

CONFIDENTIAL

UK SMOKE CONSTITUENTS STUDY

Part 8: Determination of Tobacco Specific Nitrosamines Yields in Cigarette Smoke

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UK SMOKE CONSTITUENTS TESTING STUDY PROTOCOL

Determination of TSNAs (Tobacco Specific Nitrosamines) 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.

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.

In agreement with the client, TSNA analysis was carried out at Arista Laboratories USA.

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 Kentucky reference cigarettes have been smoked as part of the study.

This report details the results for tobacco specific nitrosamines (TSNAs): N-nitrosanabasine (NAB); N-nitrosanatabine (NAT); 4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NNK) and N-nitrosornicotine (NNN)

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 conditioned at a temperature of $22 \pm 1^\circ\text{C}$ and $60 \pm 3\%$ relative humidity¹ 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 20 channel linear smoking machines.

5 cigarettes were sub-sampled from packets chosen on a random basis and smoked to determine the yield of TSNAs 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

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 $35 \pm 0.3 \text{ cm}^3$ 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 TSNA's in mainstream tobacco smoke by LC-MS/MS. For each sample, five conditioned cigarettes are smoked on a linear 20 channel smoking machine. The mainstream smoke is passed through a Cambridge filter pad to collect the TPM. After smoking, each pad is transferred to labelled flasks, an internal standard added followed by 20 mL of 0.15 % (w/w) aqueous ammonium acetate solution. The flasks are wrapped in aluminium foil (to keep the contents away from light) and shaken for an hour. The samples are filtered and an aliquot of the solution placed in an auto-sampler vial and sealed. The extract solution is analysed by LC-MS/MS. Deuterated internal standards (d-NNN and d-NNK) are added to the buffer extraction solution and are used to correct for recovery of nitrosamines.

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

The method is in current use and has been validated. The validation data used to show that the method is suitable for use in the study 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 6). Linear least squares regression analysis has been carried out for each TSNA yield versus carbon monoxide (Page 7 to 10) and TSNA yield versus NFDPM (Page 11 to 14) for the twenty five cigarette brands (excluding 1R4F and 1R5F).

A reporting limit has been used based on the limit of quantitation for the method ($\text{NAB} \equiv 2.5 \mu\text{g cig}^{-1}$; NAT, NNK and NNN $10 \mu\text{g cig}^{-1}$).

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 were 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 TSNAs 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 3402:1999 – 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.

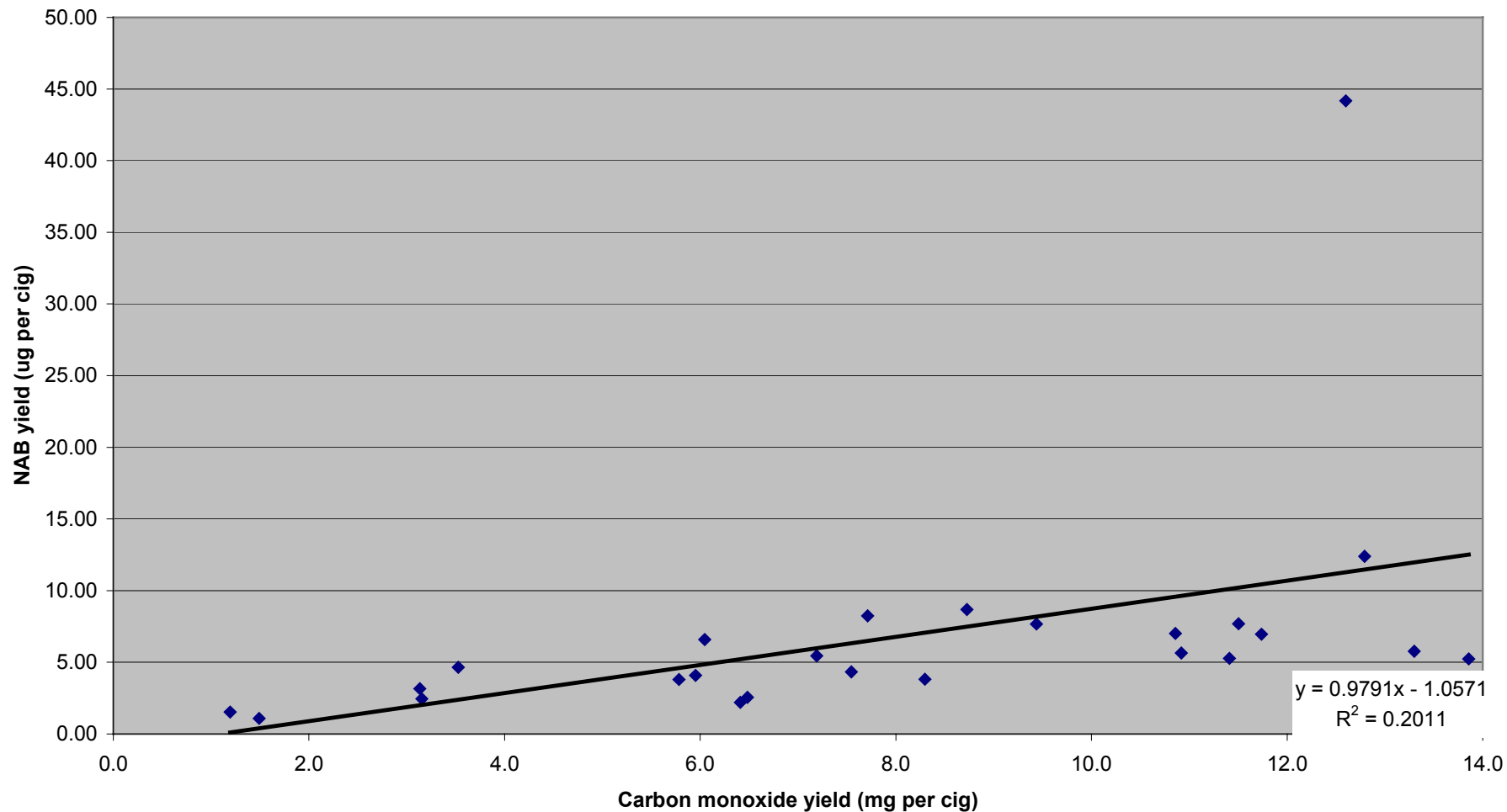
Tables

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

	N-nitrosanabasine (NAB) ng/cig	N-nitrosanatabine (NAT) ng/cig	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NNK) ng/cig	N-nitrososornicotine (NNN) ng/cig	NFDPM mg/cig	Carbon Monoxide mg/cig
1R4F	16.1	113	93.0	107	9.06	12.26
1R5F	7.2	52.6	23.9	53.6	1.92	3.36
Benson & Hedges King Size	7.0	53.0	31.8	42.0	10.30	11.74
Berkely Superkings	7.7	59.8	39.5	46.6	9.69	11.50
Camel Ultra Lights	3.2	23.4	15.4	22.9	3.09	3.13
Consulate Menthol	3.8	25.5	28.1	26.0	7.06	8.30
Gitanes Caporal Filter	44.2	148	258	500	12.00	12.60
Lambert & Butler King Size	5.8	32.0	29.5	21.1	11.93	13.30
Lambert & Butler Lights King Size	2.6	18.2	17.2	12.5	5.24	6.48
Lambert & Butler Ultra Lights	<2.5	7.8	6.6	5.2	1.61	1.49
Marlboro King Size	12.4	86.8	84.3	105	12.69	12.79
Marlboro Lights King Size	5.5	43.2	29.4	44.8	6.10	7.19
Mayfair Lights King Size	8.7	66.4	43.8	58.7	7.23	8.73
Mayfair Menthol King Size	4.1	33.4	23.1	30.6	4.65	5.95
Red Band Lights King Size	<2.5	16.1	13.6	11.7	5.55	6.41
Regal Filter	5.7	30.5	25.1	21.7	10.65	10.92
Regal King Size	5.2	31.5	30.2	22.8	11.96	13.86
Rothman Royals 120s	7.7	48.9	36.3	74.3	10.39	9.44
Rothman Royals King Size	7.0	47.0	49.2	67.7	11.00	10.86
Senior Service	8.2	57.0	33.6	44.0	11.92	7.71
Silk Cut Extra Mild	<2.5	14.8	11.6	13.0	2.67	3.16
Silk Cut King Size	3.8	27.6	19.8	17.9	5.62	5.78
Silk Cut Ultra King Size	<2.5	10.2	6.5	7.9	1.01	1.20
Superkings	5.3	36.8	33.4	22.7	10.71	11.41
Superkings Lights	4.3	29.7	23.4	17.6	8.09	7.54
Superkings Ultra Lights	4.7	27.4	24.3	39.1	3.08	3.53
Vogue Superslims	6.6	48.2	26.2	58.9	7.38	6.05

