

CONFIDENTIAL

UK SMOKE CONSTITUENTS STUDY

Part 7: Determination of Semi Volatile Compounds Yields in Cigarette Smoke

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London SW1P 3QLT

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Contact Point: Pete Houlgate

Tel: 020 8943 7375

Prepared by: Pete Houlgate
Arista Laboratories Europe

Contents

Contents.....	2
Determination of SVCs (semi volatile compounds) Yields in Cigarette Smoke.....	3
1. Introduction	3
2. Summary	3
3. Samples	3
4. Smoking	3
5. Method and Validation.....	4
6. Results & Discussion	4
7. Outlier Test.....	4
8. Information provided in the Appendices and Annex	5
Tables	6
Summary of mean results for 25 cigarette brands plus 1R4F and 1R5F.....	6
Regression analysis of pyridine versus carbon monoxide.....	7
Regression analysis of quinoline versus carbon monoxide.....	8
Regression analysis of styrene versus carbon monoxide	9
Regression analysis of pyridine versus NFDPM.....	10
Regression analysis of quinoline versus NFDPM.....	11
Regression analysis of styrene versus NFDPM.....	12
1R4F	13
1R5F	14
Benson & Hedges King Size	15
Berkely Superkings	16
Camel Ultra Lights	17
Consulate Menthol	18
Gitanes Caporal Filter	19
Lambert & Butler King Size	20
Lambert & Butler Lights King Size	21
Lambert & Butler Ultra Lights.....	22
Marlboro King Size.....	23
Marlboro Lights King Size.....	24
Mayfair Lights King Size.....	25
Mayfair Menthol King Size.....	26
Red Band Lights King Size.....	27
Regal Filter.....	28
Regal King Size.....	29
Rothman Royals 120s.....	30
Rothman Royals King Size	31
Senior Service	32
Silk Cut Extra Mild	33
Silk Cut King Size.....	34
Silk Cut Ultra King Size.....	35
Superkings.....	36
Superkings Lights.....	37
Superkings Ultra Lights.....	38
Vogue Superslims.....	39
Appendix 1: Technical opinions and interpretations.....	41
Appendix 2: Selected smoke constituents for UK study	42
Appendix 3: Selected abbreviations and terms used in this report.....	43
Appendix 4: Description of brands (sold in the UK - Nov/Dec 2001) used in the benchmark study ...	44

UK SMOKE CONSTITUENTS TESTING STUDY PROTOCOL

Determination of SVCs (semi volatile compounds) Yields in Cigarette Smoke

1. Introduction

This work was undertaken by Arista Laboratories Europe* at the request of the Tobacco Manufacturers' Association in accordance with the Study Protocol provided by, and agreed with, the UK Department of Health.

2. Summary

The objective of this study is to determine the yield ratings of selected smoke constituents (Appendix 2) in mainstream cigarette smoke as identified by the United Kingdom Department of Health. The study encompassed 25 brands of cigarettes representing a 58% market share (July 2001) of the UK market. In addition a Kentucky reference cigarette(s) has been smoked as part of the study.

This report details the results for semi volatile compounds (SVCs) – pyridine, quinoline and styrene.

3. Samples

25 brands of cigarettes were selected because their design parameters are representative of the brands in the UK market place. The selection criteria include a range of “tar” values, ventilation, paper permeability, circumference, length, tobacco weight, blend and market share. The Kentucky reference cigarettes 1R4F and 1R5F were included in this part of the study.

2000 cigarettes of each brand were obtained from a single production batch of current specification (November/December 2001), and stored in plastic containers at 4°C. Cigarettes were selected from packets on a random basis for testing.

Cigarettes were conditioned¹ at a temperature[†] of $22 \pm 1^\circ\text{C}$ and $60 \pm 2\%$ relative humidity[†] for a minimum of 48 hours but not exceeding 10 days.

Butt marking was done in accordance with ISO butt length specifications². Filtered cigarettes were smoked to a measured butt length equal to either the tipping paper + 3 mm or filter length + 8 mm whichever was longer. The minimum butt length was 23 mm and this was used for non filter brands. All smoking was conducted in an environment of temperature $22 \pm 2^\circ\text{C}$ and $60 \pm 5\%$ relative humidity¹.

4. Smoking

The cigarettes were smoked on a 20 channel Rotary Borgwaldt smoking machine.

5 cigarettes were sub-sampled from packets chosen on a random basis and smoked to determine the yield of SVCs using the method given below (see section 5). Five determinations were performed for each of the 25 brands, 1R4F and 1R5F. As far as was

* Arista Laboratories Europe acquired the smoke constituent analytical business of LGC Ltd, on the 23rd December 2002. LGC Ltd was previously the contractor for the study.

† The parameter is slightly more stringent than that specified in ISO.

practicable sub-samples of each brand were smoked on different channels on different smoking runs.

ISO conditions³ for smoking cigarettes were used. The smoking machine puffing parameters were $35 \pm 0.2 \text{ cm}^3$ puff volume[†] with 2.0 ± 0.02 second puff duration once every 60.0 ± 0.5 seconds.

5. Method and Validation

This method is applicable to determination of SVC's in mainstream tobacco smoke by GC-MS. For each sample, five conditioned cigarettes are smoked on a Borgwaldt rotary smoking machine. The mainstream smoke is passed through a Cambridge filter pad and the vapour phase passed through a solid sorbent tube (XAD-4). After smoking, both the pad and contents of the sorbent tube are transferred to a flask. Triethylamine is added to stabilise the extract. Methanol is added and the resulting solution shaken to extract the semi-volatile compounds. The solution is analysed by gas chromatography/mass spectrometry. For low tar brands the amount of extraction solvent is reduced. For high SVC yield brands an aliquot of the extract solution can be diluted before analysis.

The full method is given in an Annexe to this report.

Before use, the method was validated to show that it was suitable for carrying out the bench mark study. The validation data is given in an Annexe to this report.

6. Results & Discussion

The results were tabulated for each brand (see Tables). The mean, standard deviation and relative standard deviation were determined for each set of results.

A summary of the results is included at the beginning (Page 3). Linear least squares regression analysis has been carried out for each SVC yield versus carbon monoxide (Page 3 to 3) and SVC yield versus NFDPM (Page 3 to 3) for the twenty five cigarette brands (excluding 1R4F and 1R5F).

The study showed that the calibration range was not sufficient to cover the yields from all the brands in the survey. The sample extract solution for one brand needed to be diluted by half to bring it within the calibration range. A reporting limit has been used based on the concentration of the lowest standard (\equiv pyridine & styrene $0.375 \mu\text{g cig}^{-1}$; quinoline $0.0375 \mu\text{g cig}^{-1}$). There were a couple of instances where the measured sample analyte concentration was found to be below the lowest standard. NB Cigarettes giving low yields are extracted with a smaller volume of solution to increase the analyte concentration in the sample solution.

Recoveries (and syringe spike areas) were generally consistent. One result has been flagged where the recovery for all three analytes was considered to be outside the normal range – possibly due to an error in the amount of internal standard solution added.

Calibration curves were found to be consistent, variations in the correlation coefficient appear to be linked to the standard batch (e.g. one set of standards gave, on average, $r^2 \approx 0.995$, another set $r^2 \approx 0.999$).

7. Outlier Test

It was agreed as part of the study protocol that Dixon's outlier test would be performed on each set of results. This has been carried out and where an outlier has been detected then the

result has been flagged “95%”. A judgement was then made as to whether to use the original results or recalculate the mean excluding the outlier. The CV values for each analyte across the 25 brands were examined before making this judgement. As a result of this, the original results have been used in the summary table as comparison of the CV values did not confirm that there are true outliers present in the original data.

8. Information provided in the Appendices and Annex

Appendix 1 contains technical opinions and interpretations about the method, validation data and the results.⁴

Appendix 2 lists the specific analytes to be determined in the study.

Appendix 3 contains a brief glossary of selected abbreviations and terms used in this report

Appendix 4 contains a brief description of the cigarettes used in this survey. It also lists the butt lengths determined for each brand of cigarette.

The Annex to this report lists the method used to determine the SVCs yields in cigarette smoke. It also contains a summary of the validation data used to show that the method was suitable for the purposes of the bench mark study.

