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SUMMARY REPORT FOR UGLCC INTERLABORATORY STUDIES ON THE ANALYSIS OF POLYNUCLEAR AROMATIC HYDROCARBONS IN WATER AND STANDARD SOLUTIONS

by

W.C. Li and A.S.Y. Chau

Research and Applications Branch
National Water Research Institute
Canada Centre for Inland Waters
867 Lakeshore Road, P.O. Box 5050
Burlington, Ontario L7R 4A6

and the Data Quality Management Work Group

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MANAGEMENT PERSPECTIVE

The Upper Great Lakes Connecting Channels (UGLCC) have been designated as "Areas of Concern" by the International Joint Commission. A Canada-U.S. binational study (UGLCCS) involving the identification and assessment of the environmental impacts of toxic substances in those areas was initiated in late 1985. In order to assist contributing analytical laboratories, to generate reliable and accurate data during the study, a Date Quality Management Work Group was formed and 13 interlaboratory performance evaluation studies were initiated.

Final reports for the 13 interlaboratory studies have been completed. This report presents a summary of interlaboratory studies QM-2 and QM-10 on the analysis of polynuclear aromatic hydrocarbons in water and standard solutions contained in ampules. The information contained in this report will assist project leaders, managers and users of UGLCC data in evaluating the performance of participating laboratories.

Dr. J. Lawrence
Director
Research and Applications Branch

PERSPECTIVE-GESTION

La Commission mixte internationale a qualifié de "zones préoccupantes" les chenaux interlacustres des Grands Lacs d'amont. Une étude canado-américaine sur ces chenaux, qui prévoyait l'identification et l'évaluation de l'impact environnemental des substances toxiques dans ces zones, a été entreprise vers la fin de 1985. Un Groupe de travail sur la gestion de la qualité des données a été constitué et 13 études interlaboratoires destinées à évaluer le rendement des analyses ont été entreprises, dans le but d'aider les laboratoires participants à obtenir des données fiables et précises au cours de l'étude.

Les rapports finals des 13 études interlaboratoires sont maintenant terminés. On résume dans le présent rapport les études interlaboratoires QM-2 et QM-10 qui portaient sur le dosage des hydrocarbures aromatiques polycycliques dans l'eau et dans des solutions étalons contenues dans des ampoules. L'information contenue dans ce rapport aidera les chargés de projet, les gestionnaires et les utilisateurs des données sur les chenaux interlacustres des Grands Lacs d'amont à évaluer le rendement des laboratoires participants.

M. J. Lawrence

Directeur

Direction de la recherche et des applications.

ABSTRACT

In the early planning stages of the Upper Great Lakes Connecting Channels (UGLCC) Study, it was recognized that quality assurance/quality control (QA/QC) aspects would be crucial to the overall usefulness of the study results. In order to address this matter, a Data Quality Management Work Group was established and thirteen interlaboratory performance evaluation (PE) studies for inorganic and organic parameters were designed and conducted during the duration of the UGLCC study (1985 - 1987).

Final reports for the 13 interlaboratory studies have been completed. Results from interlaboratorry PE studies Nos. QM-2 and QM-10 on the analysis of polynuclear aromatic hydrocarbons in water and standard solutions contained in ampules are now integrated into this report. The information contained in this report will assist project leaders, managers and users of UGLCCS data in evaluating the performance of participating laboratories.

RÉSUMÉ

Dès les premières étapes de planification de l'Étude sur les chenaux interlacustres des Grands Lacs d'amont, on a reconnu que l'assurance et le contrôle de la qualité auraient un effet décisif sur l'utilité globale des résultats de l'étude. Afin de régler cette question, on a mis sur pied un Groupe de travail sur la gestion de la qualité des données et on a élaboré treize études interlaboratoires destinées à évaluer le rendement des analyses relatives aux paramètres inorganiques et organiques; ces études ont ensuite été mises en application au cours de l'Étude sur les chenaux interlacustres des Grands Lacs d'amont (soit de 1985 à 1987).