Regression analysis of NAB versus carbon monoxide

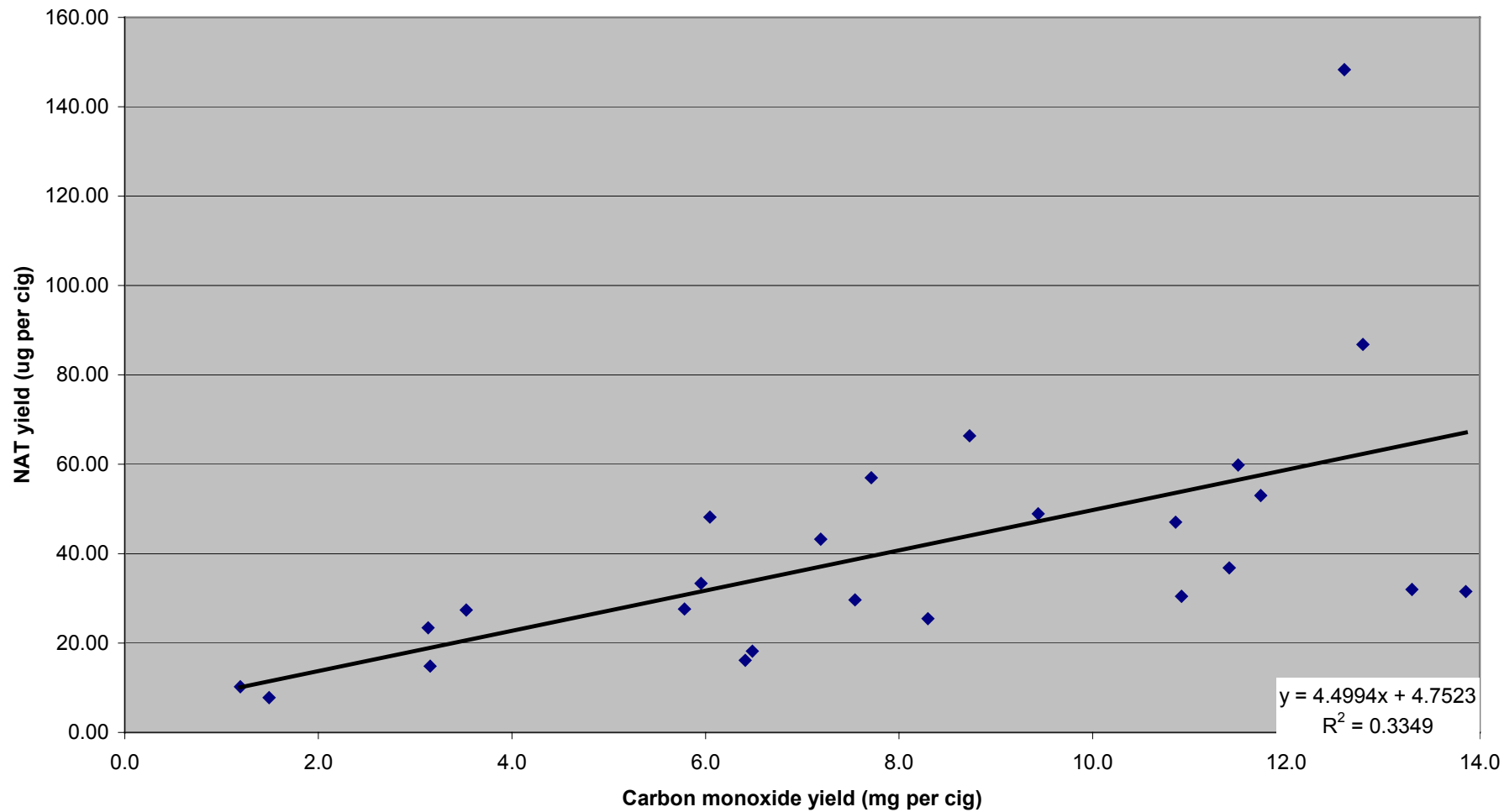
Regression analysis of NAB versus carbon monoxide for 25 cigarette brands



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

Regression analysis of NAT versus carbon monoxide

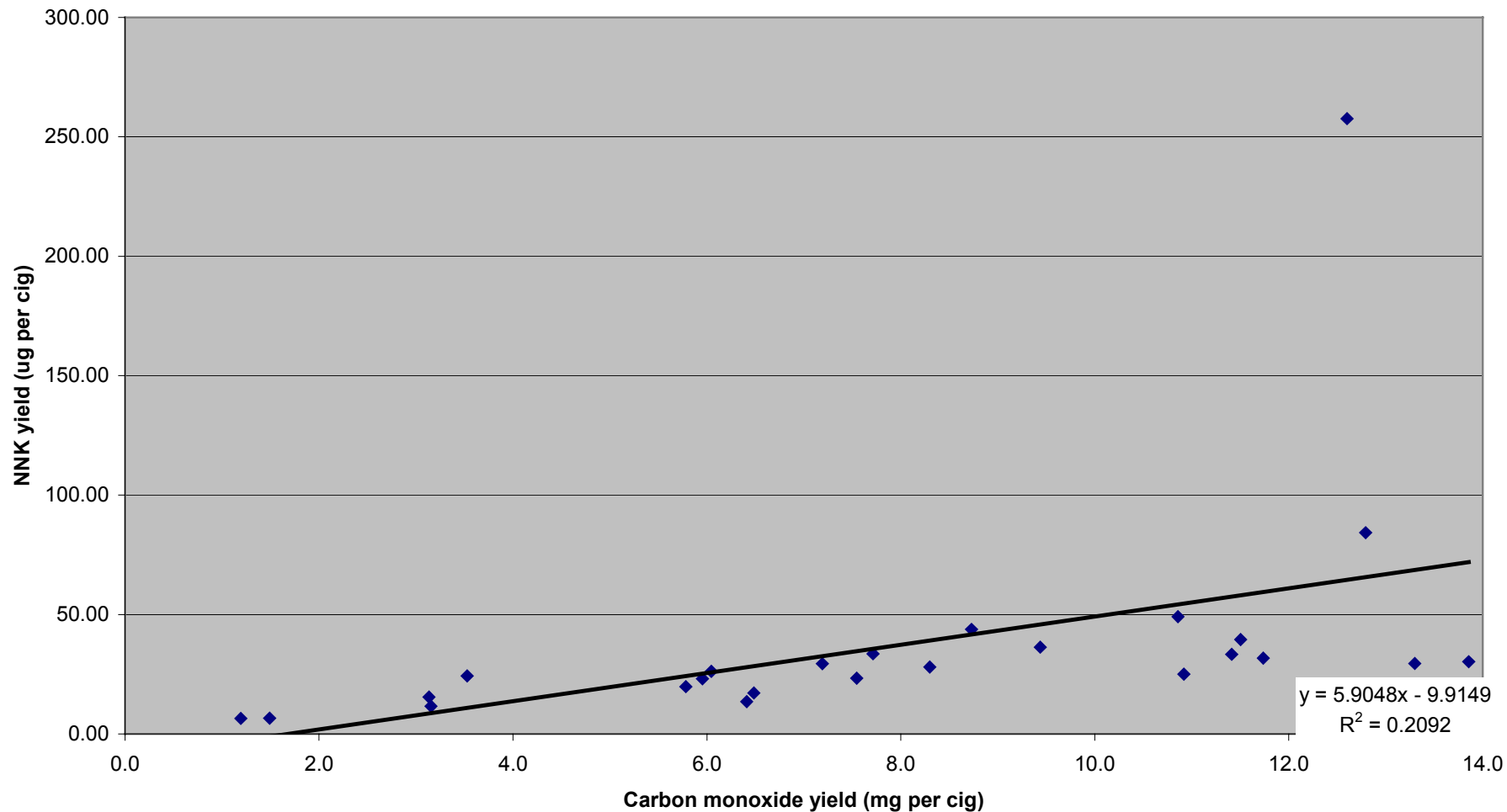
Regression analysis of NAT versus carbon monoxide for 25 cigarette brands



