09.24	09.53	2.2	63.8	0.37	Acton Town → Heathrow Airport 1-3 → Wood Green → Acton Town → Heathrow 1-3 → Wood Green → Acton Town
			04/12/06	10.00	11.10	2.2	154		
			04/12/06	11.37	12.26	2.2	107.8		
			04/12/06	13.24	15.28	2.2	272.8		
			04/12/06	15.37	16.24	2.2	103.4		

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Table 6: Victoria Line Train Operators

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/31	RD	Tony Barrett, TO, Driving train	13/12/06	08.00	11.00	2.2	396	0.50	Seven Sisters → Walthamstow → Brixton → Walthamstow → Brixton → Seven Sisters → Walthamstow → Brixton → Walthamstow → Brixton → Walthamstow → Brixton → Seven Sisters
			13/12/06	11.50	15.50	2.2	528		

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/64	RD	Amada Philpet, TO, Driving train	14/12/06	08.10	11.10	2.2	396	0.52	Seven Sisters → Walthamstow → Brixton → Walthamstow → Brixton → Seven Sisters → Walthamstow → Brixton → Walthamstow → Brixton → Seven Sisters
			14/12/06	12.10	15.10	2.2	396		

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/53	RD	Gundry Burak, Train operator, staff no. 6689035	15/12/06	09.29	11.10	2.2	222.2	0.58	Seven Sisters → Walthamstow → Brixton → Seven Sisters → Walthamstow → Brixton → Walthamstow → Brixton → Seven Sisters
			15/12/06	12.19	15.14	2.2	385.0		

Air Quality Monitoring for Respirable Dust: Train Operators and Platform Staff

Table 7: Bakerloo Line Train Operators

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/17	RD	Dennis Abrey, TO, staff no. 7687407, Driving train	08/12/06	09.25	09.55	2.2	66	0.59	Queens Park → Elephant and Castle → Queens Park → Elephant and Castle → Queens Park → Elephant and Castle → Queens Park → Elephant and Castle → Queens Park → Elephant and Castle
			08/12/06	10.26	10.56	2.2	66		
			08/12/06	11.04	11.36	2.2	70.4		
			08/12/06	11.42	12.49	2.2	147.4		
			08/12/06	13.53	15.07	2.2	162.8		
			08/12/06	15.17	16.24	2.2	147.4		

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/61	RD	Hass Mehmet, TO, Driving train	11/12/06	08.50	12.20	2.2	462	0.67	Elephant and Castle → Queens Park → Elephant and Castle → Queens Park → Elephant and Castle → Queens Park → Elephant and Castle → Queens Park → Queens Park → Elephant and Castle → Willesden Junction → Stonebridge Park Depot → Elephant and Castle
			11/12/06	12.50	15.20	2.2	330		

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	ROUTE COVERED
060755/29	RD	Chantelle Patterson, TO, Driving train	12/12/06	08.50	11.50	2.2	396	1.44	Elephant and Castle → Queens Park → Elephant and Castle → Queens Park → Elephant and Castle → Queens Park → Queens Park → Elephant and Castle → Willesden Junction → Stonebridge Park Depot → Elephant and Castle
			12/12/06	12.50	15.20	2.2	330		

Air Quality Monitoring for Respirable Dust: Train Operators and Platform Staff

Table 8: Hampstead Station

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	LOCATIONS & COMMENTS
060755/97	RD	Bill Stop, staff no. 9809683 Customer Service Assistant at Gate	08/03/07	07.49	12.01	2.2	554.4	0.75	Gate line until 09.15. Platform duty until 09.45 Remainder security check and lift training.
060755/101	RD	Alexander Boateng, staff no. 4699093 Ticket Office	08/03/07	07.55	12.03	2.2	545.6	0.77	Ticket office until 10.30. Remainder gate line and break.
060755//102	RD	Brian Thomas, Customer Service Assistant at Gate	08/03/07	07.38	12.00	2.2	576.4	0.52	Gate line and camera check until 10.00. Remainder break and Gate line.

