Smoke Analysis Sub-Group

Technical Report

2019 Collaborative Study for B[a]P and TSNA Compounds in Mainstream Cigar Smoke

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Table of Contents

1. Summary

In 2019, the CORESTA Smoke Analytes Sub-Group[1] (SMA SG) launched a collaborative study (CS) in an effort to expand the scopes of CRM No. 75 and CRM No. 58, currently only valid for cigarettes, to include cigar smoke analysis for tobacco specific nitrosamines (TSNAs) and Benzo[a]pyrene (B[a]P), respectively. Additionally, an experiment to determine the feasibility of simultaneous analysis for volatile organics (VO) (CRM No. 70/ISO 21330) was included.

The study was conducted using four reference cigars and one CORESTA Monitor (CM) test piece cigarette smoked under the cigar smoking regime (CRM No. 64). Although using a cigar smoking regime, the CM was included in the study due to the short history of testing with the new cigar references and the previous inclusion of CM cigarettes in the collaborative study for TNCO undertaken by Cigar Smoking Methods (CSM) Sub-Group as a surrogate monitor in the absence of cigar reference products.

There were eight participating labs for TSNAs and four participating labs for B[a]P. Due to the low participant count, results are treated as indicative rather than conclusive. It is anticipated that in the near-term participation will remain relatively low. It may be necessary to combine results from multiple CS to increase the robustness of r & R estimations.

A review of smoking related parameters revealed that smoking was generally consistent among the labs within the study and compared to smoking the same test articles as in the 14th Collaborative Study on Cigar Smoke Analysis on cigar TNCO (project CSM-292). The Total Particulate Matter (TPM) ranged from ~15 mg/test article to ~90 mg/test article for the study samples.

Statistical analysis was carried out following the ISO standard 5725 to generate repeatability (r) and reproducibility (R) for TSNAs. Typically, r and R values were estimated at approximately 30 % and 70 % of the mean, respectively for NNN and NNK for samples with a range of yield range of ~20 ng – 3000 ng/cigar across the test set. r&R value estimates were 20 % and 60 % for B[a]P for a sample set yielding 10 ng – 100 ng/cigar.

Based on the results of this study, CRM No. 75 will be updated to include initial r&R values for TSNA analytes. B[a]P participation was too low to warrant the addition of even preliminary r&R values to the CRM. The feasibility experiment with volatile organics (VO) indicates that this work has merit and should be considered for inclusion in SA SG plans as priority and timing allows.

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[1] In 2020, the SMA SG merged with the Routine Analytical Chemistry (RAC) Sub-Group to form the Smoke Analysis (SA) SG

2.   Introduction

In 2019, the SG was charged with development of CRMs for cigar smoke analytes of interest. The initial approach chosen was to attempt a scope expansion of existing cigarette CRMs as a practical means of increasing laboratories' capability. The SG began this effort with TSNAs (CRM No. 75) and Benzo[a]pyrene (B[a]P) (CRM No. 58) based on the extensive experience among laboratories for these analytes. Additionally, one laboratory volunteered to include a feasibility experiment for a combined TSNA or B[a]P and VO method in anticipation of launch of a formal project proposal if results were promising.

The timing of the study launch was planned concurrent to the release the University of Kentucky's new set of cigar reference products 1C1, 1C2, 1C3, and 1C4. CM8 was included in the study due to the lack of historical data with the new cigar references and the previous inclusion of CM test pieces as surrogates in CSM collaborative studies on TNCO.

Participating laboratories (8) were instructed to smoke the test articles using the cigar smoking regime and to extract and test samples for tobacco specific nitrosamines, N-Nitrosonornicotine (NNN) and 4-(N-nitrosomethylamino)-1-(3-pyridyl)-1-butanone (NNK) by LC-MS/MS using CRM No. 75. Separately, participants smoked and tested samples for B[a]P by GC-MS using CRM No. 58. One laboratory volunteered to include an impinger in-line with the collection for either TSNAs or B[a]P followed by workup and analysis for volatile organics (CRM No. 70/ISO 21330).

Statistical evaluations were made in general conformance to ISO 5725-2 recommendations. Included in this report are descriptive statistics, raw data, and repeatability and reproducibility estimates.

Additionally, an evaluation of smoking parameters and measures and an assessment of the VO feasibility are included in this report.

3.   Organisation

3.1 Participants

The laboratories that participated in the CS are listed in alphabetical order in Table 1. To ensure anonymity of the results, each laboratory was given a unique code that was used for reporting of the data and was shared with each laboratory separately.

Table 1. Participating laboratories

Testing Participants
Altria Client Services
British American Tobacco (Germany) GmbH
China National Tobacco Quality Supervision & Test Center
Enthalpy Analytical
Global Laboratory Services
Manifatture Sigaro Toscano
Reemtsma / Imperial Brands Hamburg
University of Kentucky, CTRP

3.2 Study Test Articles

The study test articles are noted in Table 2 below along with key design features. The University of Kentucky cigar reference products were used for the study as they represent a range of design features typical of the product category. CORESTA Monitor cigarette CM8 was included as a study reference. CM8 was chosen to coordinate with a concurrent CSM SG TNCO collaborative study[2].

Table 2. Study Test Articles

Sample ID	Description	Diameter, mm	Nominal avg Mass, g	Comment
1C1	Large machine-made cigar	15.9	6.4	
1C2	Machine-made filtered cigar	<12.1	1.4	
1C3	Cigarillo	<12.1	2.7	Machine-made
1C4	Large machine-made cigar with natural wrapper	12.8	3.2	
CM8	Monitor Cigarette	<12.1	0.96[3]	As a study reference

3.3 Protocol

The Study Protocol is described briefly below and in full in Appendix A. Participating laboratories were asked to obtain their own supply of Kentucky Reference cigars and CORESTA Monitor test pieces.

Participating laboratories were asked to smoke using the Cigar Smoking CRMs for smoking related requirements and the cigarette CRMs for analysis of TSNAs and B[a]P. Additionally, one laboratory agreed to include addition of an impinger and testing for volatile organics (VO) according to CRM No. 70/ISO 21330 as a feasibility study for a combined method of VO with either TSNAs or B[a]P.

Five replicates of each test article and each smoking regime were requested to be generated.

Reportable measures included conditioning time, diameter, puff volume, puff count, TPM, B[a]P, NNN, NNK and, optionally, NAB and NAT using the template provided. Reportable measures for the feasibility experiment were puff count, TPM, isoprene, 1,3-butadiene, benzene, toluene, and acrylonitrile.

4. Data – Statistical Analysis

Data analysis was performed following the statistical model provided by ISO 5725-2 (1994) ("basic method for the determination of repeatability and reproducibility of a standard measurement method").

Summary data are tabulated in Appendix B and Appendix C. Raw data are presented in Appendix D and Appendix E.

4.1 Outlier Detection

Due to the small number of labs and without historical results for the samples, outlier detection was not employed for the study.

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[2] CSM-292-CTR 14th Collaborative Study – March 2021
[3] Average of values from Table 5 of RAC-187-CTR CM8 CM9 Coll. Study 2018 – February 2019

4.2 Repeatability and Reproducibility

The mean, repeatability, and reproducibility estimates are displayed below in Table 3 to Table 6. As can be seen for column three from the tables, the number of reporting labs is relatively low for the study. While minimum size recommendations differ, in general it is difficult to obtain robust quantitative assessment of method variation with fewer than about six or eight participants.

Table 3. r&R summary – Puff Count (/cigar)

Sample	Method	N Labs	Mean	r	%r	R	%R
1C1	B[a]P	3	78	7.4	9.50 %	58.5	75.00 %
1C1	TSNA	6	87.6	18.2	20.80 %	74.6	85.10 %
1C2	B[a]P	6	21.4	1.9	9.10 %	4.2	19.90 %
1C2	TSNA	8	20.5	2.2	11.00 %	7.4	36.30 %
1C3	B[a]P	5	37.3	8.8	23.70 %	10.1	27.00 %
1C3	TSNA	7	35.4	5.4	15.10 %	9.8	27.60 %
1C4	B[a]P	4	44.9	12.3	27.50 %	14.8	32.80 %
1C4	TSNA	6	41	7.1	17.40 %	12.2	29.70 %
CM8	B[a]P	6	12.3	0.7	5.80 %	1.8	14.40 %
CM8	TSNA	7	12.1	1	8.40 %	2.3	19.00 %

where r = repeatability, R = reproducibility

Table 4. r&R summary – TPM (mg/cigar)

Sample	Method	N Labs	Mean	r	%r	R	%R
1C1	B[a]P	4	73.8	24.5	33.10 %	64.7	87.70 %
1C1	TSNA	6	86.5	25.7	29.80 %	104.9	121.30 %
1C2	B[a]P	6	21.8	3.3	15.30 %	8.7	40.00 %
1C2	TSNA	8	20.3	2.8	13.90 %	10.9	53.80 %
1C3	B[a]P	4	64.1	11.8	18.40 %	13.6	21.10 %
1C3	TSNA	7	72.9	9.7	13.30 %	57.8	79.30 %
1C4	B[a]P	4	64.7	9.2	14.20 %	20.8	32.10 %
1C4	TSNA	6	65.4	24.9	38.10 %	41.1	62.80 %
CM8	B[a]P	6	14.8	1.4	9.40 %	5.3	36.10 %
CM8	TSNA	8	15.0	1.8	12.00 %	5.1	34.20 %

where r = repeatability, R = reproducibility

Table 5. r&R summary – Smoke TSNA (ng/cigar)