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

Regression analysis of NNK versus carbon monoxide

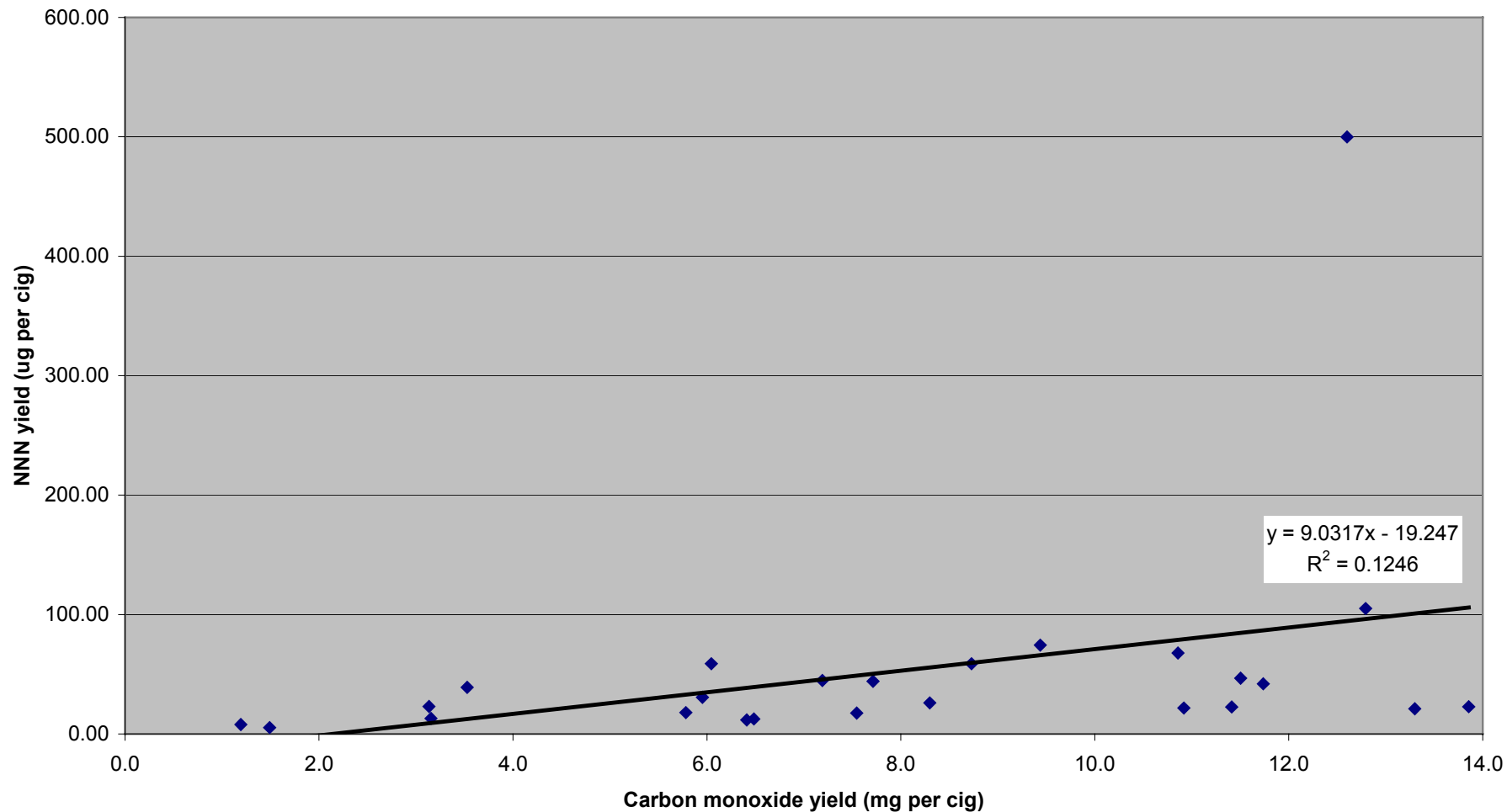
Regression analysis of NNK versus carbon monoxide for 25 cigarette brands



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

Regression analysis of NNN versus carbon monoxide

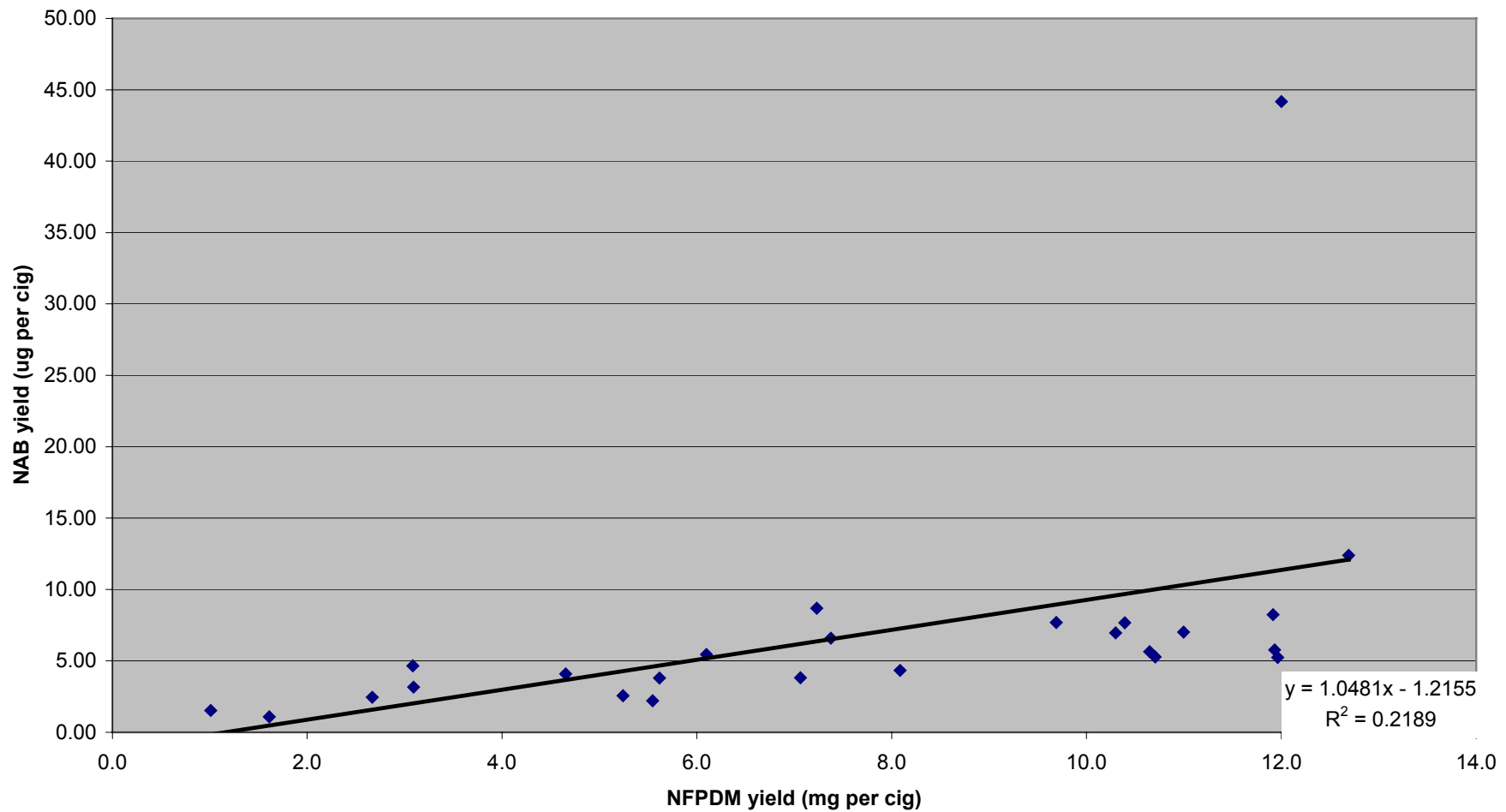
Regression analysis of NNN versus carbon monoxide for 25 cigarette brands



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

Regression analysis of NAB versus NFDPM

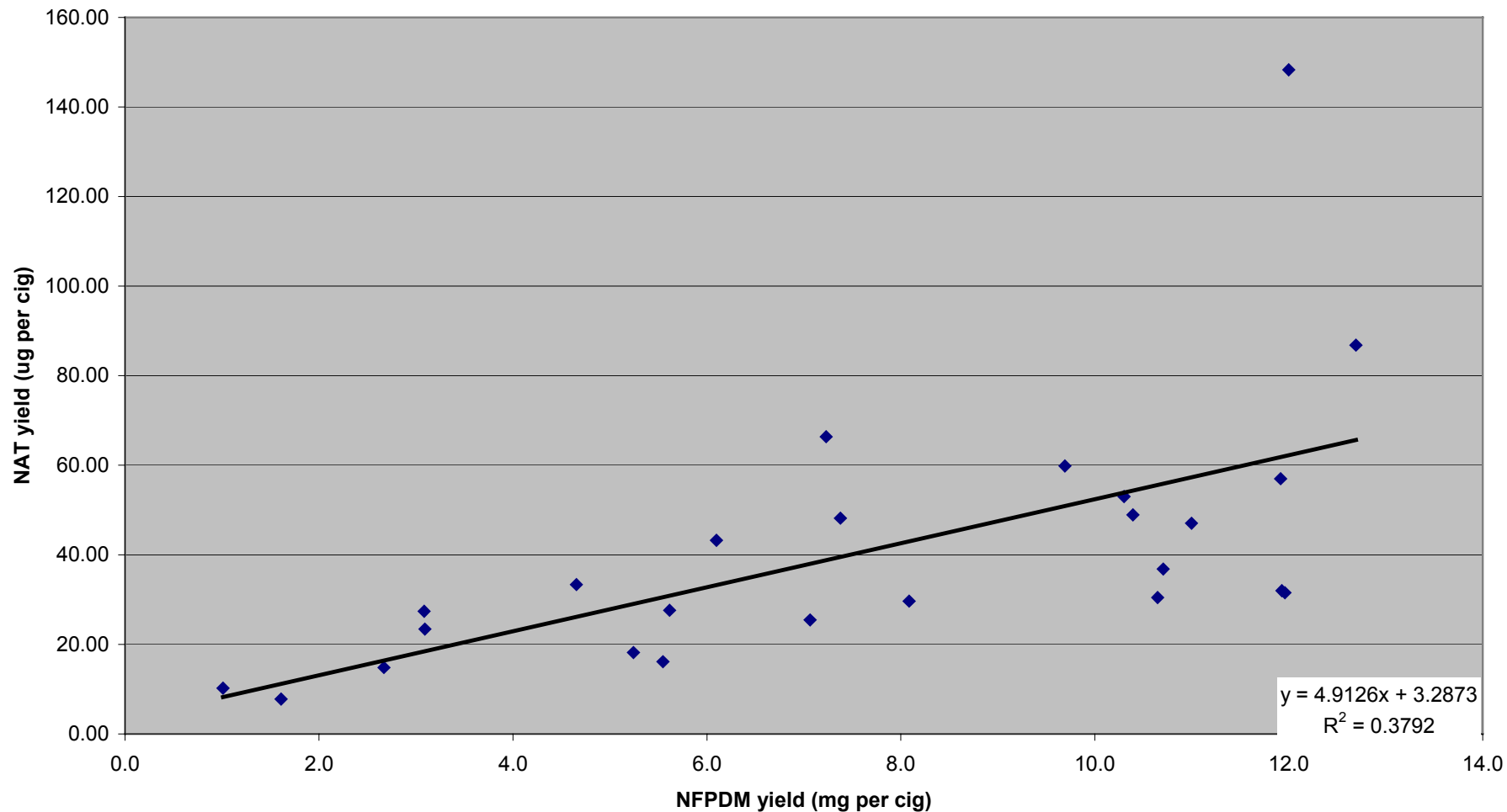
Regression analysis of NAB versus NFDPM for 25 cigarette brands