Les rapports finals des 13 études interlaboratoires sont maintenant terminés. Les résultats des études interlaboratoires QM-2 et QM-10, qui évaluaient le rendement de la méthode de dosage des hydrocarbures aromatiques polycycliques dans l'eau et dans des solutions étalons contenues dans des ampoules, ont maintenant été intégrés au présent rapport. L'information contenue dans ce rapport aidera les chargés de projet, les gestionnaires et les utilisateurs des données sur les chenaux interlacustres des Grands Lacs d'amont à évaluer le rendement des laboratoires participants.

1.0 INTRODUCTION

The Upper Great Lakes Connecting Channels Study (UGLCCS) was established to identify and deal with environmental problems associated with the St. Mary's, St. Clair and Detroit Rivers and Lake St. Clair. A three-year, binational study was started in late 1985 and involved Canadian and U.S. environmental and resource agencies.

In the early planning stages of the study, it was recognized that quality assurance/quality control (QA/QC) aspects would be crucial to the overall usefulness of the study results. In order to address this matter, a Data Quality Management Work Group (see Appendix I-A) was established and thirteen interlaboratory performance evaluation studies were conducted.

Thirteen individual final reports on the interlaboratory studies have been completed, as listed in Appendix I-B. This report is a summary of some interlaboratory studies (Nos. QM-2 and QM-10) for polynuclear aromatic hydrocarbons (PAHs) in water and standard solutions contained in ampules. The data accuracy and precision for individual laboratories are discussed as well as data addressing between-laboratory comparability drawn from various studies.

2.0 STUDY DESIGN

At the outset, the Data Quality Management Work Group considered that control of standards and the calibration process (1) were the two most serious sources of variation in results between different laboratories. Therefore, a series of check standards covering all of the UGLCCS parameters for which check standards were available was distributed to laboraotries participating in the study.

Table 2.1 provides a listing of the samples distributed for these interlaboratory studies and the constituents to be

analyzed covering 36 inorganic and 50 organic parameters. The participants in these studies included different governmental and private laboratories in both Canada and the U.S., and are enumerated in Table 2.2. The schedule of the QC studies are listed in Table 2.3.

Each study consisted of between four and eight samples which contained either standard solutions in ampules, surrogate spikes for waters, or a limited number of natural reference materials. Test compounds were of fixed concentration for each sample, but levels were made to vary between samples by as much as two orders of magnitude. Most samples were sent out with blind duplicates, so that reproducibility could be assessed. All samples were well-characterized and their stability was verified in advance. Sample stability was also assessed by re-using samples in various studies. This approach has been successfully employed in IJC and LRTAP interlaboratory studies (2,3).

These studies were designed and conducted under the direction of the QA Team of the Research and Applications Branch at the National Water Research Institute in Burlington.

3.0 DATA EVALUATION

In the past, a technique known as Youden ranking (4) was employed to determine bias in a laboratory's results. However, because of the small number of laboratories which provided data, this technique could not be used. As an alternative, each laboratory's result for a particular parameter and a given sample was treated as a 'recovery' and the design value for that parameter and sample was taken as the true value. Percent recoveries for each sample and parameter combination were then calculated and compared to value ranges in the table listed below.

Average or Individual % Recovery	Individual Result Designation (Flag)	Multiple Result Designation (Bias)
≥ 150	Very high (VH)	Very High (VH)
149 - 125	High (H)	High (H)
124 - 76	Satisfactory (S)	Satisfactory (S)
75 - 51	Low (L)	Low (L)
≤ 50	Very low (VL)	Very Low (VL)

In addition to the flagging of individual sample results, bias was also evaluated as an average for all results in a study with the same parameter (i.e. regardless of sample concentration or matrix). The same designation scheme was used as with individual test results (see above).