Sample	Analyte	N Labs	Mean	r	%r	R	%R
1C1	NNN	4	580	150	25.90 %	361	62.30 %
1C2	NNN	7	241	53	22.00 %	201	83.40 %
1C3	NNN	7	992	288	29.00 %	772	77.80 %
1C4	NNN	6	3060	1503	49.10 %	1503	49.10 %
CM8	NNN	8	21.7	10.2	46.90 %	16.8	77.20 %
1C1	NNK	4	303	116	38.50 %	276	91.20 %
1C2	NNK	7	206	41	20.00 %	171	83.10 %
1C3	NNK	7	432	145	33.60 %	249	57.70 %
1C4	NNK	6	2592	1527	58.90 %	1914	73.80 %
CM8	NNK	7	32	12.6	39.20 %	12.6	39.20 %
1C1	NAT	4	417	90	21.60 %	275	66.00 %
1C2	NAT	7	148	31	21.10 %	159	107.00 %
1C3	NAT	6	359	84	23.30 %	157	43.80 %
1C4	NAT	6	1387	509	36.70 %	1002	72.30 %
CM8	NAT	8	45.2	13.9	30.70 %	36.2	80.20 %
1C1	NAB	4	69.9	16.4	23.50 %	41.2	58.90 %
1C2	NAB	7	28.7	6.4	22.30 %	25.7	89.60 %
1C3	NAB	6	88	24.4	27.70 %	93.3	106.00 %
1C4	NAB	6	294	111	37.80 %	235	80.10 %
CM8	NAB	8	5.1	2	39.40 %	4.8	94.50 %

where r = repeatability, R = reproducibility

Table 6. r&R summary – B[a]P (ng/cigar)

Sample	Analyte	N Labs	Mean	r	%r	R	%R
1C1	B[a]P	4	101	37	36.70 %	103	102.10 %
1C2	B[a]P	6	25.7	3.4	13.30 %	8.4	32.80 %
1C3	B[a]P	5	77.8	17.4	22.30 %	36.2	46.50 %
1C4	B[a]P	4	64.2	12.3	19.10 %	40.5	63.10 %
CM8	B[a]P	6	13.5	2.2	16.60 %	7	51.70 %

where r = repeatability, R = reproducibility

5. Data Interpretation

In order to evaluate the analytical methods' performance for the analytes of interest, it was important to assess the consistency and quality of the smoking sessions. Therefore, the data discussion below includes smoking input parameters and smoking-specific data along with the analytical results.

5.1 Smoking-related variables

Cigar conditioning and smoking are similar but not the same as conventional cigarette parameters. In accordance with CRM No. 46, cigars are conditioned until the variation in weight is not more than 0.1 % in 24 hours which typically takes a minimum of 72 hours and, for very large products, up to several weeks.

Information for 1C1 and 1C4 were of particular interest due to their relative size. As noted in Table 7 and Table 8 below, laboratories' data for diameter varied for 1C1 and 1C4. Thus, the puff volume settings also varied among the labs. In particular, the puff volume ranged from 25 mL to 32.0 mL for 1C2.

Table 7. Differences in Input Variables – 1C1

Lab #	Cond. Wt (mg/cigar)	Diameter At 33mm (mm)	Puff Volume (mL)
1	5870.4	13.4	25.0
2	7022.4	15.4	32.0
3	6694.3	14.7	30.9
4	NR	NR	NR
5	NR	NR	NR
6	6138.9	15.0	31.0
7	5896.8	14.6	30.9
8	6363.1	15.1	32.0

Table 8. Differences in Input Variables – 1C4

Lab #	Cond. Wt (mg/cigar)	Diameter At 33 (mm)	Puff Volume (mL)
1		12.4	21.4
2		12.3	20.0
3		12.1	21.4
4		NR	NR
5		NR	NR
6		12.1	21.0
7		12.6	21.4
8		12.8	21.0

Where puff volume is calculated as $V = 0.139 * d^2$, d = diameter at 33 mm after cutting for cigars with a diameter >12.0 mm or V=20.0 mL for diameter $\leq$ 12.0 mm

5.2 TPM for the Study

In order to evaluate the analytical methods' performance for the analytes of interest, it was important to assess the consistency and quality of the smoking sessions. For example, if a lab's B[a]P results are higher or more variable, but so is the TPM, the B[a]P difference may likely be a result of smoking not the analytical method.

While r&R values are relatively high for laboratories more used to smoking cigarettes, generally, the TPM yields show agreement among the labs and for a given lab across the two methods. Exceptions are notable in the figure below. For example, Lab 1 results appear lower or higher than the other labs but consistent between the two methods. Lab 7 TSNA TPM results appear relatively high compared to other values for 1C1.
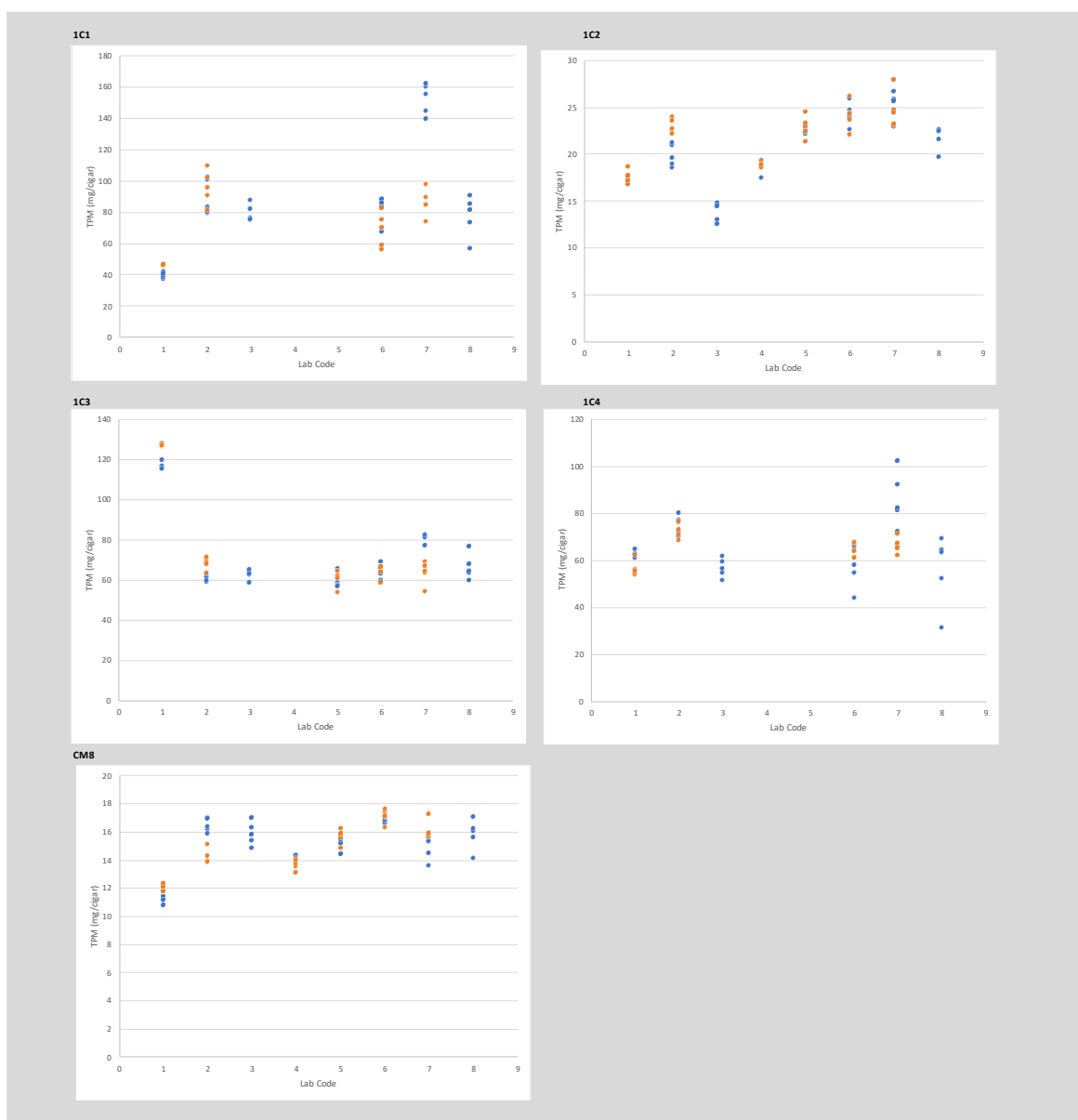

Figure 1. TPM (mg/cigar) comparison among labs and across methods

Where blue (dark) circle = TPM from TSNA smoking and orange (light) circle = TPM from B[a]P smoking

5.3 TPM Compared to concurrent TNCO study

To aid our ability to assess the results, this study was planned in collaboration with the CSM SG's annual TNCO CS to use the same test articles and similar testing timelines to allow for comparison of TPM results. A summary of means, r %, and R % for the TSNA and B[a]P TPM results for this study and for the TNCO TPM results for CSM's 14th CS (project 292) are shown below. With so few labs reporting, it would be difficult to be conclusive but the results do appear generally consistent. Samples 1C1 and 1C3 results appear to have higher %R values than seen for TNCO. In a larger study, outlier detection would likely bring the anomalous values more in line.