Table 9: Baker Street Station

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	LOCATIONS & COMMENTS
060755/108	RD	Kumar Arjunan, staff no. 9801995 Customer Service Assistant, SATS, Platform 8	13/03/07	07.41	12.30	2.2	635.8	0.51	SATS, Southbound, Bakerloo Line, Platform 8, 2 hrs. Remainder Met gate Line, Chiltern Gate Line and break
060755/109	RD	Shabika Khan, staff no. 9814050 trainee for Customer Service Assistant SATS, Platform 8	13/03/07	07.41	12.30	2.2	635.8	0.47	SATS, Southbound, Bakerloo Line, Platform 8, 2 hrs. Remainder Met gate Line, Chiltern Gate Line and break
060755/110	RD	Siegfried Irish, staff no. 1103335, Customer Service Assistant, SATS, Platform 7	13/03/07	07.41	12.28	2.2	637.4	0.45	SATS, Southbound, Jubilee Line, Platform 7, 2 hrs. Remainder Chiltern gate line, security check and break

Air Quality Monitoring for Respirable Dust: Train Operators and Platform Staff

Table 10: Euston Square Station

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	LOCATIONS & COMMENTS
060755/72	RD	Albert Young, staff no. 4675585	08/01/07	05.45	10.45	2.2	660	0.23	Gate line until 07.30 then remainder Ticket Office
060755/70	RD	Departure end Eastbound, Platform 2	08/01/07	06.00	11.00	2.2	660	0.18	Static 5 hours
060755/71	RD	Ken Alia, staff no. 3090334	08/01/07	07.00	11.00	2.2	528	0.17	Gate line until 10.15 then remainder break and Ticket Office

Table 11: Aldgate East Station

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)*	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	LOCATIONS & COMMENTS
060755/39	RD	Abdul Rashid, staff no. 7054448, Station Supervisor	21/12/06	07.16	08.40	2.2	180	0.80	Platform, Ticket Office and Gate line
060755/40	RD	Paul Bailey, staff no. 1692420	21/12/06	07.38	11.20	2.2	476	0.97	Ticket Office
060755/43	RD	Sue Clatworthy, staff no. 9803940	21/12/06	08.44	13.29	2.2	611	0.41	Assisting customers at Gate line
060755/42	RD	Shahinoor Miah, staff no. 9806766	21/12/06	07.19/ 09.05	09.01/ 10.43	2.2	429	0.27	Customer Services Assistant
060755/44	RD	Samuel Dada, staff no. 5691824	21/12/06	10.55	12.49	2.2	244.46	0.21	Assisting customers at Gate line

* Pressure on day >1030mbar volume correction made.

Air Quality Monitoring for Respirable Dust: Train Operators and Platform Staff

Table 12: Elephant and Castle Station

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	LOCATIONS & COMMENTS
060755/103	RD	Arjun Floray, staff no. 9813469, Customer Service Assistant at Shopping Centre Gate line	09/03/07	07.45	11.58	2.2	556.6	0.06	Gate line until 10.45. Remainder Platform checks until 11.15, break and return to Gate line
060755//105	RD	Violet Brown, staff no. 9805322 Customer Service Assistant at Southbank University Gate line	09/03/07	07.31	11.59	2.2	589.6	0.07	Gate line until 10.15, break then return to Gate line

Table 13: Piccadilly Circus Station

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	LOCATIONS & COMMENTS
060755/75	RD	Static sample Southbound Platform 2 ramp Bakerloo Line	10/01/07	08.07	12.07	2.2	528	0.66	Static sample, 4 hrs
060755/76	RD	David Nash, staff no. 9812574, Customer Service Assistant	10/01/07	07.51	10.46	2.2	385	0.73	2hrs SATS, Eastbound, Piccadilly Line
060755//81	RD	Angela Loach, staff no. 9811756, Customer Service Assistant	10/01/07	07.56	10.45	2.2	371.8	0.65	2hrs SATS, Westbound, Piccadilly Line. Shift finish 10.45

Air Quality Monitoring for Respirable Dust: Train Operators and Platform Staff

Table 14: Tottenham Court Road Station

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	LOCATIONS & COMMENTS
060755/85	RD	Ramp at Southbound, Northern Line, Platform 4	11/01/07	07.45	12.38	2.2	644.6	0.54	Static sample
060755/86	RD	Suzete Wright, staff no 9805198, Customer Service Assistant on Eastbound, Central Line, Platform 2	11/01/07	07.56	12.20	2.2	624.8	0.24	SATS on Platform 2 until 10.00 then break and duties on Gate line and Lower concourse until shift finish
060755/87	RD	Ramp at Northbound Northern Line Platform 3	11/01/07	07.56	12.22	2.2	585.2	0.62	Static sample