Appendix II contains a summary of each laboratory's appraisal for flags and bias in various studies.

In these laboratory comparison studies, medians rather than means were preferred for evaluating accuracy of interlaboratory results where there were relatively few data and the means were strongly influenced by outliers. For evaluating precision of interlaboratory results, means and standard deviations were calculated with outliers removed by using Grubb's test (3). The standard deviation (σ) and relative standard deviation (RSD) were calculated as follows:

$$\sigma = \sqrt{(x_i-\bar{x})^2/n-1} \qquad \text{and} \qquad \text{RSD, \%} = \sigma/\bar{x} \times 100$$

where x_i = individual result, $\bar{x}$ = mean,
and n = number of individual results

4.0 RESULTS AND DISCUSSION

4.1 Interlaboratory Comparability

Two studies contained samples which were used for

polynoclear aromatic hydrocarbons (PAH) analysis: QM-2 (January 24, 1986) and QM-10 (May 1, 1986). The participants in these studies are listed in Table 4.1.1. Standard solutions contained in ampules were used as PAH samples in both study QM-2 and study QM-10; additional spiked water samples were used only in study QM-10.

Both studies also included sample duplicates which were used to assess reproducibility within the same laboratory. Appendix III provides a summary of within-lab precision for the analysis of PAHs in various studies.

For tracibility of interlaboratory studies, some samples were used in both QM-2 and QM-10. Samples 203/204 in QM-2 and sample 1002 in QM-10 were identical samples. A summary of the design values and interlaboratory medians for 16 PAHs in these identical samples is given in Table 4.1.2. Figure 4.1.1 presents the percent recoveries of interlaboratory medians for all PAH parameters in these test samples. Overall the agreement of interlaboratory medians in these samples was comparable in most cases. However, it was obvious that better results were obtained in QM-10 than in QM-2 indicated as follows: six out of 16 PAHs were different by more than ±25% of the design values for both samples 203/204 in QM-2 while only one out of 16 PAHs (phenanthrene) was different by more than ±25% of the design values for sample 1002 in QM-10.

The range and average values of percent recoveries of interlaboratory medians for PAHs in various studies are summarized in Table 4.1.3. Figure 4.1.2 presents graphically the condensed results of average recovery of interlabortory medians for all 16 PAHs in various studies. For the samples in ampules, the interlaboratory results were satisfactory within ±25% of the design values for most of PAH parameters. However, a comparison between QM-2 and QM-10, three out of 16 PAH parameters in QM-2 were different by more than ±25% of the design values while all 16 PAH parameters in QM-10 were within ±25% of the design values. It suggests that the positive impact of interlaboratory study is

evident for participting laboratories by improving their performance.

The average recoveries of PAHs in spiked water samples (QM-10) were less satisfactory as compared with those samples in ampules (QM-10). As can be seen from figure 4.1.2, four out of 16 PAHs (acenaphthylene, acenaphthene, fluorene and phenantracene) were different by more than ±25% of the design values. The lower recoveries of these 4 PAHs may be attributed to their high volatilization and subjected to loss during sample preparation steps.

Data on the precision of interlaboratory results expressed as RSDs for PAHs in various studies are summarized in Table 4.1.4. Figure 4.1.3 graphically presents the condensed results of average RSDs for all 16 PAH parameter detemined in various interlaboratory studies. For the samples in ampules, obviously better interlaboratory results were obtained in QM-10 as compared with QM-2 indicated as follows: three out of 16 PAHs (pyrene, dibenzo(a,h)anthracene and benzo(g,h,i)perylene) were less than ±25% average RSDs in QM-2, while eleven out of 16 PAHs were less than ±25% average RSDs in QM-10. For the spiked waters in QM-10, only six out of 16 PAHs were less than ±25% average RSDs.