Table 9. TPM results for this project compared to CSM Project 292 TNCO results

Sample	Method	N Labs	Mean	%r	%R
1C1	B[a]P	4	73.8	33	88
	TSNA	6	86.5	30	121
	TNCO	9	77.9	34	59
1C2	B[a]P	6	21.8	15	40
1C2	TSNA	8	20.3	14	54
	TNCO	10	22.0	24	40
1C3	B[a]P	4	64.1	18	21
1C3	TSNA	7	72.9	13	79
	TNCO	9	59.4	15	30
1C4	B[a]P	4	64.7	14	32
1C4	TSNA	6	65.4	38	63
	TNCO	9	58.0	33	45
CM8	B[a]P	6	14.8	9.4	36
CM8	TSNA	8	15.0	12	34
	TNCO	10	15.8	15	25

where r = repeatability, R = reproducibility

5.4 TSNAs

All labs participated in the TSNA phase of the study. The samples cover a very wide range of yield with a low of 10 ng (CM8) and a high of 4000 ng (1C4) for both NNN and NNK. The samples generally appear distinguishable from each other. The r&R values are relatively high but this is likely reasonable for a highly variable product category, a relatively small number of participating labs, and an analyte class reporting at such low levels (ng range). Multiple small CS or a larger CS would allow for outlier testing for refinement of the data and an improved robustness of the method r&R over time. The results indicate that it is likely reasonable to expand the scope of CRM No. 75 to include cigar testing.

5.5 B[a]P

Unfortunately, the number of participants (4-6) was lower for the B[a]P segment of the study. As with TSNAs, the sample set allowed for testing across a wide range of analyte yields. Samples appear distinguishable with a low of 13.5ng for CM8 and a high of 101ng for 1C1. The r % and R % values were relatively low excluding 1C1 which indicate that it is likely acceptable to expand the scope of CRM No. 58 with addition testing.

5.6 Volatile Organics Feasibility

One laboratory tested TSNAs with impingers connected for cold-trapping for VO determination. Data evaluation to indicate feasibility included 1) Impact on TPM; 2) Impact on the TSNAs; 3) General reasonableness of VO results.

As shown in Table 10, TPM results with and without the VO impinger are similar for most of the samples. Figure 2 is a display of NNN results for each of the labs. Most of the results are similar for the VO-feasibility set and the other sample sets. As there was no coordinated effort to evaluate VO results in support of this study, reasonableness for VO values was determined by seeking to compare to a cigarette data set with similar TPM to one or more samples in this study. Table 11 shows the VO results from this study. A 1R6F sample (TPM ~10 mg/cigarette) is included in the table and has lower but roughly similar VO results compared to the CM8 sample (TPM ~15 mg/cig) in the VO-feasibility set in this study.

Based on these results, it appears feasible that VO (impinger-only) could be tested concurrent to one of these methods. A larger, controlled, study will be considered for future SG project plans.

Table 10. TPM Average and %RSD comparison

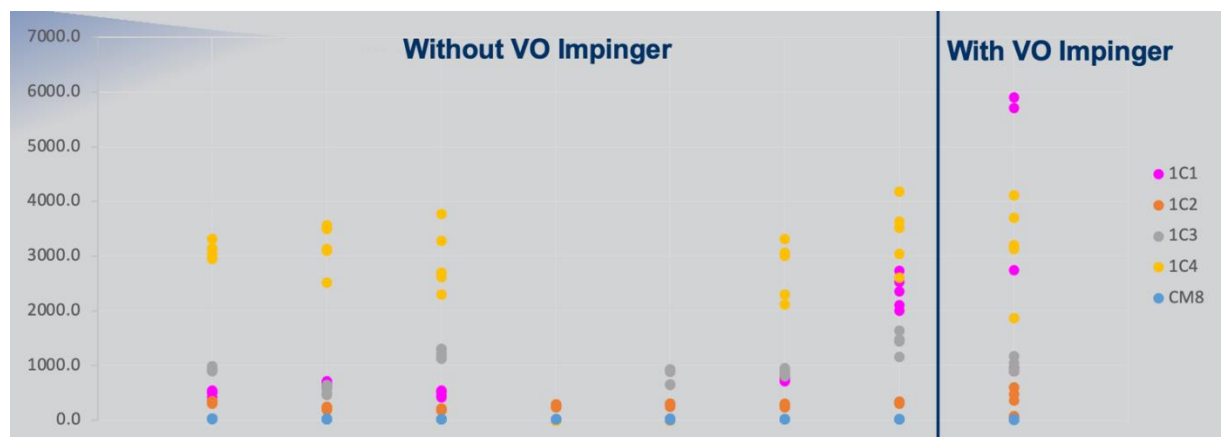|		Without VO	With VO
1C1	Avg	86	152
	%RSD	10	7
1C2	Avg	25	25
	%RSD	8	6
1C3	Avg	63	81
	%RSD	9	3
1C4	Avg	66	86
	%RSD	5	13
CM8	Avg	16	15
	%RSD	4	6

Figure 2. NNN Results (ng/cigar) - TSNA-Only Smoking vs TSNA+VO Smoking

Table 11. Feasibility VO Results (Compared to 1R6F results from a separate study)

		MS TPM (mg/cig)	Isoprene (ug/cig)	1,3-Butadiene (ug/cig)	Benzene (ug/cig)	Toluene (ug/cig)	Acrylonitrile (ug/cig)
	1C1	152	3962	619	692	1301	180
	1C2	25	781	92	108	173	19
	1C3	81	1977	333	351	600	84
	1C4	86	2797	389	396	710	93
	CM8	15	475	38	39	51	6
Cigar Regime, TNCO;9 labs x 5 reps CSM-121	CM8	15					
Cigarette ISO Normal, VO; 1 lab x 5 reps; CVAR-083-CTR	1R6F	10	276	27	33	50	6

6. Conclusions

Through this CS, CORESTA was able to assess the validity of expanding the scopes of cigarette CRMs to include testing for cigar samples for smoke TSNAs and B[a]P. The sample set allowed for a wide range of analytes of interest (100-fold for TNSAs and 10-fold for B[a]P. While the number of participating labs was relatively low (4-8), estimated r&R values were calculated. TPM results were comparable to results determined by a concurrent CSM TNCO study. Feasibility of combining analysis of volatile organics through the addition of a cold-trap impinger to the smoking set-up was determined as viable. It is anticipated that the number of laboratories to regularly be available for cigar smoking CS will remain small for the foreseeable future. Therefore, it is recommended that CRM No. 75 be updated with initial r&R values and guidance for inclusion of cigar testing and that any update of CRM No. 58 be held pending additional CS to increase the total participant count to nearer 6-8. A larger controlled study to further evaluate combined testing for volatile organics will be considered by the SG for general project prioritization.

Appendix A: Study Protocol

CORESTA Smoke Analytes Sub-Group

Project Title:	Project 198 - Cigar Collaborative Study: Smoke B[a]P and TSNAs
Type of Document:	Protocol
Date:	October 15, 2019
Written by:	Rana Tayyarah (ITG Brands, LLC)

1. Objective

The objective of this study is to determine if existing cigarette CRMs for Benzo[a]pyrene (B[a]P, CRM No. 58) and TSNA (CRM No. 75) are fit for purpose for the analysis of machine-made cigars (MMC) conditioned and smoked according to CRMs No. 46, 64, and 65. Initial repeatability and reproducibility (r&R) values for MMCs will be determined for the analytes.

2. Time Schedule

Date	Activity
Oct 15, 2019	Laboratories confirm participation and order test products
February 27, 2020	Laboratories to submit results prior to this date
April 2020	SG review of draft TR
May 30, 2020	Final report submitted to Scientific Commission

3. Methods

3.1 Test Products

Sample ID	Description	Minimum Quantity/box
1C1	University of Kentucky Reference 1C1 Large machine-made cigar, diameter 15.9 mm	50/box
1C2	University of Kentucky Reference 1C2 Cigar machine-made little cigar, diameter ≤ 12.0 mm	200/carton
1C3	University of Kentucky Reference 1C3 Small machine made cigarillo, diameter ≤ 12.0 mm	60/box
1C4	University of Kentucky Reference 1C4 Large machine-made cigar with natural wrapper, diameter 12.8 mm	48/box
CM8	CM8 cigarette (study reference)	200/carton

Cigar Test products will be ordered from the University of Kentucky (UofK) by each participating laboratory. A minimum of 40[4] units per product will be shipped to each volunteer laboratory. All units for a given product shall be from the same manufacturing lot as is feasible; request "Same batch for SMA Project 198".

Each laboratory shall verify the lot and condition of the products and notify the product supplier and study coordinators of any issues.

Any retains shall be held in original packaging under laboratory conditions until completion of the study. Each laboratory shall dispose of retained samples in accordance with their own internal practices for cigar disposal.

3.2 Study Control/Reference

A CM8 cigarette, smoked under CRM N°64/65 parameters is included as a study reference, as is typical for the Cigar Sub-Group TNCO collaborative studies. Additionally, laboratories should include their own typical lab reference/control and process according to internal practices (reporting of results will not be required).

3.3 Testing Atmosphere

Samples will be conditioned to meet equilibrium requirements according to CRM No. 46 prior to analysis. The temperature and RH shall be maintained in accordance with CRM No. 65 during smoking. Equilibrium time along with testing temperature and RH values shall be reported in the data reporting template.

3.4 Sample Handling

All samples shall be stored under the laboratory conditions that will be used for testing and remain in their original packaging prior to preparation for testing.

Glass fiber filter pads to be used for smoke collection shall be stored under conditions equivalent to the testing atmosphere for a minimum of 24 hours before use.

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[4] This number may be rounded up as necessary for ordering and shipping convenience.