¹ ISO 3402: 2000 - Tobacco and tobacco products – atmosphere for conditioning and testing

² ISO 4387: 2000 - Methods for chemical analysis of tobacco and tobacco products: Determination of total and nicotine- free dry particulate matter using a routine analytical smoking machine

³ ISO 3308:2000 – Routine analytical cigarette smoking machine: Definitions and standard conditions

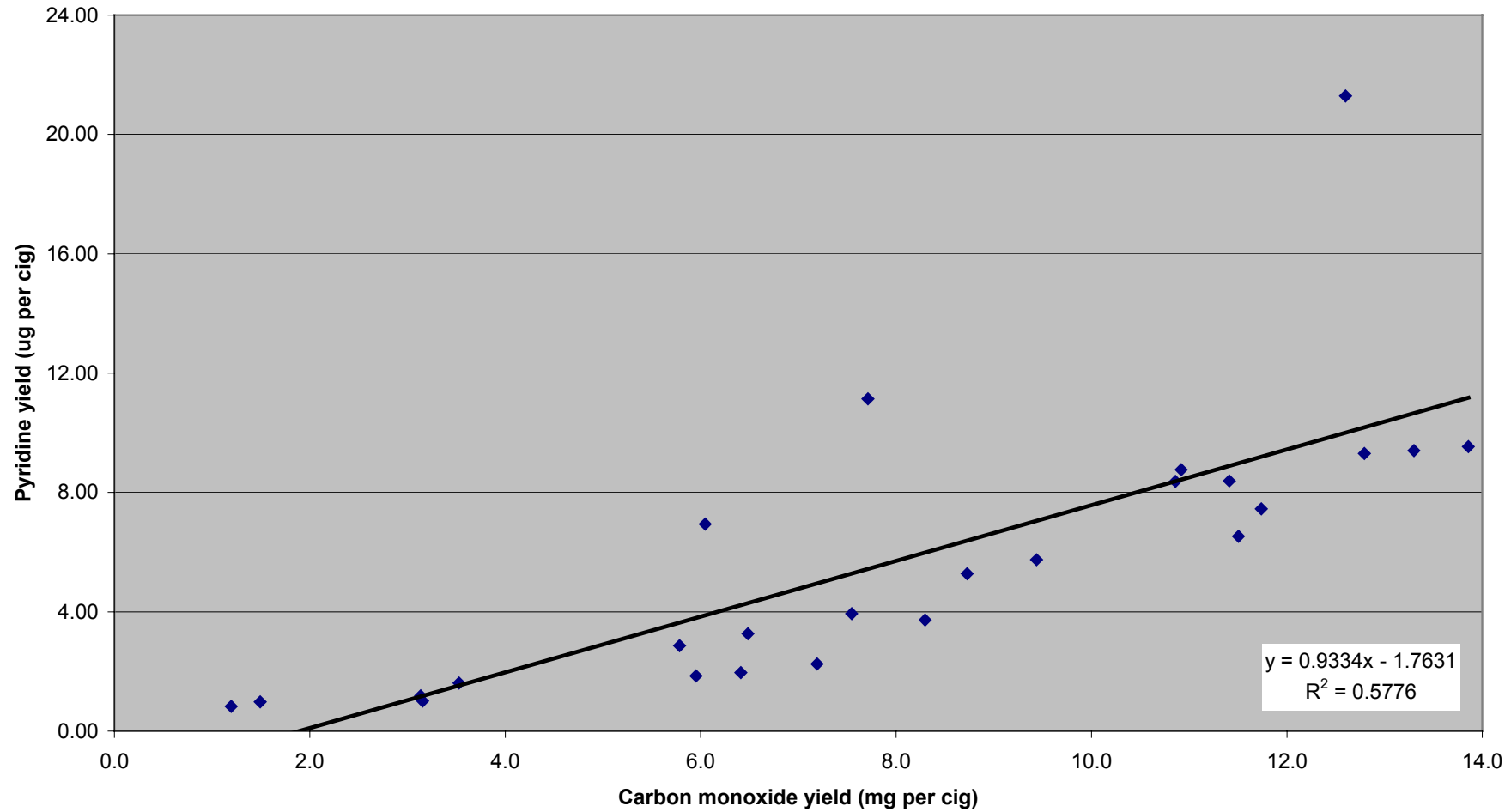
⁴ NB When evaluating a set of results obtained using a particular method it is important to put the results in context and this is what we have set out to do in this Appendix.

Tables**Summary of mean results for 25 cigarette brands plus 1R4F and 1R5F**

	Pyridine	Styrene	Quinoline	NFDPM	Carbon Monoxide
	ug/cig	ug/cig	ug/cig	mg/cig	mg/cig
1R4F	4.14	5.63	0.22	9.06	12.26
1R5F	1.70	2.93	0.08	1.92	3.36
Benson & Hedges King Size	7.45	7.22	0.28	10.30	11.74
Berkely Superkings	6.53	6.09	0.24	9.69	11.50
Camel Ultra Lights	1.19	1.84	0.09	3.09	3.13
Consulate Menthol	3.72	4.45	0.22	7.06	8.30
Gitanes Caporal Filter	21.3	9.53	0.44	12.00	12.60
Lambert & Butler King Size	9.40	8.61	0.28	11.93	13.30
Lambert & Butler Lights King Size	3.26	4.07	0.18	5.24	6.48
Lambert & Butler Ultra Lights	0.98	1.09	0.06	1.61	1.49
Marlboro King Size	9.31	8.13	0.31	12.69	12.79
Marlboro Lights King Size	2.25	2.67	0.16	6.10	7.19
Mayfair Lights King Size	5.27	5.36	0.22	7.23	8.73
Mayfair Menthol King Size	1.85	2.45	0.11	4.65	5.95
Red Band Lights King Size	1.96	2.49	0.12	5.55	6.41
Regal Filter	8.76	6.93	0.26	10.65	10.92
Regal King Size	9.54	9.70	0.27	11.96	13.86
Rothman Royals 120s	5.75	5.82	0.30	10.39	9.44
Rothman Royals King Size	8.37	7.70	0.34	11.00	10.86
Senior Service	11.1	6.52	0.39	11.92	7.71
Silk Cut Extra Mild	1.01	1.47	0.07	2.67	3.16
Silk Cut King Size	2.86	3.31	0.16	5.62	5.78
Silk Cut Ultra King Size	0.83	0.93	<0.02	1.01	1.20
Superkings	8.39	7.94	0.25	10.71	11.41
Superkings Lights	3.94	4.42	0.22	8.09	7.54
Superkings Ultra Lights	1.61	2.04	0.08	3.08	3.53
Vogue Superslims	6.94	4.93	0.25	7.38	6.05

Regression analysis of pyridine versus carbon monoxide

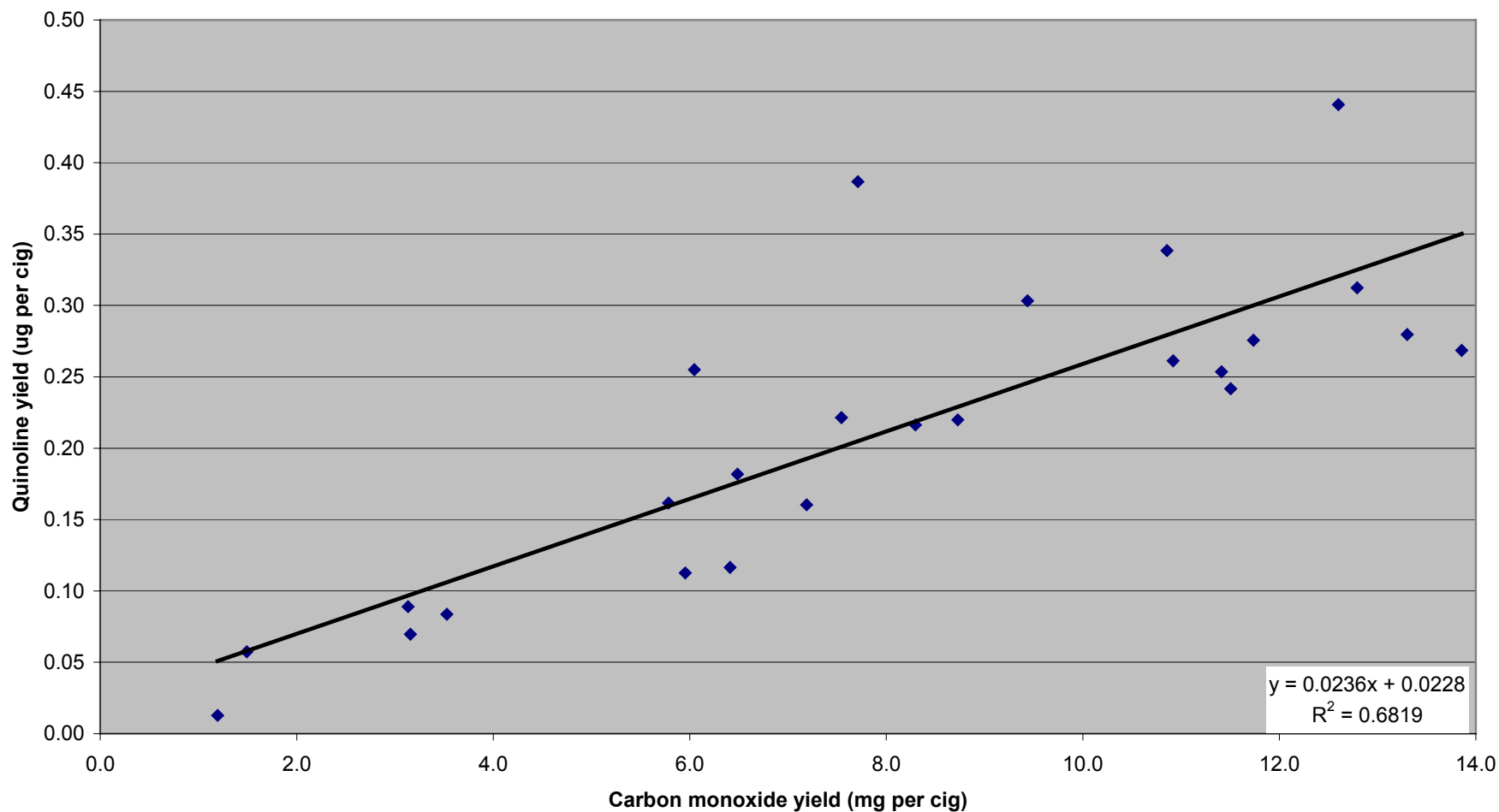
Regression analysis of pyridine versus carbon monoxide for 25 cigarette brands