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

Regression analysis of NAT versus NFDPM

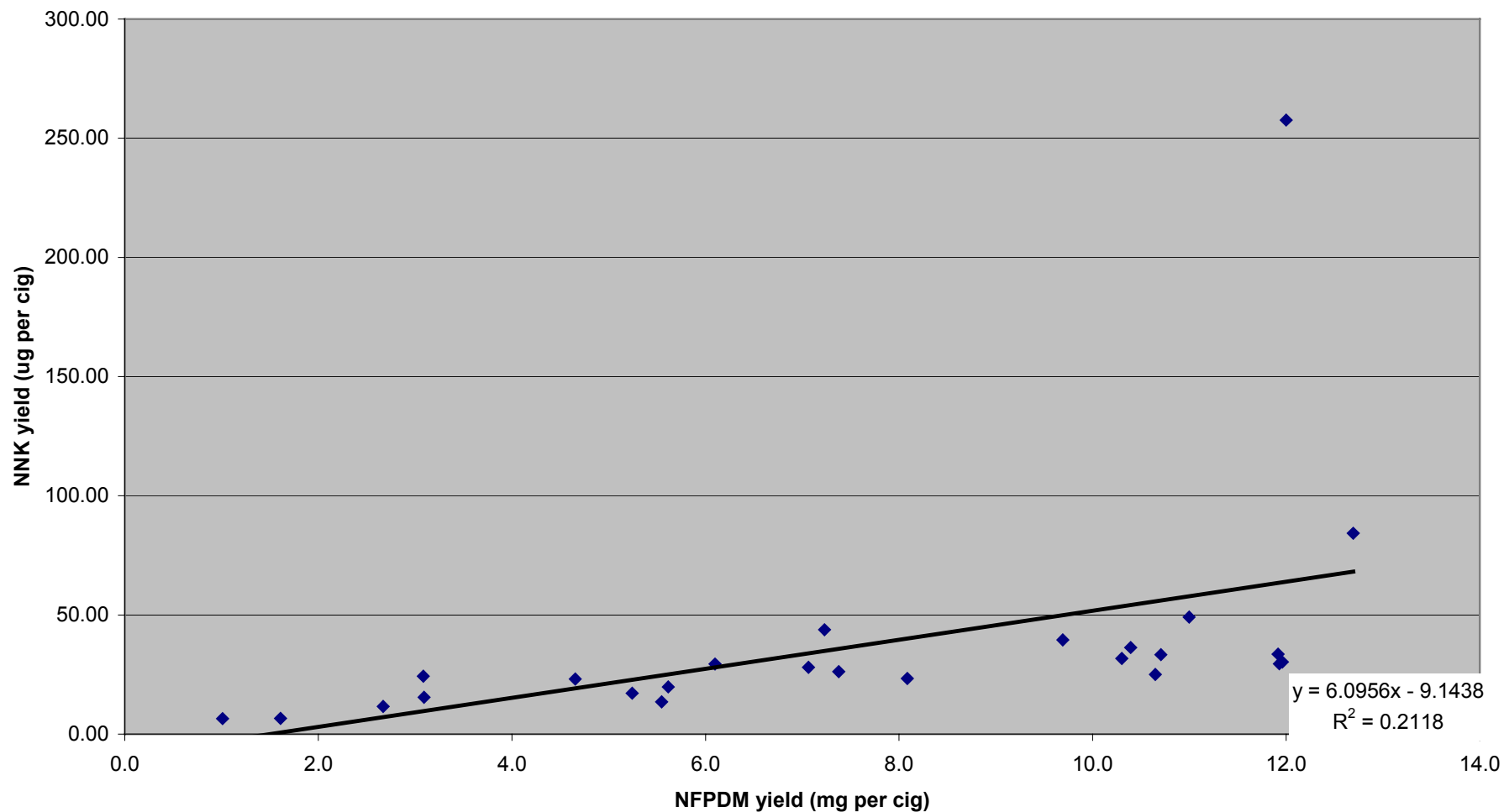
Regression analysis of NAT versus NFDPM for 25 cigarette brands



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

Regression analysis of NNK versus NFDPM

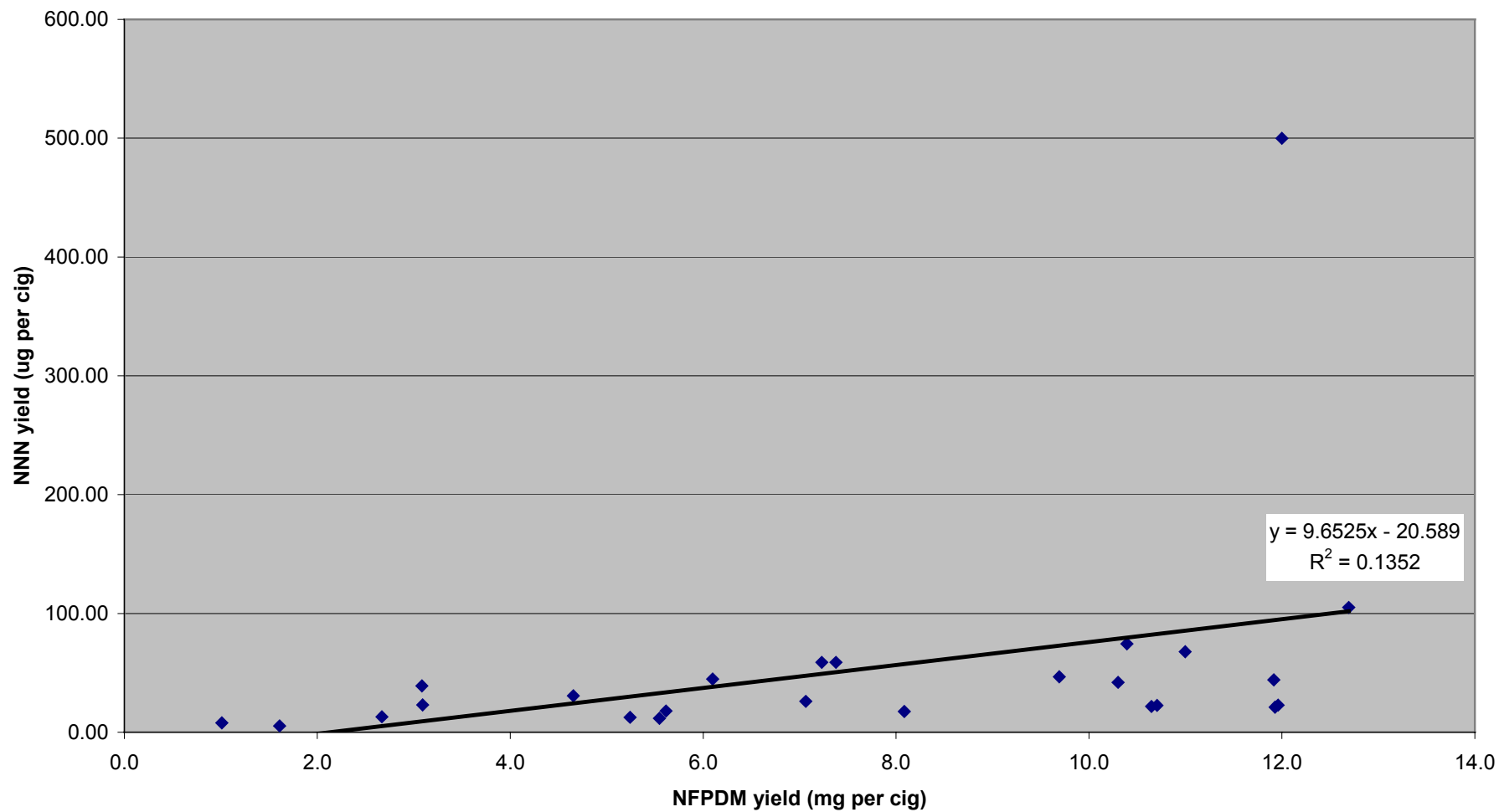
Regression analysis of NNK versus NFDPM for 25 cigarette brands