3.5   Replicates and Run Order

For purposes of this study, a replicate consists of the measurement of a specified number of cigars on one smoke trap.

The analysis of five (5) replicates per sample shall be reported. No run order is specified. There are no timing requirements for spacing of smoking runs. Run # and collection and testing dates shall be reported in the data template.

Sample	TPM estimate (mg/cigar)	Cigars/pad
1C1	124	1
1C2	20	3
1C3	62	1
1C4	67	1
CM8	15[5]	3

3.6   Relighting

If relighting is required for a given sample, it is preferable that an electric lighting source is used. In any case, the type of heat source, number of relights, and number of puff counts shall be recorded. If the product fails to relight and based on analyst judgement will not properly re-ignite, a repeat analysis should be performed.

3.7   Smoking Requirements

Smoking parameters shall be in accordance with CRM N°64. Use an optical measurement device for the determination of diameter to calculate puff volume. Or, use the puff volumes noted in the table below as determined by one of the participating laboratories:

Sample	Nominal Diameter	Puff Volume (mL)[6]
1C1	14.9 mm	30.9
1C2	≤12.0 mm	20
1C3	≤12.0 mm	20
1C4	12.4 mm	21.4
CM8	≤12.0 mm	20

3.8   Extraction and Analysis

Each laboratory shall follow the current versions of CRM No. 58 and CRM No. 75 for extraction and analysis. Method details and deviations shall be reported using the template provided. Additionally, cigar holder type and information, such as sealing material, sleeve size, etc. shall be reported.

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[5] Estimated TPM using CRM N°64 Cigar smoking regime
[6] Rounded as needed based on the capability of your equipment

3.9 Analytes and Measures

Report data in the provided Data Reporting Sheet.

Diameter, pressure drop, and conditioned weight shall be recorded. Any deviations from CRMs No. 46, No. 64, No. 65, No. 58, and No. 75 shall be reported.

Report the equilibration time.

Physical properties: report results for cigar diameter (mm/cigar), cigar pressure drop (mm H2O/cigar), cigar conditioned weight (mg/cigar).

Smoke Yields: report puff volume and type of smoke trap used. Report results for puff count (puff/cigar), total particulate matter (TPM) (mg/cigar), Benzo[a]pyrene (ng/cigar), NNN (ng/cigar), NNK (ng/cigar) and, optionally, N-Nitrosoanabasine (NAB) (ng/cigar) and N-Nitrosoanatabine (NAT) (ng/cigar) .

4. Data Submission

The attached template shall be used for data submission. Please supply data in the requested format without altering the spreadsheet.

Results shall be reported back to Rana Tayyarah and Jana Jeffrey or before February 27, 2020.

5. Data Analysis

A statistical analysis in general conformance with ISO 5725-2:1994 and ISO/TR 22971:2005 or with ISO 5725-5:1998 will be conducted.

6. Reference Documents

Smoke collection parameters and analytical procedures	CORESTA Recommended Method No.: 46, 64, 65, 58, and 75
Data reporting Template	Excel spreadsheet provided

Appendix B: Summarized Data – TSNAs

1C1

Lab Code	1C1	Puff Count	MS TPM	NNN	NNK	NAB	NAT
		(per cig)	(mg/cig)	(ng/cig)	(ng/cig)	(ng/cig)	(ng/cig)
1	avg	96.1	39.38	506.35	226.88	63.26	355.22
	stdev	0.60	1.71	47.42	29.06	2.76	28.17
	%RSD	0.6	4.3	9.4	12.8	4.4	7.9
2	avg	88.8	89.04	563.34	290.28	69.11	410.29
	stdev	3.03	11.43	72.78	62.73	7.97	32.32
	%RSD	3.4	12.8	12.9	21.6	11.5	7.9
3	avg	129.8	79.04	496.35	259.20	57.88	350.52
	stdev	12.26	5.33	52.95	26.10	6.30	39.67
	%RSD	9.4	6.7	10.7	10.1	10.9	11.3
4	avg	NR	NR	NR	NR	NR	NR
	stdev	NR	NR	NR	NR	NR	NR
	%RSD	NR	NR	NR	NR	NR	NR
5	avg	NR	NR	NR	NR	NR	NR
	stdev	NR	NR	NR	NR	NR	NR
	%RSD	NR	NR	NR	NR	NR	NR
6	avg	84.6	82.34	754.40	433.84	89.28	552.00
	stdev	6.11	8.50	33.54	38.24	4.54	26.98
	%RSD	7.2	10.3	4.4	8.8	5.1	4.9
7	avg	50.6	152.00	2352.52	1701.77	290.90	2006.85
	stdev	3.36	10.07	297.48	80.05	47.95	355.67
	%RSD	6.6	6.6	12.6	4.7	16.5	17.7
8	avg	75.6	77.00	1371.73	617.79	135.62	968.65
	stdev	6.69	13.08	513.06	278.62	56.73	373.40
	%RSD	8.9	17.0	37.4	45.1	41.8	38.5

Where NR = not reported

1C2

Lab Code	1C2	Puff Count	MS TPM	NNN	NNK	NAB	NAT
		(per cig)	(mg/cig)	(ng/cig)	(ng/cig)	(ng/cig)	(ng/cig)
1	avg	21.4	17.01	111.55	114.25	15.15	79.94
	stdev	0.51	0.19	5.72	2.63	0.51	6.35
	%RSD	2.4	1.1	5.1	2.3	3.4	7.9
2	avg	20.2	19.81	227.28	168.90	22.58	121.94
	stdev	1.23	1.20	21.47	14.67	2.33	9.68
	%RSD	6.1	6.1	9.4	8.7	10.3	7.9
3	avg	15.3	13.84	201.94	171.77	23.69	113.26
	stdev	0.58	1.01	13.77	11.33	1.50	8.37
	%RSD	3.8	7.3	6.8	6.6	6.3	7.4
4	avg	20.3	18.55	264.07	207.46	33.51	133.83
	stdev	0.29	0.69	20.18	6.19	1.72	6.48
	%RSD	1.4	3.7	7.6	3.0	5.1	4.8
5	avg	22.2	22.49	283.67	262.67	32.00	164.00
	stdev	0.92	0.40	23.32	20.47	3.98	21.78
	%RSD	4.1	1.8	8.2	7.8	12.4	13.3
6	avg	23.9	24.20	271.20	230.66	31.38	172.80
	stdev	1.17	1.65	24.80	19.57	2.40	9.86
	%RSD	4.9	6.8	9.1	8.5	7.6	5.7
7	avg	18.9	25.11	327.19	287.42	42.62	253.39
	stdev	0.67	1.45	16.32	18.13	2.03	7.43
	%RSD	3.6	5.8	5.0	6.3	4.8	2.9
8	avg	21.5	21.66	933.82	573.19	84.34	471.50
	stdev	0.54	1.22	676.32	430.08	61.83	347.35
	%RSD	2.5	5.6	72.4	75.0	73.3	73.7

1C3

Lab Code	1C3	Puff Count	MS TPM	NNN	NNK	NAB	NAT
		(per cig)	(mg/cig)	(ng/cig)	(ng/cig)	(ng/cig)	(ng/cig)
1	avg	36.0	116.38	947.64	475.27	94.75	352.89
	stdev	1.12	1.84	32.83	20.11	1.43	7.53
	%RSD	3.1	1.6	3.5	4.2	1.5	2.1
2	avg	30.4	60.80	666.05	305.79	55.86	276.45
	stdev	1.34	1.63	41.83	30.54	2.87	6.74
	%RSD	4.4	2.7	6.3	10.0	5.1	2.4
3	avg	36.8	62.42	1227.29	432.98	97.48	421.21
	stdev	1.44	2.50	81.97	39.53	4.27	23.25
	%RSD	3.9	4.0	6.7	9.1	4.4	5.5
4	avg	NR	NR	NR	NR	NR	NR
	stdev	NR	NR	NR	NR	NR	NR
	%RSD	NR	NR	NR	NR	NR	NR
5	avg	37.6	59.72	816.00	469.00	70.00	342.00
	stdev	3.42	3.65	145.71	76.11	23.45	45.08
	%RSD	9.1	6.1	17.9	16.2	33.5	13.2
6	avg	38.9	64.20	892.80	421.28	73.92	392.40
	stdev	2.55	3.31	54.87	39.32	7.72	25.98
	%RSD	6.6	5.1	6.1	9.3	10.4	6.6
7	avg	32.1	80.64	1438.46	541.85	144.51	728.55
	stdev	0.81	2.05	169.93	90.46	18.27	71.33
	%RSD	2.5	2.5	11.8	16.7	12.6	9.8
8	avg	36.2	66.26	956.04	374.58	61.72	369.94
	stdev	1.30	6.54	106.98	18.05	5.80	44.58
	%RSD	3.6	9.9	11.2	4.8	9.4	12.1