The regression analysis trend line has been calculated on the basis of a linear relationship ($y = mx + c$)

Regression analysis of quinoline versus carbon monoxide

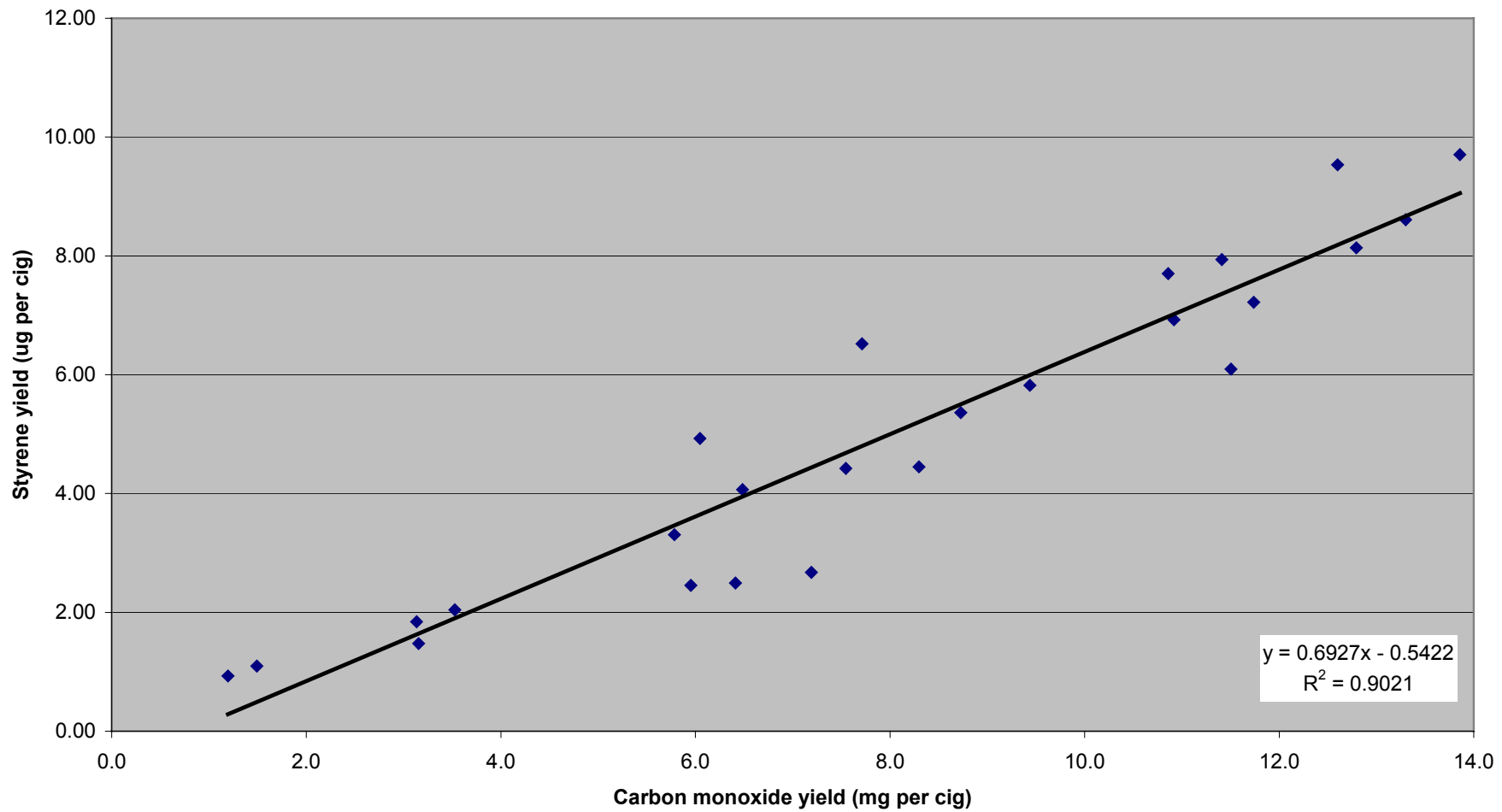
Regression analysis of quinoline versus carbon monoxide for 25 cigarette brands



The regression analysis trend line has been calculate on the basis of a linear relationship ($y = mx + c$)

Regression analysis of styrene versus carbon monoxide

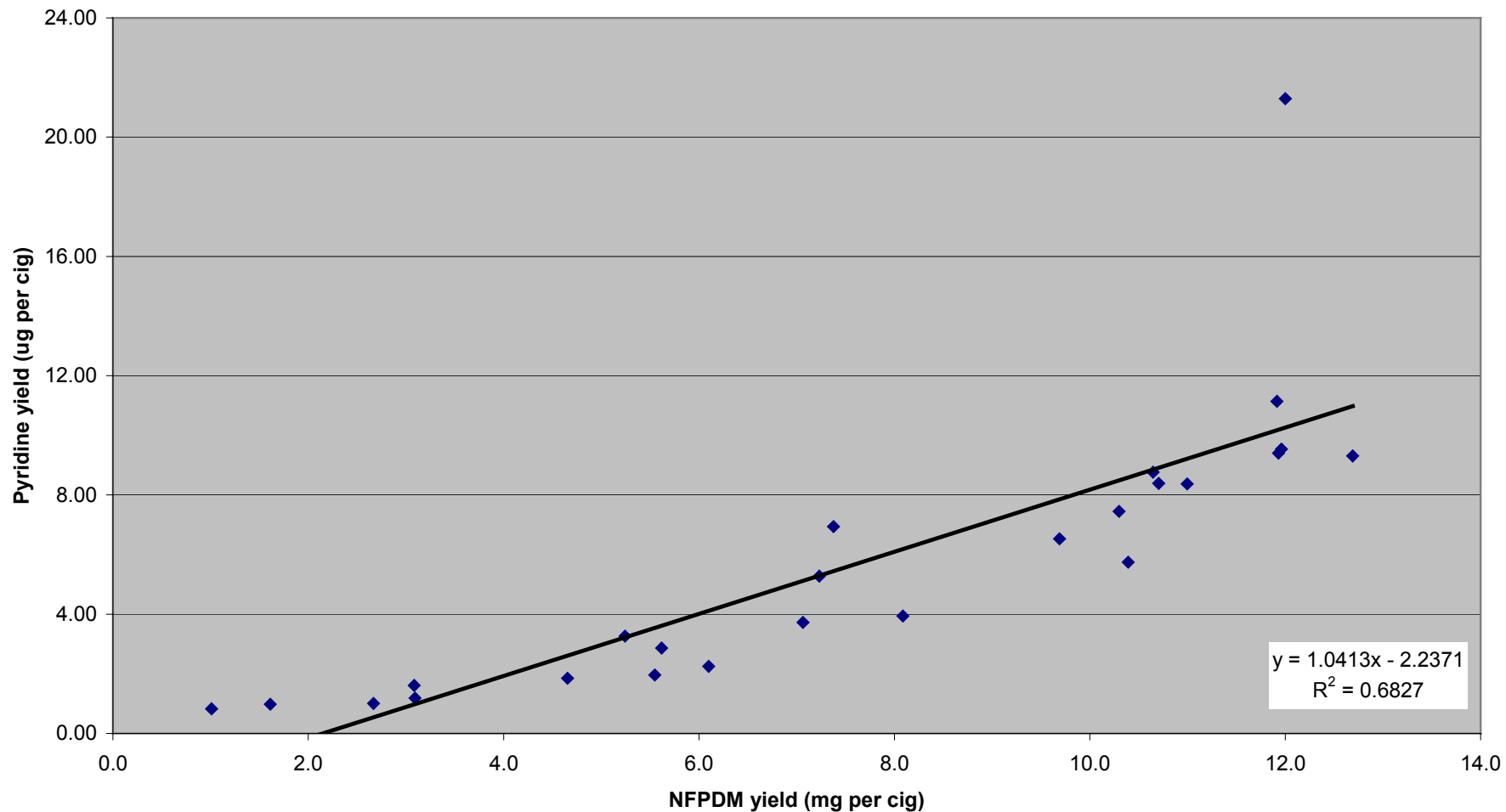
Regression analysis of styrene versus carbon monoxide for 25 cigarette brands