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

Regression analysis of NNN versus NFDPM

Regression analysis of NNN versus NFDPM for 25 cigarette brands



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

1R4F

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanol (NNK) yield (ng per cigarette)	N-nitrosornicotine (NNN) yield (ng per cigarette)
1R4F	16.3	110	87.7	113
1R4F	16.1	135	88.2	103
1R4F	17.9	110	102	110
1R4F	15.6	105	91.8	110
1R4F	14.8	105	95.1	102
Mean (ug/cig)	16.1	113	93.0	107
Standard Deviation	1.12	12.5	5.93	4.99
CV (%)	6.9	11.1	6.4	4.6
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	14.80800	104.89600	87.70400	101.69200
	15.63200	105.02400	88.16800	102.56000
	16.10400	109.53200	91.75600	109.61600
	16.26400	109.60800	95.12400	109.94400
	17.85200	134.82000	102.12000	113.08400
Statistical test applied				
Dixons low end test	0.270696452	0.0042775	0.032186459	0.07619382
Outlier detected at 95%				
Dixons high end test	0.521681997	0.8425344	0.485294118	0.275632022
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)	16.1	107	93.0	107
Standard Deviation	1.12	2.66	5.93	4.99
CV (%)	6.9	2.5	6.4	4.6

1R5F

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3- pyridinyl)-1-butanone (NNK) yield (ng per cigarette)	N-nitrosornicotine (NNN) yield (ng per cigarette)
1R5F	7.9	58.3	24.6	58.1
1R5F	6.9	59.0	22.2	51.7
1R5F	6.5	53.4	21.7	47.4
1R5F	6.7	43.8	22.7	53.6
1R5F	8.1	48.4	28.1	57.5
Mean (ug/cig)	7.2	52.6	23.9	53.6
Standard Deviation	0.72	6.51	2.59	4.39
CV (%)	10.0	12.4	10.8	8.2
Outlier Test				
Dixons outlier test was applied to the above data				
Data sorted	6.47200	43.81200	21.70000	47.42400
	6.70000	48.36800	22.22400	51.66400
	6.94000	53.41200	22.74800	53.58000
	7.91600	58.30800	24.55600	57.50000
	8.05200	59.03200	28.06400	58.08000
Statistical test applied				
Dixons low end test	0.1443038	0.299343	0.082338	0.397898
Outlier detected at 95%				
Dixons high end test	0.08607595	0.047569	0.551226	0.054429
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)	7.2	52.6	23.9	53.6
Standard Deviation	0.72	6.51	2.59	4.39
CV (%)	10.0	12.4	10.8	8.2

Benson & Hedges King Size

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3- pyridinyl)-1-butanone (NKK) yield (ng per cigarette)	N-nitrosornnicotine (NNN) yield (ng per cigarette)
Benson & Hedges King Size	6.9	49.2	32.8	38.1
Benson & Hedges King Size	6.0	46.8	28.3	41.3
Benson & Hedges King Size	7.0	51.3	30.7	42.6
Benson & Hedges King Size	6.9	60.3	34.3	40.5
Benson & Hedges King Size	8.0	57.6	32.7	47.3
Mean (ug/cig)	7.0	53.0	31.8	42.0
Standard Deviation	0.72	5.69	2.32	3.42
CV (%)	10.4	10.7	7.3	8.2
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	5.99600	46.77200	28.31600	38.12000
	6.87200	49.22800	30.74400	40.47200
	6.90400	51.25200	32.72400	41.25200
	7.00800	57.55200	32.81200	42.63600
	8.03200	60.26400	34.33200	47.34000
Statistical test applied				
Dixons low end test	0.4302554	0.182034	0.40359	0.255098
Outlier detected at 95%				
Dixons high end test	0.50294695	0.201008	0.25266	0.510195
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)	7.0	53.0	31.8	42.0
Standard Deviation	0.72	5.69	2.32	3.42
CV (%)	10.4	10.7	7.3	8.2

Berkely Superkings

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NNK) yield (ng per cigarette)	N-nitrosornicotine (NNN) yield (ng per cigarette)
Berkely Superkings	7.1	59.4	33.5	43.4
Berkely Superkings	7.6	63.9	36.9	49.2
Berkely Superkings	7.9	57.0	39.9	44.3
Berkely Superkings	8.1	66.3	49.8	50.2
Berkely Superkings	7.7	52.6	37.4	46.0
Mean (ug/cig)	7.7	59.8	39.5	46.6
Standard Deviation	0.39	5.45	6.21	2.98
CV (%)	5.0	9.1	15.7	6.4
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	7.10800	52.61200	33.47200	43.40800
	7.58400	56.98400	36.86000	44.31600
	7.66000	59.39600	37.36400	45.95600
	7.92000	63.91200	39.94800	49.18000
	8.12800	66.28000	49.81600	50.21200
Statistical test applied				
Dixons low end test	0.466666667	0.319871	0.207293	0.133451
Outlier detected at 95%				
Dixons high end test	0.203921569	0.173251	0.603769	0.151675
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)	7.7	59.8	39.5	46.6
Standard Deviation	0.39	5.45	6.21	2.98
CV (%)	5.0	9.1	15.7	6.4

Camel Ultra Lights

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NNK) yield (ng per cigarette)	N-nitrosornicotine (NNN) yield (ng per cigarette)
Camel Ultra Lights	3.6	26.4	17.1	24.1
Camel Ultra Lights	2.9	21.6	15.7	20.9
Camel Ultra Lights	3.2	24.4	16.2	24.6
Camel Ultra Lights	3.4	24.6	16.4	25.9
Camel Ultra Lights	2.6	19.9	11.9	19.0
Mean (ug/cig)	3.2	23.4	15.4	22.9
Standard Deviation	0.41	2.62	2.06	2.84
CV (%)	13.0	11.2	13.3	12.4
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	2.56800	19.89600	11.88000	19.02000
	2.94400	21.56800	15.69600	20.92000
	3.24400	24.42000	16.16000	24.11600
	3.44000	24.60400	16.35200	24.63600
	3.60400	26.44400	17.11600	25.85200
Statistical test applied				
Dixons low end test	0.36293436	0.255345	0.728801	0.278103
Outlier detected at 95%			95%	
Dixons high end test	0.15830116	0.281002	0.145913	0.177986
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)	3.2	23.4	16.3	22.9
Standard Deviation	0.41	2.62	0.59	2.84
CV (%)	13.0	11.2	3.6	12.4

Consulate Menthol

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NNK) yield (ng per cigarette)	N-nitrososornicotine (NNN) yield (ng per cigarette)
Consulate Menthol	3.5	23.0	31.0	24.2
Consulate Menthol	3.7	25.6	35.7	28.1
Consulate Menthol	4.5	26.5	28.8	25.8
Consulate Menthol	3.8	27.2	21.1	26.3
Consulate Menthol	3.6	25.0	23.7	25.4
Mean (ug/cig)	3.8	25.5	28.1	26.0
Standard Deviation	0.40	1.61	5.82	1.44
CV (%)	10.4	6.3	20.7	5.5
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	3.47200	23.00400	21.10800	24.18000
	3.62000	24.99600	23.66400	25.44800
	3.74800	25.57600	28.80400	25.83600
	3.76400	26.47200	30.96800	26.27200
	4.50000	27.20400	35.72800	28.13600
Statistical test applied				
Dixons low end test	0.14396887	0.4742857	0.174829	0.3205258
Outlier detected at 95%				
Dixons high end test	0.71595331	0.1742857	0.3255814	0.471183
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)	3.7	25.5	28.1	26.0
Standard Deviation	0.14	1.61	5.82	1.44
CV (%)	3.7	6.3	20.7	5.5

Gitanes Caporal Filter

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3- pyridinyl)-1-butanone (NNK) yield (ng per cigarette)	N-nitrosornnicotine (NNN) yield (ng per cigarette)
Gitanes Caporal Filter	39.9	130	238	479
Gitanes Caporal Filter	46.0	159	267	526
Gitanes Caporal Filter	45.9	156	267	505
Gitanes Caporal Filter	46.5	159	251	520
Gitanes Caporal Filter	42.6	138	264	469
Mean (ug/cig)	44.2	148.3	258	500
Standard Deviation	2.87	13.5	12.7	25.3
CV (%)	6.5	9.1	4.9	5.1
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	39.88	130.152	238.464	468.78
	42.568	137.54	250.744	478.696
	45.868	155.748	264.332	505.172
	46	158.9	266.896	520.38
	46.548	159.124	267.384	526.244
Statistical test applied				
Dixons low end test	0.403119376	0.255005	0.42462	0.17256
Outlier detected at 95%				
Dixons high end test	0.082183563	0.007732	0.016874	0.102046
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)	44.2	148	258	500
Standard Deviation	2.87	13.5	12.7	25.3
CV (%)	6.5	9.1	4.9	5.1