where NR = not reported

1C4

Lab Code	1C4	Puff Count	MS TPM	NNN	NNK	NAB	NAT
		(per cig)	(mg/cig)	(ng/cig)	(ng/cig)	(ng/cig)	(ng/cig)
1	avg	42.9	62.39	3116.21	2711.54	368.94	1292.26
	stdev	1.11	1.37	142.43	258.94	21.89	103.59
	%RSD	2.6	2.2	4.6	9.5	5.9	8.0
2	avg	38.4	74.96	3167.13	2285.05	263.14	1340.50
	stdev	3.21	4.08	417.51	647.42	32.19	109.19
	%RSD	8.4	5.4	13.2	28.3	12.2	8.1
3	avg	42.4	56.46	2940.00	2494.00	267.20	1086.80
	stdev	3.47	4.02	588.43	574.70	52.24	140.99
	%RSD	8.2	7.1	20.0	23.0	19.6	13.0
4	avg	NR	NR	NR	NR	NR	NR
	stdev	NR	NR	NR	NR	NR	NR
	%RSD	NR	NR	NR	NR	NR	NR
5	avg	NR	NR	NR	NR	NR	NR
	stdev	NR	NR	NR	NR	NR	NR
	%RSD	NR	NR	NR	NR	NR	NR
6	avg	45.7	56.98	2764.80	2383.20	270.72	1414.40
	stdev	2.86	8.71	521.77	623.69	35.80	182.44
	%RSD	6.3	15.3	18.9	26.2	13.2	12.9
7	avg	35.2	85.80	3404.12	3495.58	398.71	1993.90
	stdev	1.56	11.50	599.95	523.42	54.34	265.47
	%RSD	4.4	13.4	17.6	15.0	13.6	13.3
8	avg	41.2	55.78	2965.58	2182.25	192.78	1192.39
	stdev	2.13	15.23	782.56	553.01	30.55	227.90
	%RSD	5.2	27.3	26.4	25.3	15.8	19.1

where NR = not reported

CM8

Lab Code	CM8	Puff Count	MS TPM	NNN	NNK	NAB	NAT
		(per cig)	(mg/cig)	(ng/cig)	(ng/cig)	(ng/cig)	(ng/cig)
1	avg	13.0	11.27	10.64	11.09	1.73	21.26
	stdev	0.81	0.43	0.46	0.56	0.19	1.12
	%RSD	6.2	3.8	4.3	5.0	11.1	5.3
2	avg	12.2	16.45	25.62	30.79	5.08	43.25
	stdev	0.30	0.50	7.48	7.47	1.13	9.68
	%RSD	2.4	3.0	29.2	24.3	22.2	22.4
3	avg	12.5	15.84	20.44	32.57	4.82	43.01
	stdev	0.32	0.83	1.44	3.47	0.31	2.73
	%RSD	2.6	5.3	7.0	10.6	6.4	6.3
4	avg	11.8	14.06	23.33	29.71	6.05	43.51
	stdev	0.16	0.22	1.27	0.95	0.27	1.59
	%RSD	1.3	1.6	5.4	3.2	4.5	3.7
5	avg	12.1	15.18	21.33	35.00	4.67	44.33
	stdev	0.26	0.48	6.28	8.08	1.39	5.73
	%RSD	2.1	3.2	29.4	23.1	29.9	12.9
6	avg	13.1	16.73	22.96	33.20	6.44	54.84
	stdev	0.70	0.13	1.35	1.35	0.59	3.02
	%RSD	5.3	0.8	5.9	4.1	9.2	5.5
7	avg	10.7	14.83	21.92	32.74	7.00	63.95
	stdev	0.34	0.85	0.86	2.18	0.55	4.82
	%RSD	3.2	5.7	3.9	6.7	7.9	7.5
8	avg	12.4	15.79	27.44	30.29	5.08	47.29
	stdev	0.22	1.08	1.97	2.08	0.21	5.13
	%RSD	1.7	6.8	7.2	6.9	4.1	10.9

Appendix C: Summarized Data – B[a]P

1C1

Lab Code	1C1	Puff Count (per cig)	MS TPM (mg/cig)	B[a]P (ng/cig)
1	avg	96.42	45.98	52.56
	stdev	1.66	0.52	1.97
	%RSD	1.7	1.1	3.7
2	avg	82.00	95.56	133.20
	stdev	3.54	10.63	19.30
	%RSD	4.3	11.1	14.5
3	avg	NR	NR	NR
	stdev	NR	NR	NR
	%RSD	NR	NR	NR
4	avg	NR	NR	NR
	stdev	NR	NR	NR
	%RSD	NR	NR	NR
5	avg	NR	NR	NR
	stdev	NR	NR	NR
	%RSD	NR	NR	NR
6	avg	101.80	68.12	116.89
	stdev	13.81	10.96	17.60
	%RSD	13.6	16.1	15.1
7	avg	55.52	85.62	100.51
	stdev	2.44	8.49	3.17
	%RSD	4.4	9.9	3.2
8	avg	NR	NR	NR
	stdev	NR	NR	NR
	%RSD	NR	NR	NR

where NR = not reported

1C2

Lab Code	1C2	Puff Count (per cig)	MS TPM (mg/cig)	B[a]P (ng/cig)
1	avg	21.62	17.47	27.64
	stdev	0.28	0.69	0.55
	%RSD	1.3	3.9	2.0
2	avg	20.64	22.96	27.24
	stdev	0.42	0.73	0.55
	%RSD	2.0	3.2	2.0
3	avg	NR	NR	NR
	stdev	NR	NR	NR
	%RSD	NR	NR	NR
4	avg	20.07	18.86	23.65
	stdev	0.34	0.25	0.65
	%RSD	1.7	1.3	2.7
5	avg	21.70	22.87	20.84
	stdev	1.00	1.14	0.67
	%RSD	4.6	5.0	3.2
6	avg	23.87	24.06	27.07
	stdev	0.98	1.48	1.95
	%RSD	4.1	6.1	7.2
7	avg	20.39	24.59	27.53
	stdev	0.76	1.99	1.91
	%RSD	3.7	8.1	6.9
8	avg	NR	NR	NR
	stdev	NR	NR	NR
	%RSD	NR	NR	NR

where NR = not reported

1C3

Lab Code	1C3	Puff Count (per cig)	MS TPM (mg/cig)	B[a]P (ng/cig)
1	avg	35.94	127.02	76.39
	stdev	1.34	0.63	2.32
	%RSD	3.7	0.5	3.0
2	avg	35.00	68.20	83.54
	stdev	0.71	2.92	9.25
	%RSD	2.0	4.3	11.1
3	avg	NR	NR	NR
	stdev	NR	NR	NR
	%RSD	NR	NR	NR
4	avg	NR	NR	NR
	stdev	NR	NR	NR
	%RSD	NR	NR	NR
5	avg	39.58	60.84	58.11
	stdev	5.57	4.42	3.76
	%RSD	14.1	7.3	6.5
6	avg	39.84	64.06	83.98
	stdev	3.78	3.39	5.85
	%RSD	9.5	5.3	7.0
7	avg	36.20	63.48	87.02
	stdev	1.48	5.59	7.30
	%RSD	4.1	8.8	8.4
8	avg	NR	NR	NR
	stdev	NR	NR	NR
	%RSD	NR	NR	NR

where NR = not reported

1C4

Lab Code	1C4	Puff Count (per cig)	MS TPM (mg/cig)	B[a]P (ng/cig)
1	avg	41.64	56.15	84.93
	stdev	0.47	3.43	1.16
	%RSD	1.1	6.1	1.4
2	avg	45.20	72.64	57.12
	stdev	3.27	3.26	4.83
	%RSD	7.2	4.5	8.4
3	avg	NR	NR	NR
	stdev	NR	NR	NR
	%RSD	NR	NR	NR
4	avg	NR	NR	NR
	stdev	NR	NR	NR
	%RSD	NR	NR	NR
5	avg	NR	NR	NR
	stdev	NR	NR	NR
	%RSD	NR	NR	NR
6	avg	49.68	63.80	59.29
	stdev	7.35	3.12	6.98
	%RSD	14.8	4.9	11.8
7	avg	43.14	66.20	55.38
	stdev	3.58	3.27	1.80
	%RSD	8.3	4.9	3.2
8	avg	NR	NR	NR
	stdev	NR	NR	NR
	%RSD	NR	NR	NR

where NR = not reported

CM8

Lab Code	CM8	Puff Count (per cig)	MS TPM (mg/cig)	B[a]P (ng/cig)
1	avg	12.64	11.99	17.78
	stdev	0.23	0.24	0.53
	%RSD	1.8	2.0	3.0
2	avg	12.08	14.18	12.96
	stdev	0.26	0.53	1.16
	%RSD	2.1	3.7	9.0
3	avg	NR	NR	NR
	stdev	NR	NR	NR
	%RSD	NR	NR	NR
4	avg	11.62	13.66	13.12
	stdev	0.15	0.43	0.53
	%RSD	1.3	3.1	4.0
5	avg	12.24	15.65	10.39
	stdev	0.28	0.51	0.46
	%RSD	2.3	3.3	4.4
6	avg	13.22	17.08	13.83
	stdev	0.34	0.48	0.42
	%RSD	2.6	2.8	3.0
7	avg	11.79	16.08	13.17
	stdev	0.21	0.67	1.25
	%RSD	1.8	4.2	9.5
8	avg	NR	NR	NR
	stdev	NR	NR	NR
	%RSD	NR	NR	NR