4.2 Comparison of Laboratory Performance in Various Studies

The key step in evaluating laboratory data is the selection of acceptance criterion. The acceptance criteron used for this report was based on the average of % bias and % flags within a study. This approach was similar to that used by the LRTAP QA program for the evaluation of laboratories involved in the analyses of major ions, nutrients and physical parameters in surface waters (2). This criterion provided a simple way to compare laboratory performance in various studies as shown below:

Average of Percent Bias and Percent Flags	Comment	
≤ 25%	Satisfactory	(A)
26 - 50%	Moderate	(B)
≥ 51%	Poor	(C)

An analysis of the data obtained in various studies for PAHs has been carried out on the basis of the criterion given above and the results are summarized in Table 4.2.1. As shown in Table 4.2.1, only one laboratory (U077) have consistently produced satisfactory results for PAH analysis of both samples in ampules and spiked water samples. Less satisfactory results were generated by two laboaratories in either samples in ampules (U063) in study QM-2 or spiked water samples (U075) in study QM-10. However, the performance of U063 was very satisfactiry for both samples in ampules and spiked water samples in study QM-10 with the average of % bias and % flags as 13.4% and 8.0%, respectively, as compared with that obtained in QM-2 (55.5%). The improvement in this laboratory demonstrated that the impact of these interlaboratory studies was very constructive to help participating laboratory to excell and correct their internal QA/QC problems.

For the evaluation of the relative performance of participating laboratories, the results of each study were summarized in Tables 4.2.2a and 4.2.2b, respectively. These tables provide useful information to project leaders, manager and users of data on the comparability of participating laboratories.

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TABLE 2.1

QC Study Parameters for UGLCC
Interlaboratory Performance Evaluation Studies

Study	Test Samples	Parameters	Substrate
QM-1	4 Ampules	Aroclors	Std. Solutions
	4 Ampules	Chlorinated Insecticides	Std. Solutions
	4 Ampules	Chlorinated Hydrocarbon	Std. Solutions
QM-2	4 Ampules	16 PAHs	Std. Solutions
QM-3	5 Sediments	10 Metals	Sediment CRM or RM
QM-4	4 Waters	23 Major Ions & Nutrients	Water CRM
QM-5	4 Waters	7 Metals	Water CRM
QM-6	4 Sediments	Chlorinated Hydrocarbons	Sediment CRM or RM
	2 Ampules	Chlorinated Hydrocarbons	Std. Solutions
QM-7	2 Ampules	Aroclors	Std. Solutions
	2 Ampules	Chlorinated Hydrocarabons	Std. Solutions
	4 Ampules	Aroclor & Chlorinated Hydrocarbons	Spiking Solutions & Natural Water
QM-8	4 Ampules	Chlorinated Insecticides	Std. Solutions
	4 Ampules	Chlorinated Insecticides	Spiking Solutioins & Natural Water
QM-9	4 Waters	Mercury	Water CRM
QM-10	2 Ampules	16 PAH	Std. Solutions
	4 Ampules	15 PAHs	Spiking Solutions & Natural Waters
QM-11	4 Waters	Cyanide	Water CRM
QM-12	4 Waters	Total Phenol	Water CRM
QM-13	2 Ampules	5 Chlorophenols	Std. Solutions
	2 Oils		Fish Oils
	2 Tissues		Fish Tissues