Lambert & Butler King Size

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NNK) yield (ng per cigarette)	N-nitrosornnicotine (NNN) yield (ng per cigarette)
Lambert & Butler King Size	5.8	34.7	39.7	20.8
Lambert & Butler King Size	6.2	33.5	28.6	23.8
Lambert & Butler King Size	5.7	33.8	25.1	19.4
Lambert & Butler King Size	5.8	30.0	29.9	21.8
Lambert & Butler King Size	5.4	28.1	24.3	19.8
Mean (ug/cig)	5.8	32.0	29.5	21.1
Standard Deviation	0.28	2.83	6.15	1.79
CV (%)	4.8	8.8	20.8	8.5
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	5.4	28.076	24.292	19.376
	5.7	30.024	25.092	19.788
	5.756	33.492	28.644	20.808
	5.796	33.792	29.916	21.804
	6.18	34.7	39.68	23.836
Statistical test applied				
Dixons low end test	0.384615385	0.294082	0.051989	0.092377
Outlier detected at 95%				
Dixons high end test	0.492307692	0.137077	0.63452	0.455605
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)	5.8	32.0	29.5	21.1
Standard Deviation	0.28	2.83	6.15	1.79
CV (%)	4.8	8.8	20.8	8.5

Lambert & Butler Lights King Size

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NNK) yield (ng per cigarette)	N-nitrosornicotine (NNN) yield (ng per cigarette)
Lambert & Butler Lights King Size	2.6	16.6	18.1	11.8
Lambert & Butler Lights King Size	<2.5	16.3	14.8	11.3
Lambert & Butler Lights King Size	<2.5	15.7	14.4	11.2
Lambert & Butler Lights King Size	3.1	25.6	16.1	16.9
Lambert & Butler Lights King Size	<2.5	16.6	22.6	11.5
Mean (ug/cig)*	2.6	18.2	17.2	12.5
Standard Deviation*	0.32	4.17	3.37	2.46
CV (%)	12.5	23.0	19.6	19.6
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	2.304	15.656	14.38	11.2
	2.328	16.28	14.776	11.276
	2.468	16.62	16.072	11.472
	2.644	16.636	18.08	11.848
	3.084	25.576	22.632	16.92
Statistical test applied				
Dixons low end test	0.030769231	0.062903	0.047988	0.013287
Outlier detected at 95%				
Dixons high end test	0.564102564	0.90121	0.551624	0.886713
Outlier detected at 95%		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)*	2.6	16.3	17.2	11.4
Standard Deviation*	0.32	0.46	3.37	0.29
CV (%)	12.5	2.8	19.6	2.5

*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 <2.5 ng per cigarette (NNN)

Lambert & Butler Ultra Lights

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NNK) yield (ng per cigarette)	N-nitrosanornicotine (NNN) yield (ng per cigarette)
Lambert & Butler Ultra Lights	<2.5	7.2	7.5	6.3
Lambert & Butler Ultra Lights	<2.5	8.6	7.4	5.9
Lambert & Butler Ultra Lights	<2.5	9.7	5.7	5.2
Lambert & Butler Ultra Lights	<2.5	6.3	6.1	4.5
Lambert & Butler Ultra Lights	<2.5	7.2	6.4	4.3
Mean (ug/cig)	<2.5	7.8	6.6	5.2
Standard Deviation	n/a	1.35	0.80	0.89
CV (%)	n/a	17.3	12.1	17.1
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	0.816	6.34	5.716	4.26
	0.984	7.168	6.088	4.468
	1.052	7.188	6.392	5.164
	1.116	8.58	7.444	5.92
	1.416	9.744	7.48	6.324
Statistical test applied				
Dixons low end test	0.28	0.243243	0.210884	0.100775
Outlier detected at 95%				
Dixons high end test	0.5	0.341951	0.020408	0.195736
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)	<2.5	7.8	6.6	5.2
Standard Deviation	n/a	1.35	0.80	0.89
CV (%)	n/a	17.3	12.1	17.1

Marlboro King Size

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NKK) yield (ng per cigarette)	N-nitrosornnicotine (NNN) yield (ng per cigarette)
Marlboro King Size	11.4	81.3	91.2	101
Marlboro King Size	13.1	103	85.0	111
Marlboro King Size	11.2	80.4	82.3	105
Marlboro King Size	11.7	85.6	84.3	104
Marlboro King Size	14.5	84.2	78.5	103
Mean (ug/cig)	12.4	86.8	84.3	105
Standard Deviation	1.42	9.07	4.61	3.81
CV (%)	11.5	10.4	5.5	3.6
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	11.18	80.412	78.536	101.46
	11.424	81.328	82.3	102.872
	11.66	84.172	84.304	104.272
	13.144	85.616	85.012	105.188
	14.532	102.604	91.184	111.356
Statistical test applied				
Dixons low end test	0.07279236	0.041276	0.297596	0.142684
Outlier detected at 95%				
Dixons high end test	0.41408115	0.765501	0.487982	0.623282
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)	12.4	82.9	84.3	105
Standard Deviation	1.42	2.43	4.61	3.81
CV (%)	11.5	2.9	5.5	3.6

Marlboro Lights King Size

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NKK) yield (ng per cigarette)	N-nitrosornnicotine (NNN) yield (ng per cigarette)
Marlboro Lights King Size	7.1	48.5	31.4	50.8
Marlboro Lights King Size	5.9	41.7	27.0	41.9
Marlboro Lights King Size	4.5	49.5	32.9	46.8
Marlboro Lights King Size	5.1	44.5	28.6	43.0
Marlboro Lights King Size	4.5	31.9	26.9	41.5
Mean (ug/cig)	5.5	43.2	29.4	44.8
Standard Deviation	1.10	7.05	2.71	3.95
CV (%)	20.2	16.3	9.2	8.8
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	4.528	31.948	26.864	41.54
	4.548	41.704	26.956	41.892
	5.128	44.492	28.644	43.028
	5.944	48.548	31.428	46.844
	7.14	49.484	32.9	50.804
Statistical test applied				
Dixons low end test	0.007656968	0.556341	0.015242	0.037997
Outlier detected at 95%				
Dixons high end test	0.457886677	0.053376	0.24387	0.427461
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)	5.5	43.2	29.4	44.8
Standard Deviation	1.10	7.05	2.71	3.95
CV (%)	20.2	16.3	9.2	8.8

Mayfair Lights King Size

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NNK) yield (ng per cigarette)	N-nitrosornicotine (NNN) yield (ng per cigarette)
Mayfair Lights King Size	9.1	57.6	38.6	57.1
Mayfair Lights King Size	8.3	68.9	37.1	60.4
Mayfair Lights King Size	9.5	74.5	44.6	61.5
Mayfair Lights King Size	9.4	75.9	59.6	61.5
Mayfair Lights King Size	7.2	54.8	39.1	53.3
Mean (ug/cig)	8.7	66.4	43.8	58.7
Standard Deviation	0.94	9.66	9.29	3.53
CV (%)	10.8	14.6	21.2	6.0
Outlier Test				
Dixons outlier test was applied to the above data				
Data sorted	7.228	54.808	37.056	53.312
	8.272	57.636	38.6	57.052
	9.112	68.936	39.136	60.384
	9.352	74.52	44.624	61.464
	9.46	75.892	59.624	61.48
Statistical test applied				
Dixons low end test	0.467741935	0.13413	0.068415	0.457884
Outlier detected at 95%				
Dixons high end test	0.048387097	0.065073	0.664658	0.001959
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)	8.7	66.4	43.8	58.7
Standard Deviation	0.94	9.66	9.29	3.53
CV (%)	10.8	14.6	21.2	6.0

Mayfair Menthol King Size

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NNK) yield (ng per cigarette)	N-nitrosornnicotine (NNN) yield (ng per cigarette)
Mayfair Menthol King Size	4.2	37.9	26.1	32.6
Mayfair Menthol King Size	4.0	35.3	18.9	28.1
Mayfair Menthol King Size	4.1	35.6	21.4	32.9
Mayfair Menthol King Size	3.8	26.7	20.6	30.2
Mayfair Menthol King Size	4.3	31.2	28.6	29.3
Mean (ug/cig)	4.1	33.4	23.1	30.6
Standard Deviation	0.22	4.43	4.05	2.08
CV (%)	5.3	13.3	17.5	6.8
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	3.772	26.708	18.86	28.06
	3.98	31.232	20.648	29.34
	4.112	35.276	21.392	30.216
	4.244	35.632	26.056	32.552
	4.312	37.924	28.56	32.916
Statistical test applied				
Dixons low end test	0.385185185	0.403352	0.18433	0.263591
Outlier detected at 95%				
Dixons high end test	0.125925926	0.204351	0.258144	0.074959
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)	4.1	33.4	23.1	30.6
Standard Deviation	0.22	4.43	4.05	2.08
CV (%)	5.3	13.3	17.5	6.8