The regression analysis trend line has been calculate on the basis of a linear relationship ($y = mx + c$)

Regression analysis of pyridine versus NFDPM

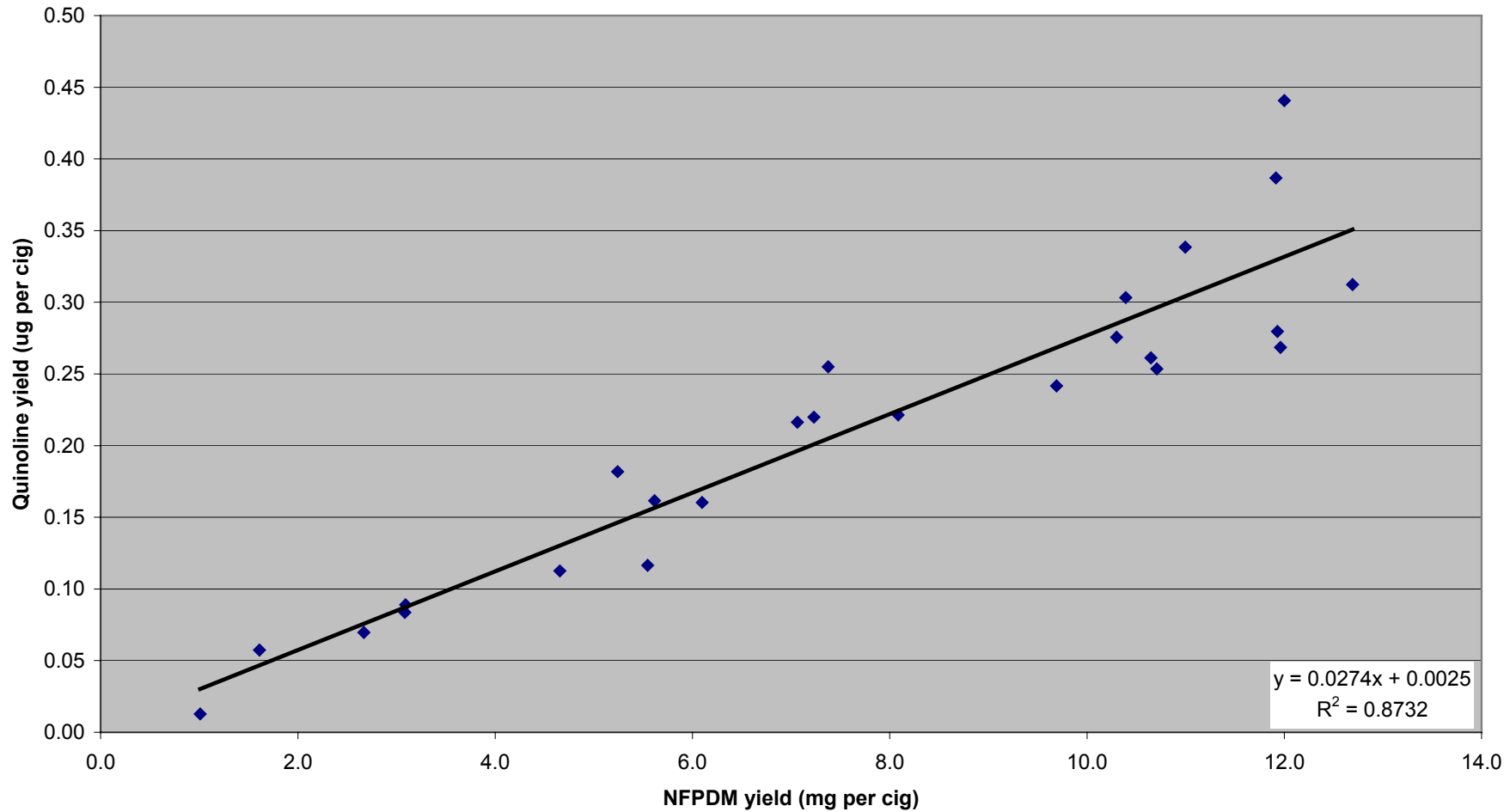
Regression analysis of pyridine versus NFDPM for 25 cigarette brands



The regression analysis trend line has been calculate on the basis of a linear relationship ($y = mx + c$)

Regression analysis of quinoline versus NFDPM

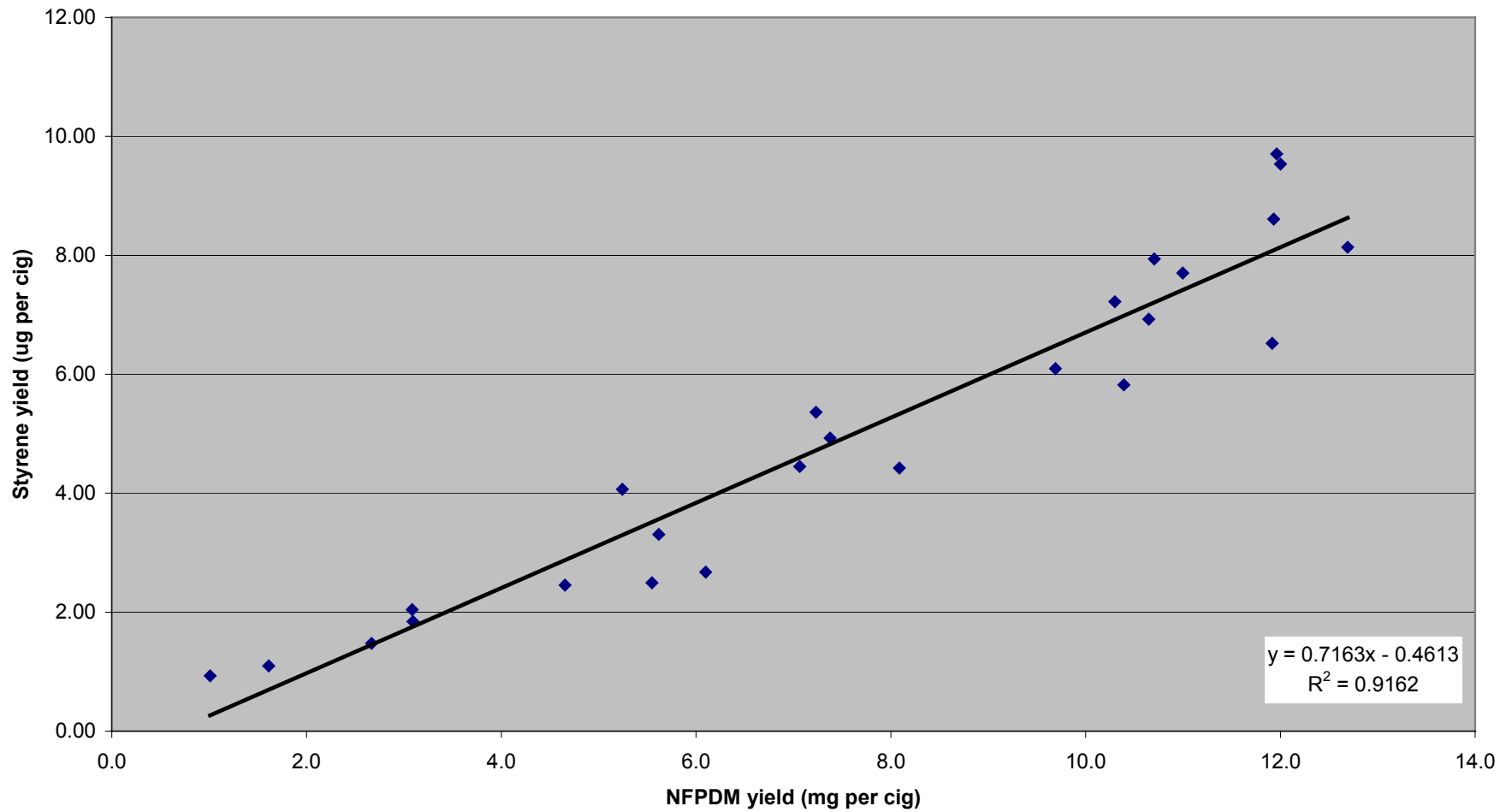
Regression analysis of quinoline versus NFDPM for 25 cigarette brands