Table 15: Vauxhall Station

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	LOCATIONS & COMMENTS
060755/91	RD	Bunmi Omilabu, Customer Service Assistant, staff no. 4701702	12/01/07	07.53	13.03	2.2	682.0	0.57	SATS Platform 1, Northbound until 09.30 then Gate line duty and break until finish.
060755/93	RD	Ramp at arrival end of Victoria Line, SB Platform	12/01/07	07.53	13.01	2.2	677.6	0.74	Static sample
060755/94	RD	Ramp at arrival end of Victoria Line, NB Platform	12/01/07	07.50	13.09	2.2	701.8	0.98	Static sample

Air Quality Monitoring for Respirable Dust: Train Operators and Platform Staff

Table 16: Kings Cross Station

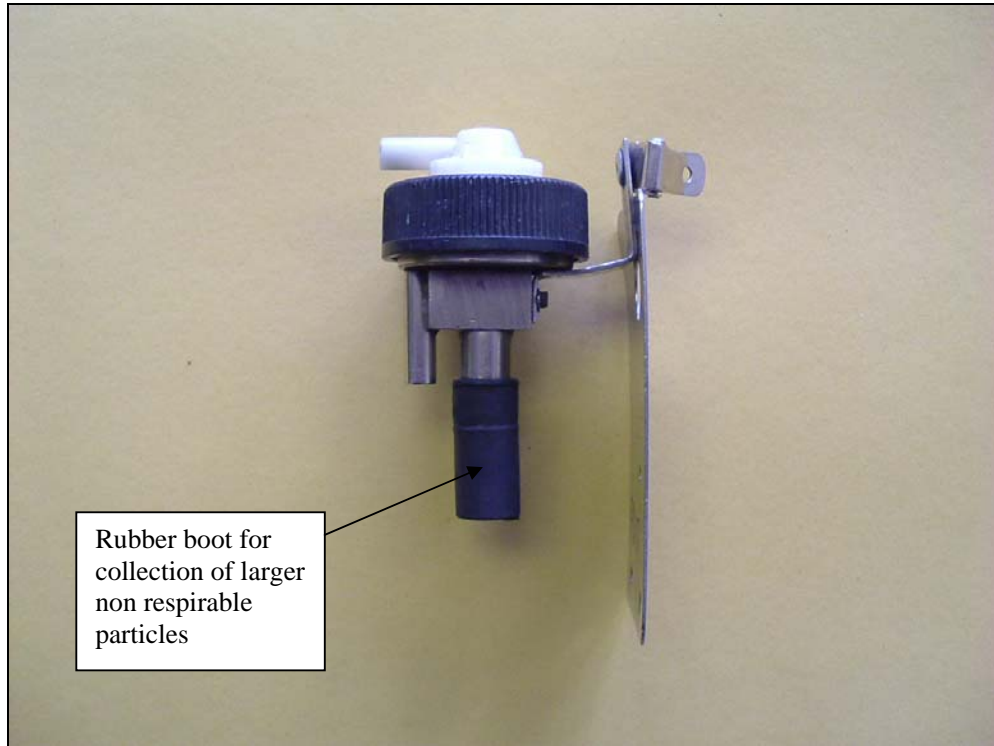
FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	START TIME	FINISH TIME	FLOW RATE (l/min)	VOLUME OF AIR (litres)	CALC. DUST CONC ^N (MG/M ³)	LOCATIONS & COMMENTS
060755/98	RD	Barry Wale, staff no. 2686698	07/03/07	07.50	12.00	2.2	550	0.30	SATS Platform 5 until 10.00 then remainder break, security checks and Victoria concourse
060755/99	RD	Thomas Muriuki, staff no. 9801023, Customer Service Assistant	07/03/07	07.44	12.01	2.2	565.4	0.59	SATS Platform 4 until 10.00 then patrol around Platforms 4 – 6 and Gate line duty
060755/100	RD	Emlyn Ragbirsingh, staff no. 2691564 Customer Service Assistant	07/03/07	07.41	12.03	2.2	576.4	0.49	SATS Platform 8 until 10.00 then break, security checks and station familiarisation