Red Band Lights King Size

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NKK) yield (ng per cigarette)	N-nitrosornicotine (NNN) yield (ng per cigarette)
Red Band Lights King Size	<2.5	15.6	12.7	11.2
Red Band Lights King Size	<2.5	18.1	14.9	14.8
Red Band Lights King Size	<2.5	15.7	16.3	12.3
Red Band Lights King Size	<2.5	16.4	12.2	11.3
Red Band Lights King Size	<2.5	14.8	11.7	9.0
Mean (ug/cig)	<2.5	16.1	13.6	11.7
Standard Deviation	n/a	1.25	1.99	2.09
CV (%)	n/a	7.8	14.7	17.8
Outlier Test				
Dixons outlier test was applied to the above data				
Data sorted	1.712	14.756	11.652	9.016
	2.096	15.568	12.156	11.212
	2.26	15.724	12.736	11.316
	2.424	16.428	14.932	12.264
	2.48	18.076	16.32	14.78
Statistical test applied				
Dixons low end test	0.5	0.244578	0.107969	0.380985
Outlier detected at 95%				
Dixons high end test	0.07291667	0.496386	0.297344	0.436502
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)	<2.5	16.1	13.6	11.7
Standard Deviation	n/a	1.25	1.99	2.09
CV (%)	n/a	7.8	14.7	17.8

Regal Filter

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3- pyridinyl)-1-butanone (NKK) yield (ng per cigarette)	N-nitrosornnicotine (NNN) yield (ng per cigarette)
Regal Filter	5.7	33.8	25.6	22.0
Regal Filter	5.7	34.3	26.5	24.4
Regal Filter	5.5	26.1	24.8	20.5
Regal Filter	5.4	26.0	22.4	17.5
Regal Filter	6.0	32.0	26.0	24.3
Mean (ug/cig)	5.7	30.5	25.1	21.7
Standard Deviation	0.22	4.09	1.62	2.88
CV (%)	4.0	13.4	6.5	13.2
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	5.408	26.044	22.404	17.504
	5.476	26.104	24.828	20.504
	5.688	32.012	25.624	22.044
	5.728	33.828	25.988	24.32
	5.972	34.284	26.54	24.356
Statistical test applied				
Dixons low end test	0.12056738	0.007282	0.586074	0.437828
Outlier detected at 95%				
Dixons high end test	0.43262411	0.05534	0.133462	0.005254
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)	5.7	30.5	25.1	21.7
Standard Deviation	0.22	4.09	1.62	2.88
CV (%)	4.0	13.4	6.5	13.2

Regal King Size

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3- pyridinyl)-1-butanone (NKK) yield (ng per cigarette)	N-nitrosornnicotine (NNN) yield (ng per cigarette)
Regal King Size	5.2	31.8	32.4	22.8
Regal King Size	4.3	29.8	24.9	22.8
Regal King Size	5.6	34.6	34.0	28.4
Regal King Size	5.7	30.4	23.1	17.4
Regal King Size	5.3	31.0	36.6	22.6
Mean (ug/cig)	5.2	31.5	30.2	22.8
Standard Deviation	0.56	1.86	5.88	3.88
CV (%)	10.7	5.9	19.5	17.0
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	4.316	29.816	23.124	17.416
	5.208	30.404	24.936	22.644
	5.268	31.048	32.388	22.768
	5.648	31.816	34.048	22.772
	5.72	34.584	36.6	28.388
Statistical test applied				
Dixons low end test	0.63532764	0.123322	0.134461	0.476486
Outlier detected at 95%				
Dixons high end test	0.05128205	0.580537	0.189374	0.511848
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)	5.2	31.5	30.2	22.8
Standard Deviation	0.56	1.86	5.88	3.88
CV (%)	10.7	5.9	19.5	17.0

Rothman Royals 120s

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NNK) yield (ng per cigarette)	N-nitrosornnicotine (NNN) yield (ng per cigarette)
Rothman Royals 120s	8.9	55.8	43.1	83.1
Rothman Royals 120s	8.3	53.0	33.6	81.6
Rothman Royals 120s	7.7	48.2	39.5	70.1
Rothman Royals 120s	7.3	44.3	33.1	64.9
Rothman Royals 120s	6.2	43.3	32.2	71.9
Mean (ug/cig)	7.7	48.9	36.3	74.3
Standard Deviation	1.04	5.40	4.75	7.79
CV (%)	13.6	11.0	13.1	10.5
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	6.172	43.328	32.204	64.912
	7.26	44.312	33.096	70.064
	7.668	48.248	33.64	71.924
	8.328	52.98	39.488	81.588
	8.9	55.8	43.076	83.136
Statistical test applied				
Dixons low end test	0.39882698	0.078897	0.082046	0.282704
Outlier detected at 95%				
Dixons high end test	0.20967742	0.226106	0.330022	0.084943
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)	7.7	48.9	36.3	74.3
Standard Deviation	1.04	5.40	4.75	7.79
CV (%)	13.6	11.0	13.1	10.5

Rothman Royals King Size

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NKK) yield (ng per cigarette)	N-nitrosornicotine (NNO) yield (ng per cigarette)
Rothman Royals King Size	6.6	46.1	48.2	59.5
Rothman Royals King Size	7.3	47.7	48.9	67.1
Rothman Royals King Size	6.5	52.4	46.0	76.7
Rothman Royals King Size	7.6	46.0	56.0	66.5
Rothman Royals King Size	7.0	43.0	46.7	68.9
Mean (ug/cig)	7.0	47.0	49.2	67.7
Standard Deviation	0.46	3.42	3.99	6.16
CV (%)	6.6	7.3	8.1	9.1
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	6.468	43.048	46.04	59.536
	6.648	45.964	46.668	66.476
	7.036	46.1	48.164	67.068
	7.276	47.732	48.904	68.92
	7.6	52.368	56	76.744
Statistical test applied				
Dixons low end test	0.159010601	0.312876	0.063052	0.403301
Outlier detected at 95%				
Dixons high end test	0.286219081	0.497425	0.71245	0.454672
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)	7.0	47.0	47.4	67.7
Standard Deviation	0.46	3.42	1.32	6.16
CV (%)	6.6	7.3	2.8	9.1

Senior Service

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NNK) yield (ng per cigarette)	N-nitrosornicotine (NNN) yield (ng per cigarette)
Senior Service	8.5	55.9	32.6	44.9
Senior Service	8.1	54.1	33.2	39.4
Senior Service	8.2	57.2	35.7	43.5
Senior Service	8.3	56.8	33.9	48.6
Senior Service	8.2	61.0	32.5	43.7
Mean (ug/cig)	8.2	57.0	33.6	44.0
Standard Deviation	0.14	2.54	1.31	3.29
CV (%)	1.7	4.5	3.9	7.5
Outlier Test				
Dixons outlier test was applied to the above data				
Data sorted	8.08	54.128	32.456	39.432
	8.176	55.856	32.64	43.516
	8.244	56.804	33.208	43.744
	8.252	57.168	33.86	44.928
	8.456	61.032	35.692	48.6
Statistical test applied				
Dixons low end test	0.255319149	0.25029	0.05686	0.445462
Outlier detected at 95%				
Dixons high end test	0.542553191	0.559676	0.566131	0.400524
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)	8.2	57.0	33.6	44.0
Standard Deviation	0.14	2.54	1.31	3.29
CV (%)	1.7	4.5	3.9	7.5

Silk Cut Extra Mild

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NKK) yield (ng per cigarette)	N-nitrosornnicotine (NNN) yield (ng per cigarette)
Silk Cut Extra Mild	<2.5	16.6	10.6	11.1
Silk Cut Extra Mild	<2.5	15.2	10.3	12.5
Silk Cut Extra Mild	<2.5	15.8	16.0	16.0
Silk Cut Extra Mild	2.9	13.2	10.6	13.4
Silk Cut Extra Mild	2.6	13.2	10.5	11.9
Mean (ug/cig)*	<2.5	14.8	11.6	13.0
Standard Deviation*	n/a	1.57	2.47	1.89
CV (%)	n/a	10.6	21.3	14.6
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	2.168	13.168	10.304	11.148
	2.208	13.2	10.532	11.92
	2.428	15.22	10.612	12.46
	2.56	15.828	10.612	13.44
	2.908	16.64	16.032	16.044
Statistical test applied				
Dixons low end test	0.05405405	0.009217	0.039804	0.15768
Outlier detected at 95%				
Dixons high end test	0.47027027	0.233871	0.946229	0.531863
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)*	<2.5	14.8	10.5	13.0
Standard Deviation*	n/a	1.57	0.15	1.89
CV (%)	n/a	10.6	1.4	14.6

*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 <2.5 ng per cigarette (NNN)

Silk Cut King Size

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NNK) yield (ng per cigarette)	N-nitrososornicotine (NNN) yield (ng per cigarette)
Silk Cut King Size	4.4	29.0	23.2	17.9
Silk Cut King Size	4.4	28.8	20.6	19.0
Silk Cut King Size	3.8	29.8	18.9	16.8
Silk Cut King Size	3.2	26.9	20.3	19.4
Silk Cut King Size	3.1	23.5	16.2	16.4
Mean (ug/cig)	3.8	27.6	19.8	17.9
Standard Deviation	0.62	2.51	2.55	1.31
CV (%)	16.3	9.1	12.8	7.3
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	3.108	23.532	16.204	16.368
	3.232	26.904	18.912	16.82
	3.848	28.752	20.316	17.856
	4.392	29.008	20.648	19.02
	4.42	29.792	23.16	19.364
Statistical test applied				
Dixons low end test	0.0945122	0.538658	0.389304	0.150868
Outlier detected at 95%				
Dixons high end test	0.02134146	0.12524	0.361127	0.11482
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)	3.8	27.6	19.8	17.9
Standard Deviation	0.62	2.51	2.55	1.31
CV (%)	16.3	9.1	12.8	7.3