where NR = not reported

Appendix D: Raw Data – TSNAs

1C1

Lab Code	Sample	Rep	# Cigars	Puff Ct	MS TPM	NNN	NNK	NAB	NAT
			(cigs/rep)	(per cig)	(mg/cig)	(ng/cig)	(ng/cig)	(ng/cig)	(ng/cig)
1	1C1	1	1	97.0	37.10	427.50	179.50	59.25	307.50
1	1C1	2	1	96.0	41.70	542.50	257.50	65.00	382.50
1	1C1	3	1	95.8	38.69	543.61	236.21	65.19	364.81
1	1C1	4	1	96.1	39.24	503.26	224.26	63.58	359.42
1	1C1	5	1	95.4	40.16	514.87	236.91	62..15	361.87
2	1C1	1	1	92.0	79.30	586.86	248.02	73.03	417.94
2	1C1	2	1	90.0	100.50	472.65	227.45	62.11	372.96
2	1C1	3	1	88.0	80.00	651.01	385.91	81.27	459.53
2	1C1	4	1	90.0	102.40	505.58	315.18	63.99	393.10
2	1C1	5	1	84.0	83.00	600.60	274.83	65.18	407.93
3	1C1	1	1	116.0	81.90	541.83	282.96	62.47	369.33
3	1C1	2	1	136.0	76.00	510.68	271.07	60.10	392.25
3	1C1	3	1	140.0	75.40	426.93	225.58	51.50	302.51
3	1C1	4	1	117.0	87.10	546.30	279.26	64.43	374.41
3	1C1	5	1	140.0	74.80	456.03	237.14	50.89	314.11
4	1C1	1	1	NR	NR	NR	NR	NR	NR
4	1C1	2	1	NR	NR	NR	NR	NR	NR
4	1C1	3	1	NR	NR	NR	NR	NR	NR
4	1C1	4	1	NR	NR	NR	NR	NR	NR
4	1C1	5	1	NR	NR	NR	NR	NR	NR
5	1C1	1	1	NR	NR	NR	NR	NR	NR
5	1C1	2	1	NR	NR	NR	NR	NR	NR
5	1C1	3	1	NR	NR	NR	NR	NR	NR
5	1C1	4	1	NR	NR	NR	NR	NR	NR
5	1C1	5	1	NR	NR	NR	NR	NR	NR
6	1C1	1	1	90.0	88.00	768.00	412.00	95.20	576.00
6	1C1	2	1	77.0	83.40	752.00	397.20	85.60	520.00
6	1C1	3	1	85.0	87.60	724.00	416.00	88.80	584.00
6	1C1	4	1	91.0	67.50	724.00	452.00	92.40	540.00
6	1C1	5	1	80.0	85.20	804.00	492.00	84.40	540.00
7	1C1	1	1	55.0	160.00	2738.17	1832.90	340.19	2297.68
7	1C1	2	1	53.0	155.00	2365.97	1675.87	225.18	1502.29
7	1C1	3	1	47.0	162.00	2116.71	1658.57	331.34	2301.61
7	1C1	4	1	50.0	139.00	2009.98	1626.17	262.67	1770.53
7	1C1	5	1	48.0	144.00	2531.79	1715.36	295.10	2162.14
8	1C1	1	1	85.0	56.40	812.52	327.29	72.02	546.09
8	1C1	2	1	71.0	84.50	1820.78	808.41	183.85	1290.53
8	1C1	3	1	80.0	73.00	1053.31	374.15	103.68	886.57
8	1C1	4	1	73.0	81.00	2001.54	978.53	205.97	1415.07
8	1C1	5	1	69.0	90.10	1170.5	600.58	112.56	705.01

where NR = not repo\rted

1C2

Lab Code	Sample	Rep	# Cigars	Puff Ct	MS TPM	NNN	NNK	NAB	NAT
			(cigs/rep)	(per cig)	(mg/cig)	(ng/cig)	(ng/cig)	(ng/cig)	(ng/cig)
1	1C2	1	3	21.0	17.07	117.50	112.92	15.29	74.58
1	1C2	2	3	20.8	16.83	104.17	110.42	15.79	76.67
1	1C2	3	3	21.3	16.77	108.84	115.09	14.54	74.90
1	1C2	4	3	21.6	17.21	110.09	117.21	14.73	85.63
1	1C2	5	3	22.1	17.16	117.14	115.60	15.42	87.94
2	1C2	1	3	22.0	18.50	197.23	150.02	19.76	109.08
2	1C2	2	3	20.9	19.57	225.85	163.85	20.51	115.51
2	1C2	3	3	19.6	20.87	223.07	166.07	23.65	131.35
2	1C2	4	3	19.0	18.87	233.16	174.77	23.79	122.97
2	1C2	5	3	19.5	21.23	257.07	189.78	25.21	130.79
3	1C2	1	3	15.5	14.5	215	184	23.9	118
3	1C2	2	3	15.3	14.7	213	180	25.2	120
3	1C2	3	3	14.9	12.5	192	160	22.9	105
3	1C2	4	3	14.7	13.0	183	159	21.6	103
3	1C2	5	3	16.2	14.4	207	175	24.9	120
4	1C2	1	5	20.7	17.44	237.60	196.53	31.46	123.89
4	1C2	2	5	20.3	18.56	293.31	210.25	35.05	139.34
4	1C2	3	5	19.9	18.54	268.94	211.35	32.36	137.35
4	1C2	4	5	20.5	19.30	257.11	210.56	35.46	137.89
4	1C2	5	5	20.3	18.92	263.41	208.63	33.22	130.67
5	1C2	1	3	23.7	22.13	255.00	241.67	30.00	150.00
5	1C2	2	3	22.3	22.20	266.67	251.67	30.00	173.33
5	1C2	3	3	21.7	22.80	305.00	268.33	33.33	193.33
5	1C2	4	3	21.3	22.30	283.33	295.00	38.33	136.67
5	1C2	5	3	22.0	23.03	308.33	256.67	28.33	166.67
6	1C2	1	3	25.4	22.6	237.30	204.00	28.50	160.00
6	1C2	2	3	22.2	25.9	304.00	257.30	33.50	184.00
6	1C2	3	3	24.1	24.63	284.00	238.70	33.60	181.30
6	1C2	4	3	23.5	23.87	264.00	224.00	29.20	170.70
6	1C2	5	3	24.2	24.1	266.70	229.30	32.10	168.00
7	1C2	1	3	18.3	22.87	304.25	315.32	43.24	249.63
7	1C2	2	3	18.9	25.80	320.85	280.15	39.95	251.55
7	1C2	3	3	18.2	24.63	342.63	295.46	45.52	266.59
7	1C2	4	3	19.0	26.67	325.04	275.01	41.86	249.21
7	1C2	5	3	19.9	25.57	343.19	271.15	42.53	249.95
8	1C2	1	3	21	22.4	1045.14	655.8	108.04	521.95
8	1C2	2	3	22	21.5	1394.4	917.27	131.41	739.39
8	1C2	3	3	21	22.5	1741.14	1038.66	145.79	864.96
8	1C2	4	3	22	19.6	210.66	128.5	17.39	107.11
8	1C2	5	3	22	22.3	277.78	125.71	19.09	124.08

1C3

Lab Code	Sample	Rep	# Cigars	Puff Ct	MS TPM	NNN	NNK	NAB	NAT
			(cigs/rep)	(per cig)	(mg/cig)	(ng/cig)	(ng/cig)	(ng/cig)	
1	1C3	1	1	37.5	115.90	992.50	502.50	95.50	360.00
1	1C3	2	1	34.5	119.50	903.75	470.00	93.38	342.50
1	1C3	3	1	36.2	116.35	962.15	489.36	95.26	352.61
1	1C3	4	1	35.4	115.24	944.58	457.21	93.16	349.12
1	1C3	5	1	36.4	114.89	935.24	457.26	96.47	360.24
2	1C3	1	1	29.0	60.90	694.65	334.33	57.18	274.88
2	1C3	2	1	29.0	61.50	650.13	342.54	50.79	273.31
2	1C3	3	1	31.0	59.20	647.85	279.00	57.27	274.41
2	1C3	4	1	31.0	63.10	721.63	293.87	56.47	271.39
2	1C3	5	1	32.0	59.30	615.97	279.20	57.60	288.28
3	1C3	1	1	36.0	64.0	1304	422	105	443
3	1C3	2	1	36.9	62.2	1134	385	97.5	390
3	1C3	3	1	35.7	64.7	1317	439	94.4	435
3	1C3	4	1	36.0	62.9	1161	424	93.9	403
3	1C3	5	1	39.2	58.3	1221	494	97.0	435
4	1C3	1	1	NR	NR	NR	NR	NR	NR
4	1C3	2	1	NR	NR	NR	NR	NR	NR
4	1C3	3	1	NR	NR	NR	NR	NR	NR
4	1C3	4	1	NR	NR	NR	NR	NR	NR
4	1C3	5	1	NR	NR	NR	NR	NR	NR
5	1C3	1	1	36.0	65.50	935.00	430.00	100.00	410.00
5	1C3	2	1	36.9	61.00	665.00	455.00	60.00	290.00
5	1C3	3	1	42.5	58.40	935.00	455.00	50.00	350.00
5	1C3	4	1	39.0	57.10	895.00	600.00	90.00	345.00
5	1C3	5	1	33.4	56.60	650.00	405.00	50.00	315.00
6	1C3	1	1	35.0	65.0	868.00	404.00	60.80	357.20
6	1C3	2	1	40.0	59.5	908.00	374.40	74.80	372.80
6	1C3	3	1	38.7	68.5	816.00	404.00	81.20	404.00
6	1C3	4	1	38.8	65.1	964.00	468.00	76.40	416.00
6	1C3	5	1	42.0	62.9	908.00	456.00	76.40	412.00
7	1C3	1	1	31.0	77.10	1169.54	446.36	122.34	637.70
7	1C3	2	1	33.0	81.70	1479.85	496.87	157.72	759.63
7	1C3	3	1	32.8	81.30	1641.26	507.55	161.64	806.23
7	1C3	4	1	32.0	80.80	1455.01	679.96	127.35	669.90
7	1C3	5	1	31.8	82.30	1446.64	578.49	153.52	769.28
8	1C3	1	1	35	76.7	1123.94	368.81	68.84	432.17
8	1C3	2	1	37	59.4	895.71	377.52	57.24	335.44
8	1C3	3	1	35	67.7	1001.07	402.17	66.83	402.1
8	1C3	4	1	36	63.2	891.54	352.37	59.79	345.42
8	1C3	5	1	38	64.3	867.95	372.04	55.88	334.57