TABLE 2.2
Participants in the UGLCCS Performance Evaluation Studies

U.S. Laboratories

The Bionetics Corporation, (U.S. Environmental Protection Agency - Great Lakes National Program Office), Chicago, Illinois, USA.
Clarkson University, (U.S. Environmental Protection Agency - Large Lakes Research Station, Gross Ile, Michigan), Potsdam, New York, USA.
Detroit Water and Sewerage Department - Analytical Laboratory, Detroit Michigan, USA.
Great Lakes Environmental Research Laboratory - National Oceanic and Atmospheric Administration, Ann Arbor, Michigan, USA.
Michigan Department of Public Health - Centre for Environmental Health Science - Epidemiological Studies Laboratory, Lansing, Michigan, USA.
Michigan Department of Natural Resources, Lansing, Michigan, USA.
Raytheon Service Corporation (U.S. Environmental Protection Agency - Large Lakes Research Station), Grosse Ile, Michigan, USA.
University of Michigan - Great Lakes Research Division, (U.S. Environmental Protection Agency - Great Lakes National Program Office and Great Lakes Environmental Research Laboratory - National Oceanic and Atmospheric Administration) Ann Arbor, Michigan, USA.
U.S. Army Corps of Engineers - Environmental Analysis Branch, Detroit, Michigan, USA.
U.S. Geological Survey - National Water Quality Laboratory, Arvada, Colorado, USA.

Canadian Laboratories

Barringer Magenta Limited, Rexdale, Ontario, Canada.
Beak Analytical Services, Mississauga, Ontario Canada.
Mann Testing Laboratories, Mississauga, Ontario, Canada
National Water Research Institute, Environmental Contaminants Division - Inorganics Section, Burlington, Ontario, Canada.
National Water Resarch Institute, Environmental Contaminants Division - Organics-Pathways Section, Burlington, Ontario, Canada.
National Water Resarch Institute - Environmental Contaminants Division - Organics-Properties Section, Burlington, Ontario, Canada.
Ontario Ministry of Environment, London, Ontario, Canada.
Ontario Ministry of Environment - Inorganic Trace Contaminants Waters Unit, Rexdale, Ontario, Canada.
Ontario Ministry of Environment - Trace Organics Section - Drinking Water, Rexdale, Ontario, Canada.
Ontario Ministry of Environment - Trace Organics Section - Sediment and Biota, Rexdale, Ontario, Canada.
Ontario Ministry of Environment - Trace Organics Section - Wastewater, Rexdale, Ontario, Canada.
Ontario Ministry of Environment - Water Quality Section, Rexdale, Ontario, Canada.
Ontario Ministry of Environment - Thunder Bay, Ontario, Canada.
Wastewater Technology Centre, (Conservation and Protection, Toronto), Burlington, Ontario, Canada.
National Water Quality Laboratory, Burlington, Ontario, Canada.
Zenon Environmental Inc., Burlington, Ontario, Canada.

TABLE 2.3
Interlaboratory Performance Evaluation or QC Studies

UGLCCS QC Study Schedules

Study No.	No. of Questionnaires	No. of Participants	Sent Out Date		Reporting Deadline	No. of Labs Reporting
			Questionnaires	Samples		
QM-1	45	16	Dec. 17/85	Jan. 24/86	Mar 20/86 Closed July 4/86	9
QM-2	45	16	Dec. 17/85	Jan. 24/86	Mar 20/86 Closed July 4/86	7
QM-3	45	15	Dec. 17/85	Jan. 24/86	Mar 20/86 Closed July 4/86	10
QM-4	50	13	Jan. 31/86	Feb. 28/86	Apr. 30/86 Closed Aug. 8/86	10
QM-5	50	14	Jan. 31/86	Feb. 28/86	Apr. 30/86 Closed Aug. 8/86	11
QM-6	50	12	Jan. 31/86	Feb. 28/86	Apr. 30/86 Closed Aug. 8/86	7
QM-7	55	16	Feb. 28/86	Mar. 27/86	May 15/86 Closed Sept 30/86	12
QM-8	55	14	Feb. 28/86	Mar. 27/86	May 15/86 Closed Sept 30/86	10
QM-9	55	12	Feb. 28/86	Mar. 27/86	May ~~27~~ 15/86 Closed Sept 30/86	11
QM-10	59	14	Apr. 2/86	May 1/86	May 30/86 Closed Oct. 10/86	9
QM-11	59	10	Apr. 2/86	May 1/86	May 30/86 Closed Oct. 10/86	7
QM-12	59	10	Apr. 2/86	May 1/86	May 30/86 Closed Oct. 10/86	7
QM-13	55	6	May 9/86	Jun. 24/86	Aug. 1/86 Closed Oct. 17/86	2