The regression analysis trend line has been calculate on the basis of a linear relationship ($y = mx + c$)

Regression analysis of styrene versus NFDPM

Regression analysis of styrene versus NFDPM for 25 cigarette brands



The regression analysis trend line has been calculate on the basis of a linear relationship ($y = mx + c$)

1R4F

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
1R4F	4.13	5.49	0.19
1R4F	3.89	5.27	0.19
1R4F	4.05	5.91	0.21
1R4F	4.54	5.84	0.23
1R4F	4.09	5.65	0.28
Mean (ug/cig)	4.14	5.63	0.22
Standard Deviation	0.24	0.26	0.04
CV (%)	5.9	4.7	17.4
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	3.892309889	5.265409	0.18607
	4.05134701	5.491535	0.194989
	4.088287119	5.653032	0.205445
	4.131727193	5.841621	0.232927
	4.544249058	5.913668	0.280621
Statistical test applied			
Dixons low end test	0.243944724	0.348821	0.094328
Outlier detected at 95%			
Dixons high end test	0.632761284	0.111139	0.504436
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	4.14	5.63	0.22
Standard Deviation	0.24	0.26	0.04
CV (%)	5.9	4.7	17.4

1R5F

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
1R5F	1.84	3.25	0.11
1R5F	1.47	2.87	0.07
1R5F	1.64	2.79	0.07
1R5F	1.56	2.67	0.06
1R5F	2.00	3.09	0.07
Mean (ug/cig)	1.70	2.93	0.08
Standard Deviation	0.22	0.23	0.02
CV (%)	12.7	8.0	27.5
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	1.46583158	2.671661	0.061654
	1.564038321	2.789469	0.065996
	1.635578109	2.866304	0.068801
	1.843787011	3.086124	0.074593
	1.996143275	3.251366	0.113966
Statistical test applied			
Dixons low end test	0.185186828	0.20322	0.083004
Outlier detected at 95%			
Dixons high end test	0.287295689	0.285045	0.752654
Outlier detected at 95%			95%
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	1.70	2.93	0.07
Standard Deviation	0.22	0.23	0.01
CV (%)	12.7	8.0	8.0

Benson & Hedges King Size

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Benson & Hedges King Size	6.48	7.83	0.25
Benson & Hedges King Size	7.58	8.74	0.27
Benson & Hedges King Size	6.76	4.29	0.30
Benson & Hedges King Size	8.01	7.27	0.27
Benson & Hedges King Size	8.40	7.98	0.29
Mean (ug/cig)	7.45	7.22	0.28
Standard Deviation	0.82	1.72	0.02
CV (%)	10.9	23.8	8.0
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	6.47599586	4.290091	0.248018
	6.763499046	7.265388	0.266948
	7.578841404	7.827386	0.26778
	8.013320432	7.97629	0.289801
	8.401030354	8.744845	0.304917
Statistical test applied			
Dixons low end test	0.149349628	0.667893	0.332699
Outlier detected at 95%			
Dixons high end test	0.201404143	0.172525	0.265659
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	7.45	7.22	0.28
Standard Deviation	0.82	1.72	0.02
CV (%)	10.9	23.8	8.0

Berkely Superkings

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Berkely Superkings	5.40	6.00	0.21
Berkely Superkings	6.83	6.33	0.25
Berkely Superkings	5.84	5.51	0.25
Berkely Superkings	7.44	6.14	0.25
Berkely Superkings	7.13	6.48	0.24
Mean (ug/cig)	6.53	6.09	0.24
Standard Deviation	0.87	0.37	0.02
CV (%)	13.3	6.1	6.6
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	5.40046853	5.512594	0.214746
	5.842228426	5.995365	0.241984
	6.834117942	6.142368	0.245025
	7.126594038	6.328898	0.252222
	7.438490639	6.480691	0.254165
Statistical test applied			
Dixons low end test	0.216759128	0.49868	0.690998
Outlier detected at 95%			
Dixons high end test	0.15303887	0.156795	0.04928
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	6.53	6.09	0.24
Standard Deviation	0.87	0.37	0.02
CV (%)	13.3	6.1	6.6

Camel Ultra Lights

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Camel Ultra Lights	0.95	1.27	0.05
Camel Ultra Lights	0.78	1.15	0.05
Camel Ultra Lights	1.35	2.23	0.11
Camel Ultra Lights	1.78	2.50	0.13
Camel Ultra Lights	1.07	2.06	0.11
Mean (ug/cig)	1.19	1.84	0.09
Standard Deviation	0.39	0.60	0.04
CV (%)	33.2	32.5	42.3
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	0.781103259	1.153729	0.048762
	0.945107855	1.268087	0.050144
	1.07334799	2.059491	0.105771
	1.345538523	2.230315	0.107017
	1.784641952	2.500683	0.133056
Statistical test applied			
Dixons low end test	0.163426281	0.084901	0.016406
Outlier detected at 95%			
Dixons high end test	0.437555056	0.200725	0.30891
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	1.19	1.84	0.09
Standard Deviation	0.39	0.60	0.04
CV (%)	33.2	32.5	42.3

Consulate Menthol

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Consulate Menthol	4.28	4.60	0.21
Consulate Menthol	3.21	4.01	0.21
Consulate Menthol	3.74	4.74	0.22
Consulate Menthol	3.51	4.34	0.21
Consulate Menthol	3.87	4.55	0.23
Mean (ug/cig)	3.72	4.45	0.22
Standard Deviation	0.40	0.28	0.01
CV (%)	10.7	6.4	4.3
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	3.211648872	4.011196	0.209073
	3.506634372	4.335794	0.209366
	3.74339276	4.554113	0.211114
	3.871897919	4.60432	0.22149
	4.277712105	4.735361	0.229986
Statistical test applied			
Dixons low end test	0.276705443	0.448238	0.013987
Outlier detected at 95%			
Dixons high end test	0.380666149	0.180955	0.406256
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	3.72	4.45	0.22
Standard Deviation	0.40	0.28	0.01
CV (%)	10.7	6.4	4.3

Gitanes Caporal Filter

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Gitanes Caporal Filter	27.2	12.2	0.48
Gitanes Caporal Filter	19.8	9.93	0.43
Gitanes Caporal Filter	20.2	9.90	0.46
Gitanes Caporal Filter	12.8	5.59	0.37
Gitanes Caporal Filter	26.4	10.0	0.45
Mean (ug/cig)	21.3	9.53	0.44
Standard Deviation	5.85	2.41	0.04
CV (%)	27.5	25.3	9.4
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	12.8172684	5.588888	0.373726
	19.80904188	9.895994	0.43274
	20.19596676	9.931586	0.454494
	26.41785298	10.02676	0.460742
	27.22931704	12.21738	0.48193
Statistical test applied			
Dixons low end test	0.485133908	0.649787	0.545396
Outlier detected at 95%			
Dixons high end test	0.05630456	0.330485	0.195817
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	21.3	9.53	0.44
Standard Deviation	5.85	2.41	0.04
CV (%)	27.5	25.3	9.4

Lambert & Butler King Size

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Lambert & Butler King Size	10.5	9.03	0.25
Lambert & Butler King Size	7.04	6.33	0.29
Lambert & Butler King Size	11.2	8.95	0.28
Lambert & Butler King Size	8.78	9.34	0.27
Lambert & Butler King Size	9.58	9.38	0.30
Mean (ug/cig)	9.40	8.61	0.28
Standard Deviation	1.60	1.28	0.02
CV (%)	17.0	14.9	6.6
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	7.038968706	6.333507	0.251781
	8.777107631	8.952555	0.274475
	9.576191099	9.033833	0.280981
	10.47361518	9.33639	0.289894
	11.15194065	9.379022	0.300851
Statistical test applied			
Dixons low end test	0.422599266	0.859969	0.462474
Outlier detected at 95%		95%	
Dixons high end test	0.164923437	0.013998	0.223299
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	9.40	9.18	0.28
Standard Deviation	1.60	0.21	0.02
CV (%)	17.0	2.3	6.6