Silk Cut Ultra King Size

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NNK) yield (ng per cigarette)	N-nitrosornicotine (NNN) yield (ng per cigarette)
Silk Cut Ultra King Size	<2.5	9.3	6.2	5.9
Silk Cut Ultra King Size	<2.5	10.6	6.8	7.4
Silk Cut Ultra King Size	<2.5	9.3	6.1	8.0
Silk Cut Ultra King Size	<2.5	10.8	6.3	9.5
Silk Cut Ultra King Size	<2.5	11.1	7.3	8.5
Mean (ug/cig)	<2.5	10.2	6.5	7.9
Standard Deviation	n/a	0.86	0.51	1.33
CV (%)	n/a	8.4	7.8	16.9
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	1.384	9.264	6.124	5.908
	1.44	9.34	6.164	7.4
	1.528	10.648	6.328	7.984
	1.568	10.836	6.768	8.54
	1.688	11.064	7.332	9.452
Statistical test applied				
Dixons low end test	0.1842105	0.04222222	0.033112583	0.420993
Outlier detected at 95%				
Dixons high end test	0.3947368	0.12666667	0.466887417	0.257336
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)	<2.5	10.2	6.5	7.9
Standard Deviation	n/a	0.86	0.51	1.33
CV (%)	n/a	8.4	7.8	16.9

Superkings

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3- pyridinyl)-1-butanone (NNK) yield (ng per cigarette)	N-nitrosornnicotine (NNN) yield (ng per cigarette)
Superkings	5.9	38.2	27.9	23.4
Superkings	5.3	39.9	34.2	23.6
Superkings	6.3	37.7	48.0	25.5
Superkings	4.9	36.7	28.3	22.5
Superkings	3.8	31.6	28.3	18.4
Mean (ug/cig)	5.3	36.8	33.4	22.7
Standard Deviation	0.96	3.14	8.61	2.62
CV (%)	18.2	8.5	25.8	11.6
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	3.836	31.596	27.944	18.388
	4.94	36.736	28.256	22.512
	5.328	37.676	28.336	23.424
	5.94	38.196	34.248	23.596
	6.3	39.888	48.032	25.452
Statistical test applied				
Dixons low end test	0.44805195	0.619875	0.015532	0.583805
Outlier detected at 95%				
Dixons high end test	0.1461039	0.204052	0.686181	0.262741
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)	5.3	36.8	33.4	22.7
Standard Deviation	0.96	3.14	8.61	2.62
CV (%)	18.2	8.5	25.8	11.6

Superkings Lights

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NNK) yield (ng per cigarette)	N-nitrosornicotine (NNN) yield (ng per cigarette)
Superkings Lights	4.5	30.0	23.0	17.9
Superkings Lights	4.3	30.8	23.7	17.2
Superkings Lights	4.9	29.3	24.4	18.3
Superkings Lights	4.6	30.2	23.3	19.3
Superkings Lights	3.4	27.9	22.5	15.2
Mean (ug/cig)	4.3	29.7	23.4	17.6
Standard Deviation	0.58	1.11	0.74	1.56
CV (%)	13.4	3.7	3.2	8.9
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	3.372	27.932	22.496	15.16
	4.304	29.304	22.96	17.16
	4.484	30.036	23.308	17.892
	4.576	30.244	23.72	18.344
	4.916	30.8	24.436	19.312
Statistical test applied				
Dixons low end test	0.60362694	0.478382	0.239175	0.481696
Outlier detected at 95%				
Dixons high end test	0.22020725	0.193863	0.369072	0.233141
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)	4.3	29.7	23.4	17.6
Standard Deviation	0.58	1.11	0.74	1.56
CV (%)	13.4	3.7	3.2	8.9

Superkings Ultra Lights

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NNK) yield (ng per cigarette)	N-nitrosornicotine (NNN) yield (ng per cigarette)
Superkings Ultra Lights	4.8	29.5	24.0	38.4
Superkings Ultra Lights	5.1	33.9	23.3	38.8
Superkings Ultra Lights	3.9	22.8	21.4	37.0
Superkings Ultra Lights	4.7	25.4	31.5	37.1
Superkings Ultra Lights	4.8	25.3	21.5	44.1
Mean (ug/cig)	4.7	27.4	24.3	39.1
Standard Deviation	0.47	4.37	4.14	2.93
CV (%)	10.1	16.0	17.0	7.5
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	3.872	22.836	21.416	36.96
	4.72	25.308	21.528	37.076
	4.784	25.372	23.268	38.404
	4.788	29.48	24	38.848
	5.136	33.948	31.476	44.108
Statistical test applied				
Dixons low end test	0.67088608	0.222462	0.011133	0.016228
Outlier detected at 95%				
Dixons high end test	0.27531646	0.402088	0.743141	0.73587
Outlier detected at 95%			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)	4.7	27.4	22.6	37.8
Standard Deviation	0.47	4.37	1.28	0.95
CV (%)	10.1	16.0	5.7	2.5

Vogue Superslims

Brand	N-nitrosanabasine (NAB) yield (ng per cigarette)	N-nitrosanatabine (NAT) yield (ng per cigarette)	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone (NNK) yield (ng per cigarette)	N-nitrosornicotine (NNN) yield (ng per cigarette)
Vogue Superslims	6.8	51.1	25.9	60.1
Vogue Superslims	6.7	47.9	27.2	64.1
Vogue Superslims	7.1	51.3	27.3	61.8
Vogue Superslims	6.2	48.0	26.1	63.2
Vogue Superslims	6.2	42.6	24.4	45.4
Mean (ug/cig)	6.6	48.2	26.2	58.9
Standard Deviation	0.37	3.50	1.19	7.73
CV (%)	5.6	7.3	4.6	13.1
<i>Outlier Test</i>				
Dixons outlier test was applied to the above data				
Data sorted	6.192	42.632	24.388	45.352
	6.244	47.892	25.932	60.06
	6.692	47.968	26.108	61.824
	6.752	51.136	27.24	63.184
	7.064	51.256	27.316	64.132
Statistical test applied				
Dixons low end test	0.05963303	0.609926	0.527322	0.783174
Outlier detected at 95%				95%
Dixons high end test	0.35779817	0.013915	0.025956	0.050479
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)	6.6	48.2	26.2	62.3
Standard Deviation	0.37	3.50	1.19	1.77
CV (%)	5.6	7.3	4.6	2.8

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.

Choice of methodology

The original intention (by LGC Limited) was to analyse the samples by gas chromatography – thermal energy analyser. Ten conditioned cigarettes were smoked and the mainstream smoke was collected onto a 44mm glass fibre filter pad. The pad was extracted with dichloromethane and concentrated to ca 1 mL. The extract solution was cleaned by passing the solution through a column containing sodium sulfate, silica and alumina. The TSNAs were eluted from the column with dichloromethane/acetone and concentrated to approximately 1 mL volume. A portion of the eluted solution was analysed by GC-TEA.

There were two problems with this approach.

The first is that it is difficult to achieve satisfactory column chromatography, i.e. to separate the TSNAs from other organic compounds present in the extract solution. If insufficient clean-up is achieved then this caused problems with the GC-TEA, e.g. the injection liner became dirty very quickly leading to poor chromatography.

The second problem was that it was observed that NNK, in particular, tended to give poor precision when analysed by GC-TEA. This may be due to breakdown of the tobacco specific nitrosamines in the GC-TEA. High temperatures are required for the non-volatile TSNAs - NNK has a melting point of 65°C.

Extraction of nitrosamines into aqueous solution and analysis by LC-MS-MS got round both of these problems.

Limit of Quantitation and Detection

The limit of quantitation for the method for N-nitrosanabasine (NAB) was 2.5 ng cig⁻¹ and the limit of detection was 0.8 ng cig⁻¹. All NAB yields were above the LoD but some were below the LoQ. The reporting limit for NAB was set at the LoQ so results below the LoQ have been reported as <2.5ng cig⁻¹.

The mean, standard deviation and CV were calculated using all 5 results. If the mean value was below the reporting limit then the results is reported as <2.5 ng cig⁻¹.

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-nitrosornicotine (nnn)
	N-nitrosoanatabine (nat)
	N-nitrosanabasine (nab)
	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone
Phenols	phenol
	catechol
	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)
LoQ	Limit of Quantitation
LoD	Limit of Detection
°C	Degree Celsius
ng	Nanogram
µg	Microgram
mg	Milligram
mL	Millilitre
L	Litre
mm	Millimetre
cig ⁻¹	per cigarette
TSNAs	Tobacco specific nitrosamines
NAB	N-nitrosanabasine
NAT	n-nitrosoanatabine
NNK	4-(N-Methyl-N-nitrosamino)-1-(3-pyridinyl)-1-butanone
NNN	N-nitrosornicotine

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