where NR = not reported

1C4

Lab Code	Sample	Rep	# Cigars	Puff Ct	MS TPM	NNN	NNK	NAB	NAT
			(cigs/rep)	(per cig)	(mg/cig)	(ng/cig)	(ng/cig)	(ng/cig)	
1	1C4	1	1	43.0	64.3	3325.0	3000.00	397.50	1412.50
1	1C4	2	1	42.0	62.9	2950.0	2317.50	340.00	1127.50
1	1C4	3	1	41.5	61.85	3126.51	2635.28	381.29	1325.62
1	1C4	4	1	43.6	60.57	3024.87	2741.69	367.42	1289.45
1	1C4	5	1	44.2	62.35	3154.69	2863.21	358.49	1306.25
2	1C4	1	1	38.0	79.80	3101.55	2175.30	277.97	1313.54
2	1C4	2	1	35.0	77.00	3501.04	1897.48	245.14	1343.25
2	1C4	3	1	40.0	70.00	2523.81	1485.10	215.79	1181.72
2	1C4	4	1	36.0	71.50	3134.04	2805.23	281.94	1381.95
2	1C4	5	1	43.0	76.50	3575.19	3062.13	294.84	1482.01
3	1C4	1	1	47.4	51.1	2700	2000	232	1120
3	1C4	2	1	43.7	61.4	2620	2330	348	1290
3	1C4	3	1	42.0	59.2	2310	2080	250	995
3	1C4	4	1	41.0	56.1	3780	2640	218	919
3	1C4	5	1	38.0	54.5	3290	3420	288	1110
4	1C4	1	1	NR	NR	NR	NR	NR	NR
4	1C4	2	1	NR	NR	NR	NR	NR	NR
4	1C4	3	1	NR	NR	NR	NR	NR	NR
4	1C4	4	1	NR	NR	NR	NR	NR	NR
4	1C4	5	1	NR	NR	NR	NR	NR	NR
5	1C4	1	1	NR	NR	NR	NR	NR	NR
5	1C4	2	1	NR	NR	NR	NR	NR	NR
5	1C4	3	1	NR	NR	NR	NR	NR	NR
5	1C4	4	1	NR	NR	NR	NR	NR	NR
5	1C4	5	1	NR	NR	NR	NR	NR	NR
6	1C4	1	1	41.0	63.5	3320.00	3460.00	318.40	1596.00
6	1C4	2	1	48.0	65.6	3064.00	2388.00	283.20	1464.00
6	1C4	3	1	45.7	54.4	2304.00	2088.00	227.60	1216.00
6	1C4	4	1	48.0	57.8	3016.00	1984.00	280.80	1568.00
6	1C4	5	1	46.0	43.6	2120.00	1996.00	243.60	1228.00
7	1C4	1	1	37.0	102.00	3049.24	3719.66	388.37	1931.52
7	1C4	2	1	32.8	81.00	3644.31	3662.54	378.02	1823.58
7	1C4	3	1	35.0	92.00	3520.32	4077.82	437.54	2285.38
7	1C4	4	1	35.0	72.00	2615.14	2688.66	325.02	1679.63
7	1C4	5	1	36.0	82.00	4191.61	3329.24	464.58	2249.39
8	1C4	1	1	39	52.0	2897.86	2556	206.08	1127.64
8	1C4	2	1	44	30.9	1733.78	1271.51	139.14	825.34
8	1C4	3	1	42	63.9	3429.73	2068.69	214.09	1342.5
8	1C4	4	1	42	69.0	3809.49	2385.84	197.68	1390.81
8	1C4	5	1	39	63.1	2957.02	2629.23	206.93	1275.68

where NR = not reported

CM8

Lab Code	Sample	Rep	# Cigars	Puff Ct	MS TPM	NNN	NNK	NAB	NAT
			(cigs/rep)	(per cig)	(mg/cig)	(ng/cig)	(ng/cig)	(ng/cig)	
1	CM8	1	3	12.3	11.93	9.92	10.29	1.41	20.25
1	CM8	2	3	12.2	10.77	10.75	11.42	1.88	22.88
1	CM8	3	3	13.5	11.21	10.52	10.86	1.86	20.20
1	CM8	4	3	14.1	11.37	10.88	11.14	1.78	21.19
1	CM8	5	3	12.9	11.08	11.14	11.75	1.71	21.81
2	CM8	1	3	12.1	16.13	23.70	28.32	4.68	39.62
2	CM8	2	3	12.2	16.37	22.67	27.00	4.51	37.01
2	CM8	3	3	12.7	17.00	38.70	44.04	6.95	60.10
2	CM8	4	3	12.3	16.90	23.30	28.53	5.19	42.44
2	CM8	5	3	11.9	15.83	19.72	26.07	4.05	37.07
3	CM8	1	3	12.5	15.37	22.10	37.28	5.12	47.02
3	CM8	2	3	13.0	14.8	19.17	28.14	4.35	39.69
3	CM8	3	3	12.1	15.8	21.67	31.90	4.69	43.20
3	CM8	4	3	12.6	16.3	18.89	31.06	5.03	41.50
3	CM8	5	3	12.5	17.0	20.36	34.47	4.92	43.64
4	CM8	1	5	11.6	13.80	25.10	30.66	6.20	44.89
4	CM8	2	5	11.8	14.30	21.99	28.84	5.84	41.02
4	CM8	3	5	11.9	14.28	22.44	30.82	5.70	43.78
4	CM8	4	5	11.8	14.00	24.10	29.20	6.17	43.04
4	CM8	5	5	12.0	13.92	23.02	29.04	6.36	44.82
5	CM8	1	3	12.4	15.23	31.67	45.00	5.00	46.67
5	CM8	2	3	11.9	15.70	15.00	33.33	5.00	36.67
5	CM8	3	3	12.0	15.17	21.67	41.67	3.33	40.00
5	CM8	4	3	11.9	15.40	20.00	28.33	6.67	50.00
5	CM8	5	3	12.4	14.40	18.33	26.67	3.33	48.33
6	CM8	1	3	13.3	16.9	25.20	33.90	6.00	52.80
6	CM8	2	3	13.0	16.7	22.30	31.90	5.70	51.70
6	CM8	3	3	12.7	16.6	21.70	32.30	6.60	56.30
6	CM8	4	3	12.3	16.7	22.50	35.20	6.70	54.10
6	CM8	5	3	14.2	16.8	23.10	32.70	7.20	59.30
7	CM8	1	3	11.1	15.57	23.15	33.07	7.72	63.53
7	CM8	2	3	10.8	15.37	21.24	31.31	7.37	70.13
7	CM8	3	3	10.8	15.27	22.47	36.37	6.91	65.58
7	CM8	4	3	10.3	14.43	21.25	31.95	6.60	63.75
7	CM8	5	3	10.3	13.53	21.47	30.99	6.37	56.75
8	CM8	1	3	12.5	16.0	29.32	31.32	5.05	49.83
8	CM8	2	3	12.1	16.2	26.25	26.8	4.75	45.64
8	CM8	3	3	12.6	15.6	27.46	31.69	5.3	54.65
8	CM8	4	3	12.3	14.1	24.81	31.7	5.16	41.17
8	CM8	5	3	12.6	17.0	29.35	29.92	5.16	45.16

Appendix E: Raw Data – B[a]P

1C1

Lab Code	Sample	Rep	# Cigars	Puff Ct	MS TPM	B[a]P
			(cigs/rep)	(per cig)	(mg/cig)	(ng/cig)
1	1C1	1	1	99.0	45.30	54.80
1	1C1	2	1	97.0	46.70	50.00
1	1C1	3	1	96.0	46.03	51.30
1	1C1	4	1	95.3	45.73	52.60
1	1C1	5	1	94.8	46.13	54.10
2	1C1	1	1	82.0	108.90	155.34
2	1C1	2	1	80.0	90.60	116.38
2	1C1	3	1	81.0	95.60	139.79
2	1C1	4	1	88.0	81.00	109.90
2	1C1	5	1	79.0	101.70	144.61
3	1C1	1	1	NR	NR	NR
3	1C1	2	1	NR	NR	NR
3	1C1	3	1	NR	NR	NR
3	1C1	4	1	NR	NR	NR
3	1C1	5	1	NR	NR	NR
4	1C1	1	1	NR	NR	NR
4	1C1	2	1	NR	NR	NR
4	1C1	3	1	NR	NR	NR
4	1C1	4	1	NR	NR	NR
4	1C1	5	1	NR	NR	NR
5	1C1	1	1	NR	NR	NR
5	1C1	2	1	NR	NR	NR
5	1C1	3	1	NR	NR	NR
5	1C1	4	1	NR	NR	NR
5	1C1	5	1	NR	NR	NR
6	1C1	1	1	116.0	58.50	104.63
6	1C1	2	1	96.0	74.50	121.21
6	1C1	3	1	105.0	69.60	116.99
6	1C1	4	1	81.0	82.10	143.62
6	1C1	5	1	111.0	55.90	98.02
7	1C1	1	1	54.0	73.70	95.94
7	1C1	2	1	54.6	89.10	104.88
7	1C1	3	1	59.0	83.90	100.30
7	1C1	4	1	57.0	84.40	100.92
7	1C1	5	1	53.0	97.00	100.52
8	1C1	1	1	NR	NR	NR
8	1C1	2	1	NR	NR	NR
8	1C1	3	1	NR	NR	NR
8	1C1	4	1	NR	NR	NR
8	1C1	5	1	NR	NR	NR