Lambert & Butler Lights King Size

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Lambert & Butler Lights King Size	3.81	4.61	0.19
Lambert & Butler Lights King Size	2.72	3.59	0.14
Lambert & Butler Lights King Size	3.35	4.40	0.20
Lambert & Butler Lights King Size	2.86	3.50	0.19
Lambert & Butler Lights King Size	3.56	4.23	0.19
Mean (ug/cig)	3.26	4.07	0.18
Standard Deviation	0.46	0.50	0.02
CV (%)	14.2	12.2	13.3
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	2.720156501	3.500797	0.140708
	2.861065007	3.588373	0.185043
	3.351810877	4.231854	0.187561
	3.561832242	4.3982	0.19146
	3.814055861	4.612922	0.204437
Statistical test applied			
Dixons low end test	0.128813043	0.078747	0.695666
Outlier detected at 95%			
Dixons high end test	0.230572966	0.193074	0.203629
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	3.26	4.07	0.18
Standard Deviation	0.46	0.50	0.02
CV (%)	14.2	12.2	13.3

Lambert & Butler Ultra Lights

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Lambert & Butler Ultra Lights	0.26	0.49	<0.02
Lambert & Butler Ultra Lights	0.65	1.24	0.06
Lambert & Butler Ultra Lights	2.14	2.13	0.12
Lambert & Butler Ultra Lights	0.90	0.60	0.05
Lambert & Butler Ultra Lights	0.96	1.01	0.04
Mean (ug/cig)*	0.98	1.09	0.06
Standard Deviation*	0.70	0.65	0.04
CV (%)*	71.9	59.8	63.7
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	0.256714645	0.492707	0.016399
	0.645342512	0.595294	0.044674
	0.895148682	1.014639	0.046724
	0.958917639	1.240082	0.063591
	2.137397032	2.130805	0.115255
Statistical test applied			
Dixons low end test	0.206641945	0.062626	0.286031
Outlier detected at 95%			
Dixons high end test	0.626623295	0.543755	0.522615
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)*	0.98	1.09	0.06
Standard Deviation*	0.70	0.65	0.04
CV (%)*	71.9	59.8	63.7

*The mean, standard deviation and CV have been calculated using all 5 results.

Marlboro King Size

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Marlboro King Size	10.9	9.44	0.30
Marlboro King Size	9.91	7.94	0.32
Marlboro King Size	9.21	8.11	0.31
Marlboro King Size	8.40	7.66	0.32
Marlboro King Size	8.12	7.52	0.30
Mean (ug/cig)	9.31	8.13	0.31
Standard Deviation	1.13	0.77	0.01
CV (%)	12.2	9.4	3.5
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	8.122822412	7.51548	0.29863
	8.398793743	7.65996	0.303515
	9.210310635	7.939949	0.314675
	9.910623745	8.114105	0.321955
	10.90254431	9.442102	0.323114
Statistical test applied			
Dixons low end test	0.099280194	0.074991	0.199521
Outlier detected at 95%			
Dixons high end test	0.356841655	0.689288	0.047325
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	9.31	8.13	0.31
Standard Deviation	1.13	0.77	0.01
CV (%)	12.2	9.4	3.5

Marlboro Lights King Size

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Marlboro Lights King Size	1.73	2.22	0.14
Marlboro Lights King Size	1.94	2.57	0.12
Marlboro Lights King Size	2.91	3.35	0.21
Marlboro Lights King Size	2.38	2.54	0.16
Marlboro Lights King Size	2.29	2.69	0.18
Mean (ug/cig)	2.25	2.67	0.16
Standard Deviation	0.45	0.42	0.03
CV (%)	20.0	15.5	20.8
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	1.732203862	2.219764	0.121903
	1.938867745	2.535233	0.136892
	2.28924845	2.56547	0.157925
	2.378416626	2.692368	0.179403
	2.905946316	3.346835	0.205791
Statistical test applied			
Dixons low end test	0.176072597	0.279901	0.178669
Outlier detected at 95%			
Dixons high end test	0.449442455	0.58068	0.314569
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	2.25	2.67	0.16
Standard Deviation	0.45	0.42	0.03
CV (%)	20.0	15.5	20.8

Mayfair Lights King Size

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Mayfair Lights King Size	5.93	5.78	0.20
Mayfair Lights King Size	4.88	5.86	0.21
Mayfair Lights King Size	4.89	5.12	0.24
Mayfair Lights King Size	4.66	4.95	0.22
Mayfair Lights King Size	6.02	5.10	0.22
Mean (ug/cig)	5.27	5.36	0.22
Standard Deviation	0.65	0.42	0.02
CV (%)	12.3	7.9	7.0
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	4.655507454	4.953327	0.199417
	4.87716385	5.097125	0.214891
	4.885494409	5.118978	0.220395
	5.928261712	5.776389	0.221844
	6.018676642	5.855758	0.242114
Statistical test applied			
Dixons low end test	0.162603731	0.159345	0.362406
Outlier detected at 95%			
Dixons high end test	0.066327005	0.08795	0.474735
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	5.27	5.36	0.22
Standard Deviation	0.65	0.42	0.02
CV (%)	12.3	7.9	7.0

Mayfair Menthol King Size

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Mayfair Menthol King Size	2.03	2.38	0.08
Mayfair Menthol King Size	1.27	2.25	0.08
Mayfair Menthol King Size	1.82	2.26	0.15
Mayfair Menthol King Size	2.34	2.90	0.15
Mayfair Menthol King Size	1.78	2.48	0.11
Mean (ug/cig)	1.85	2.45	0.11
Standard Deviation	0.39	0.27	0.03
CV (%)	21.2	10.9	29.4
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	1.268865263	2.252117	0.077543
	1.783632876	2.255205	0.081833
	1.823310062	2.37819	0.11182
	2.033499406	2.475534	0.145059
	2.340869463	2.901584	0.146313
Statistical test applied			
Dixons low end test	0.480191788	0.004756	0.06238
Outlier detected at 95%			
Dixons high end test	0.286724676	0.655999	0.018239
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	1.85	2.45	0.11
Standard Deviation	0.39	0.27	0.03
CV (%)	21.2	10.9	29.4

Red Band Lights King Size

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Red Band Lights King Size	1.43	2.21	0.08
Red Band Lights King Size	1.34	2.26	0.09
Red Band Lights King Size	2.63	3.14	0.14
Red Band Lights King Size	2.56	3.14	0.15
Red Band Lights King Size	1.85	1.72	0.13
Mean (ug/cig)	1.96	2.49	0.12
Standard Deviation	0.61	0.62	0.03
CV (%)	31.0	25.0	26.9
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	1.340451944	1.723493	0.079098
	1.42979704	2.208994	0.087305
	1.851592447	2.261377	0.127345
	2.558156387	3.136044	0.142678
	2.627667636	3.136136	0.146336
Statistical test applied			
Dixons low end test	0.069409576	0.343682	0.122066
Outlier detected at 95%			
Dixons high end test	0.054001245	6.51E-05	0.054404
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	1.96	2.49	0.12
Standard Deviation	0.61	0.62	0.03
CV (%)	31.0	25.0	26.9

Regal Filter

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Regal Filter	9.93	8.59	0.25
Regal Filter	8.04	8.02	0.25
Regal Filter	11.68	8.39	0.27
Regal Filter	8.18	7.12	0.25
Regal Filter	See note	5.98	2.50
Mean (ug/cig)	8.76	6.93	0.26
Standard Deviation	2.15	2.53	0.01
CV (%)	24.5	36.6	5.5

Outlier Test

Dixons outlier test was applied to the above data

Data sorted

5.983754806	2.504081	0.250577
8.043263397	7.124806	0.250675
8.181849056	8.021257	0.254451
9.932350613	8.38684	0.266667
11.67793244	8.589096	0.28385

Statistical test applied

Dixons low end test	0.361686748	0.759361	0.002943
Outlier detected at 95%		95%	
Dixons high end test	0.306555563	0.033238	0.516432
Outlier detected at 95%			

If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier

Summary of Results

Mean (ug/cig)	8.76	8.03	0.26
Standard Deviation	2.15	0.65	0.01
CV (%)	24.5	8.1	5.5