Air Quality Monitoring for Respirable Dust: Train Operators and Platform Staff

Table 17: Train Operator Respirable Crystalline Silica Monitoring

FILTER NUMBER	SAMPLE TYPE (RESPIRABLE DUST, RD, INHALABLE DUST, ID)	SAMPLE LOCATION	DATE	VOLUME OF AIR (litres)	CRYSTALLINE SILICA (mg/filter)	CRYSTALLINE SILICA (mg/m ³)	LOCATIONS & COMMENTS
060755/21	RD	Central Line Train Operators Driving Trains	23/11/06	710.6	0.03	0.04	West Ruislip Depot → West Ruislip → North Acton → Epping → West Ruislip → Leytonstone → West Ruislip
060755/55	RD	Jubilee Line Train Operator Driving Trains	20/12/06	739.8	<0.01	<0.01	Wembley Park → North Greenwich → Stanmore → Stratford → North Greenwich → Wembley Park → Stratford → Stanmore → Neasden
060755/23	RD	Circle Line Train Operator Driving Trains	29/11/06	739.2	<0.01	<0.01	Edgware Road → Hanger Lane → North Acton → Notting Hill Gate → Bond Street → Stratford → Epping → Bethnal Green → White City → West Ruislip → West Ruislip Depot → Hanger Lane → Liverpool Street → White City → West Ruislip
060755/27	RD	Northern Line Train Operator Driving Trains	06/12/06	761.2	<0.01	<0.01	High Barnet → Kennington → High Barnet → Morden → High Barnet → Kennington → Waterloo
060755/25	RD	Piccadilly Line Train Operator Driving Trains	04/12/06	701.8	0.01	0.01	Acton Town → Heathrow Airport 1-3 → Wood Green → Acton Town → Heathrow 1-3 → Wood Green → Acton Town
060755/53	RD	Victoria Line Train Operator Driving Trains	15/12/06	607.2	0.01	0.02	Seven Sisters → Walthamstow Central → Brixton → Seven Sisters → Walthamstow Central → Brixton → Walthamstow Central → Brixton → Seven Sisters
060755/29	RD	Bakerloo Line Train Operator Driving Trains	12/12/06	726	0.03	0.04	Elephant and Castle → Queens Park → Elephant and Castle → Queens Park → Elephant and Castle → Queens Park → Elephant and Castle → Willesden Junction → Stonebridge Park Depot → Elephant and Castle

Figure 1 : Cyclone Dust Head



Appendix 1 : Crystalline Respirable Silica Results



WORKING FOR A HEALTHY FUTURE

CERTIFICATE OF ANALYSIS

ANALYSIS REQUESTED BY: Chris Isgrove
4-Rail Services Ltd
Unit 11
Ironbridge Close
Great Central Way
London
NW10 0UF

CONTRACT NO: 09942

PROJECT NO: 610

DATE OF ISSUE: 05.02.07

DATE SAMPLES RECEIVED: 24.01.07

DATE SAMPLES ANALYSED: 01.02.07

SAMPLES: 7 x GLA-5000 PVC filters

ANALYSIS REQUESTED: Respirable crystalline silica

METHOD: The analysis was carried out using a method based on;

MDHS 101: Health and Safety Executive (2005). "Crystalline silica in respirable airborne dusts". Direct on filter analyses by infrared spectroscopy and X-ray diffraction. Methods for the Determination of Hazardous Substances No. 101. HMSO, London.

Page 1 of 2

RESEARCH CONSULTING SERVICES

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0374

CONTRACT NO: 09942
PROJECT NO: 610
DATE OF ISSUE: 05.02.07

RESULTS:

Sample Number	Quartz weight (mg)
060755/21	0.03
060755/23	<0.01
060755/25	0.01
060755/27	<0.01
060755/29	0.03
060755/53	0.01
060755/55	<0.01


Our detection limit for crystalline silica on filters by this method is 0.01 mg.

COMMENTS:

Opinions and interpretations herein are outside the scope of UKAS accreditation.

IOM Consulting cannot accept responsibility for samples sent for analysis that have been incorrectly collected or despatched.

ANALYSED BY: 
L Darling
Scientific Technician

AUTHORISED BY: 
S Clark
Mineralogy Section Manager