where NR = not reported

1C2

Lab Code	Sample	Rep	# Cigars	Puff Ct	MS TPM	B[a]P
			(cigs/rep)	(per cig)	(mg/cig)	(ng/cig)
1	1C2	1	3	21.8	18.53	27.00
1	1C2	2	3	21.2	16.70	28.50
1	1C2	3	3	21.5	17.43	27.60
1	1C2	4	3	21.7	17.10	27.40
1	1C2	5	3	21.9	17.60	27.70
2	1C2	1	3	20.9	23.90	27.01
2	1C2	2	3	20.6	22.60	26.84
2	1C2	3	3	20.6	22.13	27.89
2	1C2	4	3	21.1	23.53	27.77
2	1C2	5	3	20.0	22.63	26.70
3	1C2	1	3	NR	NR	NR
3	1C2	2	3	NR	NR	NR
3	1C2	3	3	NR	NR	NR
3	1C2	4	3	NR	NR	NR
3	1C2	5	3	NR	NR	NR
4	1C2	1	5	20.3	18.92	23.42
4	1C2	2	5	19.7	19.18	24.26
4	1C2	3	5	20.2	18.86	23.02
4	1C2	4	5	20.5	18.48	23.13
4	1C2	5	5	19.7	18.84	24.41
5	1C2	1	3	22.1	22.30	20.10
5	1C2	2	3	21.3	24.40	21.76
5	1C2	3	3	23.0	21.33	20.57
5	1C2	4	3	21.8	23.00	20.49
5	1C2	5	3	20.3	23.30	21.27
6	1C2	1	3	25.3	24.33	26.16
6	1C2	2	3	23.0	26.13	28.63
6	1C2	3	3	23.2	23.60	25.09
6	1C2	4	3	24.4	22.03	25.84
6	1C2	5	3	23.5	24.23	29.62
7	1C2	1	3	20.5	22.97	25.15
7	1C2	2	3	19.7	24.60	28.57
7	1C2	3	3	20.6	23.13	26.76
7	1C2	4	3	19.7	27.90	30.17
7	1C2	5	3	21.5	24.33	27.02
8	1C2	1	3	NR	NR	NR
8	1C2	2	3	NR	NR	NR
8	1C2	3	3	NR	NR	NR
8	1C2	4	3	NR	NR	NR
8	1C2	5	3	NR	NR	NR

where NR = not reported

1C3

Lab Code	Sample	Rep	# Cigars	Puff Ct	MS TPM	B[a]P
			(cigs/rep)	(per cig)	(mg/cig)	(ng/cig)
1	1C3	1	1	34.0	126.20	75.40
1	1C3	2	1	37.4	127.90	80.40
1	1C3	3	1	35.2	127.30	74.60
1	1C3	4	1	36.4	126.80	76.30
1	1C3	5	1	36.7	126.90	75.24
2	1C3	1	1	34.0	70.10	80.68
2	1C3	2	1	35.0	71.20	89.02
2	1C3	3	1	35.0	63.60	72.32
2	1C3	4	1	35.0	68.50	79.45
2	1C3	5	1	36.0	67.60	96.24
3	1C3	1	1	NR	NR	NR
3	1C3	2	1	NR	NR	NR
3	1C3	3	1	NR	NR	NR
3	1C3	4	1	NR	NR	NR
3	1C3	5	1	NR	NR	NR
4	1C3	1	1	NR	NR	NR
4	1C3	2	1	NR	NR	NR
4	1C3	3	1	NR	NR	NR
4	1C3	4	1	NR	NR	NR
4	1C3	5	1	NR	NR	NR
5	1C3	1	1	37.0	64.40	62.03
5	1C3	2	1	40.0	61.80	55.88
5	1C3	3	1	37.0	60.40	58.26
5	1C3	4	1	49.0	53.50	53.05
5	1C3	5	1	34.9	64.10	61.35
6	1C3	1	1	43.0	58.30	88.16
6	1C3	2	1	39.0	65.90	79.32
6	1C3	3	1	36.0	66.10	92.06
6	1C3	4	1	36.7	66.30	81.49
6	1C3	5	1	44.5	63.70	78.86
7	1C3	1	1	36.0	63.30	87.89
7	1C3	2	1	37.0	68.90	94.48
7	1C3	3	1	38.0	54.30	75.50
7	1C3	4	1	36.0	66.80	91.69
7	1C3	5	1	34.0	64.10	85.52
8	1C3	1	1	NR	NR	NR
8	1C3	2	1	NR	NR	NR
8	1C3	3	1	NR	NR	NR
8	1C3	4	1	NR	NR	NR
8	1C3	5	1	NR	NR	NR

where NR = not reported

1C4

Lab Code	Sample	Rep	# Cigars	Puff Ct	MS TPM	B[a]P
			(cigs/rep)	(per cig)	(mg/cig)	(ng/cig)
1	1C4	1	1	41.0	62.10	83.80
1	1C4	2	1	42.0	53.40	86.80
1	1C4	3	1	42.1	55.63	84.23
1	1C4	4	1	41.8	54.38	85.14
1	1C4	5	1	41.3	55.26	84.69
2	1C4	1	1	47.0	72.70	65.39
2	1C4	2	1	47.0	75.60	54.21
2	1C4	3	1	48.0	70.50	57.42
2	1C4	4	1	40.0	68.40	54.43
2	1C4	5	1	44.0	76.00	54.13
3	1C4	1	1	NR	NR	NR
3	1C4	2	1	NR	NR	NR
3	1C4	3	1	NR	NR	NR
3	1C4	4	1	NR	NR	NR
3	1C4	5	1	NR	NR	NR
4	1C4	1	1	NR	NR	NR
4	1C4	2	1	NR	NR	NR
4	1C4	3	1	NR	NR	NR
4	1C4	4	1	NR	NR	NR
4	1C4	5	1	NR	NR	NR
5	1C4	1	1	NR	NR	NR
5	1C4	2	1	NR	NR	NR
5	1C4	3	1	NR	NR	NR
5	1C4	4	1	NR	NR	NR
5	1C4	5	1	NR	NR	NR
6	1C4	1	1	62.8	63.60	62.72
6	1C4	2	1	45.9	61.00	52.76
6	1C4	3	1	46.0	60.50	52.36
6	1C4	4	1	46.7	66.50	59.73
6	1C4	5	1	47.0	67.40	68.90
7	1C4	1	1	45.7	62.00	52.68
7	1C4	2	1	45.0	66.00	56.85
7	1C4	3	1	37.0	71.00	57.08
7	1C4	4	1	45.0	65.00	54.66
7	1C4	5	1	43.0	67.00	55.62
8	1C4	1	1	NR	NR	NR
8	1C4	2	1	NR	NR	NR
8	1C4	3	1	NR	NR	NR
8	1C4	4	1	NR	NR	NR
8	1C4	5	1	NR	NR	NR

where NR = not reported

CM8

Lab Code	Sample	Rep	# Cigars	Puff Ct	MS TPM	B[a]P
			(cigs/rep)	(per cig)	(mg/cig)	(ng/cig)
1	CM8	1	3	12.8	12.10	17.50
1	CM8	2	3	12.6	11.75	17.28
1	CM8	3	3	12.3	11.72	18.21
1	CM8	4	3	12.6	12.09	17.43
1	CM8	5	3	12.9	12.27	18.49
2	CM8	1	3	12.2	15.07	14.99
2	CM8	2	3	12.4	13.83	12.57
2	CM8	3	3	11.7	13.93	12.48
2	CM8	4	3	12.1	14.27	12.73
2	CM8	5	3	12.0	13.80	12.03
3	CM8	1	3	NR	NR	NR
3	CM8	2	3	NR	NR	NR
3	CM8	3	3	NR	NR	NR
3	CM8	4	3	NR	NR	NR
3	CM8	5	3	NR	NR	NR
4	CM8	1	5	11.6	13.48	14.04
4	CM8	2	5	11.7	13.04	12.73
4	CM8	3	5	11.4	13.68	13.06
4	CM8	4	5	11.6	14.12	12.87
4	CM8	5	5	11.8	13.98	12.89
5	CM8	1	3	12.3	15.83	10.08
5	CM8	2	3	12.0	15.57	9.84
5	CM8	3	3	12.5	16.20	10.95
5	CM8	4	3	11.9	14.83	10.74
5	CM8	5	3	12.5	15.83	10.33
6	CM8	1	3	13.3	17.07	14.50
6	CM8	2	3	13.3	17.37	13.97
6	CM8	3	3	12.8	17.10	13.47
6	CM8	4	3	13.0	16.30	13.71
6	CM8	5	3	13.7	17.57	13.52
7	CM8	1	3	11.6	15.77	12.42
7	CM8	2	3	11.7	17.27	12.75
7	CM8	3	3	11.8	15.90	12.84
7	CM8	4	3	11.7	15.63	12.46
7	CM8	5	3	12.1	15.83	15.39
8	CM8	1	3	NR	NR	NR
8	CM8	2	3	NR	NR	NR
8	CM8	3	3	NR	NR	NR
8	CM8	4	3	NR	NR	NR
8	CM8	5	3	NR	NR	NR

where NR = not reported