Regal King Size

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Regal King Size	9.66	9.68	0.25
Regal King Size	7.66	9.98	0.25
Regal King Size	9.66	9.61	0.32
Regal King Size	11.88	9.80	0.28
Regal King Size	8.82	9.46	0.25
Mean (ug/cig)	9.54	9.70	0.27
Standard Deviation	1.54	0.20	0.03
CV (%)	16.2	2.0	11.1
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	7.664304409	9.459357	0.247339
	8.821783466	9.60591	0.248176
	9.656740332	9.683788	0.253386
	9.66168857	9.79723	0.275652
	11.87868526	9.97536	0.317425
Statistical test applied			
Dixons low end test	0.274649848	0.284016	0.011937
Outlier detected at 95%			
Dixons high end test	0.526055135	0.34521	0.596025
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	9.54	9.70	0.27
Standard Deviation	1.54	0.20	0.03
CV (%)	16.2	2.0	11.1

Rothman Royals 120s

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Rothman Royals 120s	4.80	5.21	0.29
Rothman Royals 120s	6.16	6.23	0.29
Rothman Royals 120s	6.28	6.10	0.31
Rothman Royals 120s	5.45	5.72	0.31
Rothman Royals 120s	6.04	5.83	0.32
Mean (ug/cig)	5.75	5.82	0.30
Standard Deviation	0.62	0.40	0.01
CV (%)	10.7	6.8	4.0
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	4.802721092	5.211856	0.289286
	5.447695895	5.719457	0.29124
	6.04165692	5.831863	0.30814
	6.155911409	6.098988	0.311636
	6.28322795	6.233842	0.316286
Statistical test applied			
Dixons low end test	0.43564459	0.49668	0.072386
Outlier detected at 95%			
Dixons high end test	0.085995239	0.131953	0.172216
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	5.75	5.82	0.30
Standard Deviation	0.62	0.40	0.01
CV (%)	10.7	6.8	4.0

Rothman Royals King Size

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Rothman Royals King Size	7.60	7.39	0.34
Rothman Royals King Size	8.05	7.67	0.33
Rothman Royals King Size	8.79	8.16	0.34
Rothman Royals King Size	8.90	7.93	0.36
Rothman Royals King Size	8.50	7.34	0.32
Mean (ug/cig)	8.37	7.70	0.34
Standard Deviation	0.54	0.35	0.02
CV (%)	6.5	4.5	4.8
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	7.597191138	7.343134	0.320302
	8.052844415	7.392612	0.331848
	8.500834345	7.670312	0.336219
	8.792840112	7.933551	0.339162
	8.895548445	8.162192	0.364676
Statistical test applied			
Dixons low end test	0.35094598	0.060409	0.26019
Outlier detected at 95%			
Dixons high end test	0.079106369	0.279151	0.574989
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	8.37	7.70	0.34
Standard Deviation	0.54	0.35	0.02
CV (%)	6.5	4.5	4.8

Senior Service

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Senior Service	11.3	6.64	0.40
Senior Service	10.2	6.04	0.39
Senior Service	10.8	6.33	0.36
Senior Service	10.2	6.34	0.41
Senior Service	13.2	7.25	0.38
Mean (ug/cig)	11.1	6.52	0.39
Standard Deviation	1.25	0.46	0.02
CV (%)	11.2	7.0	5.0
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	10.16797917	6.036746	0.357502
	10.17195908	6.334443	0.378413
	10.81653916	6.335649	0.393782
	11.3449183	6.638832	0.39728
	13.18330947	7.246402	0.40694
Statistical test applied			
Dixons low end test	0.001319893	0.246101	0.42298
Outlier detected at 95%			
Dixons high end test	0.609681524	0.502266	0.195393
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	11.1	6.52	0.39
Standard Deviation	1.25	0.46	0.02
CV (%)	11.2	7.0	5.0

Silk Cut Extra Mild

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Silk Cut Extra Mild	1.22	1.65	0.08
Silk Cut Extra Mild	0.85	1.23	0.09
Silk Cut Extra Mild	1.02	1.56	0.07
Silk Cut Extra Mild	1.02	1.45	0.06
Silk Cut Extra Mild	0.93	1.49	0.05
Mean (ug/cig)	1.01	1.47	0.07
Standard Deviation	0.14	0.16	0.01
CV (%)	13.5	10.7	16.7
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	0.853518801	1.225384	0.054565
	0.929250501	1.453053	0.062906
	1.020967321	1.485781	0.069979
	1.02431917	1.561107	0.075212
	1.216105789	1.646051	0.085014
Statistical test applied			
Dixons low end test	0.208864914	0.54121	0.273921
Outlier detected at 95%			
Dixons high end test	0.528939607	0.201927	0.321917
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	1.01	1.47	0.07
Standard Deviation	0.14	0.16	0.01
CV (%)	13.5	10.7	16.7

Silk Cut King Size

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Silk Cut King Size	2.01	2.63	0.12
Silk Cut King Size	2.88	3.74	0.16
Silk Cut King Size	3.49	3.64	0.19
Silk Cut King Size	2.97	3.37	0.18
Silk Cut King Size	2.97	3.16	0.16
Mean (ug/cig)	2.86	3.31	0.16
Standard Deviation	0.54	0.44	0.03
CV (%)	18.7	13.4	17.3
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	2.009023871	2.626117	0.11735
	2.879000725	3.159876	0.155978
	2.966958115	3.373663	0.163555
	2.966989557	3.643201	0.182876
	3.491233654	3.740918	0.187964
Statistical test applied			
Dixons low end test	0.586945832	0.478793	0.547023
Outlier detected at 95%			
Dixons high end test	0.35369089	0.087654	0.072047
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	2.86	3.31	0.16
Standard Deviation	0.54	0.44	0.03
CV (%)	18.7	13.4	17.3

Silk Cut Ultra King Size

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Silk Cut Ultra King Size	1.55	0.91	<0.02
Silk Cut Ultra King Size	0.81	0.66	<0.02
Silk Cut Ultra King Size	<0.2	0.35	<0.02
Silk Cut Ultra King Size	0.38	0.74	0.05
Silk Cut Ultra King Size	1.32	1.97	0.03
Mean (ug/cig)*	0.83	0.93	0.01
Standard Deviation*	0.61	0.62	0.03
CV (%)*	74.3	66.8	229.9
Outlier Test			
Dixons outlier test was applied to the above data			
Data sorted	0.086404949	0.35053759	-0.02621857
	0.375420512	0.65779364	-0.00010969
	0.811487627	0.7392407	0.007985075
	1.317004495	0.91455844	0.033218503
	1.547209371	1.9733672	0.048731126
Statistical test applied			
Dixons low end test	0.197846857	0.18933353	0.348352117
Outlier detected at 95%			
Dixons high end test	0.157587746	0.65244604	0.206973782
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)*	0.83	0.93	0.01
Standard Deviation*	0.61	0.62	0.03
CV (%)*	74.3	66.8	229.9
Report as			
Mean (ug/cig)	0.83	0.93	<0.02
Standard Deviation	0.61	0.62	n/a
CV (%)	74.3	66.8	n/a

*The mean, standard deviation and CV have been calculated using all 5 results. If the mean value is below the reporting limit set in the method then the results is reported as <0.02 ug per cigarette (quinoline)

Superkings

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Superkings	6.71	6.29	0.17
Superkings	7.78	8.39	0.25
Superkings	9.40	9.07	0.31
Superkings	10.2	9.07	0.28
Superkings	7.90	6.87	0.25
Mean (ug/cig)	8.39	7.94	0.25
Standard Deviation	1.37	1.28	0.05
CV (%)	16.4	16.2	21.5
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	6.71102834	6.294733	0.168664
	7.77879274	6.868475	0.247784
	7.900017789	8.393386	0.252711
	9.397091089	9.065395	0.284779
	10.15119015	9.067545	0.314186
Statistical test applied			
Dixons low end test	0.310382029	0.206917	0.543697
Outlier detected at 95%			
Dixons high end test	0.219204532	0.000775	0.202081
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	8.39	7.94	0.25
Standard Deviation	1.37	1.28	0.05
CV (%)	16.4	16.2	21.5

Superkings Lights

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Superkings Lights	3.60	4.03	0.20
Superkings Lights	3.30	4.11	0.18
Superkings Lights	4.56	4.76	0.25
Superkings Lights	4.06	4.77	0.25
Superkings Lights	4.15	4.45	0.23
Mean (ug/cig)	3.94	4.42	0.22
Standard Deviation	0.49	0.35	0.03
CV (%)	12.5	7.9	13.4
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	3.300220465	4.034055	0.181637
	3.604509249	4.105061	0.199171
	4.060921485	4.445657	0.232552
	4.149748327	4.760381	0.246227
	4.56496585	4.76534	0.247494
Statistical test applied			
Dixons low end test	0.240592919	0.097097	0.26624
Outlier detected at 95%			
Dixons high end test	0.328301275	0.006782	0.019227
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	3.94	4.42	0.22
Standard Deviation	0.49	0.35	0.03
CV (%)	12.5	7.9	13.4