TABLE 4.1.1

Participants in PAHs Interlaboratory Performance Evaluation Studies

Laboratory Code	Study Number	
	QM-2	QM-10
U001	X	X
U005	X	-
U009	X	-
U014	-	X
U063	X	X
U072	X	X
U075	-	X
U077	-	X
U078	-	X
U079	X	X
U085	X	-
U093	-	X

Note X: participated
-: did not participate

TABLE 4.1.2

Interlaboratory Medians for PAHs with Identical Samples in Various Studies

Parameter No	Parameter	Design Value	QM-2		QM-10
			203	204	1002
			ng/μL		
1	naphthalene	0.659	0.532 (80.7)	0.600 (91.0)	0.600 (91.0)
2	acenaphthylene	0.953	0.620 (65.1)	0.601 (63.1)	0.820 (86.0)
3	acenaphthene	1.09	0.820 (75.2)	0.775 (71.1)	0.955 (87.6)
4	fluorene	1.17	0.800 (68.4)	0.800 (68.4)	0.925 (79.1)
5	phenanthrene	2.54	1.44 (56.7)	1.47 (57.9)	1.90 (74.8)
6	anthracene	0.334	0.305 (91.3)	0.330 (98.8)	0.268 (80.2)
7	fluoranthene	4.80	3.27 (68.1)	3.70 (77.1)	4.40 (91.7)
8	pyrene	4.80	3.60 (75.0)	3.76 (78.3)	4.42 (92.1)
9	benzo(a)anthracene	2.08	1.40 (67.3)	1.47 (70.7)	1.73 (83.2)
10	chrysene	1.89	1.18 (62.4)	1.20 (63.5)	1.76 (93.1)
11	benzo(b)fluoranthene	0.929	0.921 (99.1)	0.730 (78.6)	0.800 (86.1)
12	benzo(k)fluoranthene	0.535	0.545 (102)	0.520 (97.2)	0.460 (86.0)
13	benzo(a)pyrene	0.954	1.06 (111)	0.977 (102)	0.783 (82.1)
14	indeno(1,2,3-Cd)-pyrene	0.889	0.771 (80.0)	0.691 (77.7)	0.800 (90.0)
15	dibenzo(a,h)-anthracene	1.00	1.00 (100)	0.835 (83.5)	0.810 (81.0)
16	benzo(g,h,i)-perylene	0.947	1.01 (107)	0.935 (98.7)	0.900 (95.0)

Note: The numbers in parentheses are the percent recoveries of design values.