Superkings Ultra Lights

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Superkings Ultra Lights	1.91	2.20	0.11
Superkings Ultra Lights	1.13	1.70	0.05
Superkings Ultra Lights	1.69	2.05	0.09
Superkings Ultra Lights	1.57	2.06	0.09
Superkings Ultra Lights	1.76	2.21	0.08
Mean (ug/cig)	1.61	2.04	0.08
Standard Deviation	0.30	0.21	0.02
CV (%)	18.4	10.1	25.4
<i>Outlier Test</i>			
Dixons outlier test was applied to the above data			
Data sorted	1.130035942	1.699469	0.049456
	1.574329369	2.045708	0.083187
	1.694535288	2.063896	0.085691
	1.764736719	2.197525	0.092608
	1.911297876	2.209123	0.107216
Statistical test applied			
Dixons low end test	0.568686899	0.679361	0.583985
Outlier detected at 95%			
Dixons high end test	0.187595416	0.022757	0.252919
Outlier detected at 95%			
<i>If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier</i>			
Summary of Results			
Mean (ug/cig)	1.61	2.04	0.08
Standard Deviation	0.30	0.21	0.02
CV (%)	18.4	10.1	25.4

Vogue Superslims

Brand	Pyridine yield (ug per cigarette)	Styrene yield (ug per cigarette)	Quinoline yield (ug per cigarette)
Vogue Superslims	6.46	4.96	0.24
Vogue Superslims	7.50	5.31	0.26
Vogue Superslims	6.73	4.80	0.26
Vogue Superslims	7.08	4.86	0.26
Vogue Superslims	6.92	4.69	0.26
Mean (ug/cig)	6.94	4.93	0.25
Standard Deviation	0.39	0.24	0.01
CV (%)	5.6	4.8	3.7

Outlier Test

Dixons outlier test was applied to the above data

Data sorted

6.460476469	4.694591	0.238549
6.733597798	4.802048	0.255186
6.918574262	4.861143	0.259432
7.082173132	4.963665	0.260592
7.503355531	5.311214	0.260939

Statistical test applied

Dixons low end test	0.26189166	0.174267	0.743066
Outlier detected at 95%			95%
Dixons high end test	0.403865045	0.563633	0.01549
Outlier detected at 95%			

If an outlier is detected then the mean, standard deviation and CV have been recalculated excluding the outlier

Summary of Results

Mean (ug/cig)	6.94	4.93	0.26
Standard Deviation	0.39	0.24	0.003
CV (%)	5.6	4.8	1.0

Appendix 1: Technical opinions and interpretations

The following comments are of a technical nature about the method, validation data and results obtained during the study. They are designed to help put the results in context.

Trapping system

An ideal trapping system should be capable of trapping 100% of the analyte(s) under investigation. It should also not significantly effect the way that the cigarette smokes – i.e. cigarette should be smoked to ISO conditions.

The trap used for this analyte consists of a standard Cambridge filter pad plus a ‘solid sorbent’ tube containing XAD-4 which will have a small effect on the puff profile.

Calibration

The study showed that a relatively wide calibration range was required to cover all the sample yields. As this is difficult to achieve while maintain linearity over the range of the calibration, the intention was that solutions with high analyte concentrations were diluted before analysis. Similarly less extraction solvent was used for low yield brands to increase the analyte concentration in the sample solution.

A seven-point calibration curve was used. Throughout the study, the linearity of the calibration remained robust as demonstrated by the correlation coefficient.

Measurement uncertainty

All measurements have an uncertainty associated with them. There are three components in the uncertainty of each result (a) sample (smoking of the cigarette), (b) trapping the smoke and (c) the analytical method.

In our opinion, the largest causes of measurement uncertainty appear to be due to

- (a) variations in smoking the cigarettes;
- (b) variations in preparing the standard solutions leading to slightly different calibration curves (slope and intercept);
- (c) measuring analyte concentrations in low yield cigarettes.*

*Quinoline is present at lower concentrations than pyridine and styrene in the sample solutions. However, there was no obvious indication that the CVs for quinoline are greater than for pyridine and styrene.

Gitanes

Some of the Gitanes samples exceed the calibration range for pyridine. As a check, another set of five samples were smoked on the same day and the solutions diluted and analysed. The results for pyridine were within the expected range but the precision had noticeably improved. On reflection, it was decided to report the original results as they gave a more realistic representation of the range of yields obtained for this brand.

A possible improvement to the method would be to smoke fewer cigarettes for brands with significantly high yields of SVCs.

Appendix 2: Selected smoke constituents for UK study

Type	Specific analyte(s)
	Nicotine free dry particulate matter
	nicotine
	carbon monoxide
	ammonia
	hydrogen cyanide
	nitrogen monoxide
Aromatic amines	1-aminonaphthalene
	2-aminonaphthalene
	3-aminobiphenyl
	4-aminobiphenyl
Aldehydes & Ketones	formaldehyde
	acetaldehyde
	acetone
	acrolein
	propionaldehyde
	crotonaldehyde
	methyl ethyl ketone
	butyraldehyde
Nitrosamines	n-nitrosanonicotine (nnn)
	n-nitrosoanatabine (nat)
	n-nitrosanabasine (nab)
	n-nitrosanormicotine ketone (nnk)
Phenols	phenol
	catchechol
	hydroquinone
	resorcinol
	ortho-cresol
	meta-cresol
	para-cresol
Polycyclic aromatic hydrocarbons	benzo[a]pyrene
Semi Volatile Compounds	pyridine
	quinoline
	styrene
Trace Metals	arsenic
	cadmium
	chromium
	lead
	mercury
	nickel
	selenium
Volatile Organic Compounds	benzene
	toluene
	1,3-butadiene
	isoprene
	acrylonitrile

Appendix 3: Selected abbreviations and terms used in this report

Term/Definition	Meaning
Channel	The channel of the smoking machine that the cigarette was smoked on
CO	Carbon Monoxide
CO(%v/v)	Percentage volume of carbon monoxide in the total volume of mainstream smoke corrected for any clearing puffs
Overwrap	The wrapper applied to the mouth end of the cigarette
Run	The smoking run that the cigarette was smoked in
TPM	Total Particulate Matter
Yield	The concentration of analyte measured in the smoke (normally per cigarette)
°C	Degree Celsius
ng	Nanogram
µg	Microgram
mg	Milligram
mL	Millilitre
L	Litre
mm	Millimetre
cig ⁻¹	per cigarette
SVCs	Semi volatile compounds

Appendix 4: Description of brands (sold in the UK - Nov/Dec 2001) used in the benchmark study

Brand	Length (mm)	Butt length used for the study (mm)	Description
Benson & Hedges King Size	84	28	filter – typical UK blend
Berkeley Superkings	99	33	filter – typical UK blend
Camel Ultra Lights	84	35	filter – typical American blend
Consulate Menthol	84	35	filter – typical UK blend – menthol
Gitanes Caporal Filter	70	23	filter – dark air cured blend
Lambert & Butler King Size	84	30	filter – typical UK blend
Lambert & Butler Lights King Size	84	34 (overwrap + 3 mm)	filter – typical UK blend
Lambert & Butler Ultra Lights	84	34 (overwrap + 3 mm)	filter – typical UK blend
Marlboro King Size	84	29	filter – typical American blend
Marlboro Lights King Size	84	35	filter – typical American blend
Mayfair Lights King Size	84	28	filter – typical UK blend
Mayfair Menthol King Size	84	33	filter – typical UK blend – menthol
Red Band Lights King Size	84	33	filter – typical UK blend
Regal Filter	71	26	filter – typical UK blend
Regal King Size	84	30	filter – typical UK blend
Rothman Royals 120s	120	38	filter – typical UK blend
Rothman Royals King Size	84	30	filter – typical UK blend
Senior Service	69	23	plain - typical UK blend
Silk Cut Extra Mild	84	33	filter – typical UK blend
Silk Cut King Size	84	28	filter – typical UK blend
Silk Cut Ultra King Size	84	33 (overwrap + 3 mm)	filter – typical UK blend
Superkings	99	34	filter – typical UK blend
Superkings Lights	99	33	filter – typical UK blend
Superkings Ultra Lights	99	34	filter – typical UK blend
Vogue Superslims	99	38	filter – typical American blend