TABLE 4.1.3

Range and Average Values of Percent Recoveries for PAHs in Various Studies

Parameter No.	Parameter	QM-2 (ampules)		QM-10 (ampules)		QM-10 (waters)	
		Range	Average	Range	Average	Range	Average
		%					
1	naphthalene	80.7-116	93.1(4)	91.0-113	102(2)	73.6-102	83.6(4)
2	acenaphthylene	63.1-96.5	79.8(4)	67.3-86.0	76.7(2)	60.9-74.6	65.4(4)
3	acenaphthene	71.1-81.2	76.7(4)	84.2-87.6	85.9(2)	55.6-69.7	64.3(4)
4	fluorene	68.4-78.8	72.8(4)	79.1-89.3	84.2(2)	60.0-67.6	64.5(4)
5	phenanthrene	56.7-75.6	66.1(4)	74.8-82.7	78.8(2)	70.1-75.6	71.9(4)
6	anthracene	89.6-98.8	92.4(4)	80.2-93.7	87.0(2)	77.9-89.8	83.0(4)
7	fluoranthene	68.1-84.2	77.6(4)	87.5-91.7	89.6(2)	69.1-84.2	75.4(4)
8	pyrene	75.0-90.8	81.9(4)	90.8-92.1	91.5(2)	74.8-85.7	81.6(4)
9	benzo(a)anthracene	67.3-96.0	81.9(4)	83.2-118	101 (2)	72.6-78.9	76.0(4)
10	chrysene	62.4-86.9	71.6(4)	93.1-115	104(2)	74.6-85.3	80.3(4)
11	benzo(b)fluoranthene	78.6-102	94.4(4)	80.6-86.1	83.4(2)	73.2-80.5	76.3(4)
12	benzo(k)fluoranthene	82.2-102	93.7(4)	86.0-92.1	89.1(2)	58.2-94.0	77.2(4)
13	benzo(a)pyrene	95.5-111	104(4)	82.1-85.3	83.7(2)	77.6-86.0	81.9(4)
14	indeno(1,2,3-Cd)-pyrene	77.7-95.3	86.0(4)	90.0-100	95.0(2)	73.1-88.8	81.4(4)
15	dibenzo(a,h)-anthracene	83.5-100	91.0(4)	81.0-90.8	85.9(2)	73.0-92.2	80.9(4)
16	benzo(g,h,i)-perylene	95.7-107	99.6(4)	95.0-96.0	95.5(2)	79.2-98.3	88.2(4)

Note: The numbers in parentheses are the number of samples.

TABLE 4.1.4

Precision of Interlaboratory Results for PAHs in Various Studies
(RSD)

Parameter No.	Parameter	QM-2 (ampules)		QM-10 (ampules)		QM-10 (waters)	
		Range	Average	Range	Average	Range	Average
		%					
1	naphthalene	7.4-50.7	33.0(4)	19.8-33.9	26.7(2)	14.2-53.2	43.2(4)
2	acenapthylene	14.0-41.8	31.0(4)	32.9-39.3	36.1(2)	11.6-42.6	30.8(4)
3	acenaphthene	18.5-44.3	33.3(4)	28.9-31.3	30.1(2)	24.3-44.0	30.1(4)
4	fluorene	17.6-64.7	40.4(4)	23.4-27.2	25.3(2)	32.3-45.1	36.1(4)
5	phenanthrene	13.9-44.0	27.0(4)	17.8-24.4	21.1(2)	14.1-43.1	23.3(4)
6	anthracene	14.3-49.3	25.9(4)	15.6-17.7	16.7(2)	16.7-53.6	37.2(4)
7	fluoranthene	10.7-47.4	28.1(4)	15.9-21.7	18.8(2)	11.6-53.0	31.5(4)
8	pyrene	8.8-38.0	20.1(4)	23.1-25.6	24.4(2)	16.1-23.0	19.1(4)
9	benzo(a)anthracene	16.0-63.2	35.8(4)	10.4-21.6	16.0(2)	4.7-33.6	22.9(4)
10	chrysene	16.7-68.2	40.1(4)	43.1-49.5	46.3(2)	28.8-34.7	32.7(4)
11	benzo(b)fluoranthene	7.1-81.9	39.0(4)	13.2-17.8	15.5(2)	21.0-36.5	29.1(4)
12	benzo(k)fluoranthene	11.0-88.7	48.9(4)	18.7-36.8	27.8(2)	25.5-58.0	40.2(4)
13	benzo(a)pyrene	13.3-52.5	26.0(4)	4.8-33.2	19.0(2)	5.3-38.5	25.7(4)
14	indeno(1,2,3-Cd)-pyrene	16.3-81.0	40.6(4)	12.3-31.8	22.1(2)	12.2-23.2	18.1(4)
15	dibenzo(a,h)-anthracene	12.0-50.5	25.2(4)	8.1-38.6	23.4(2)	22.3-28.2	25.0(4)
16	benzo(g,h,i)-perylene	11.5-39.0	23.6(4)	4.0-33.2	18.6(2)	12.1-16.8	13.8(4)

Note: The numbers in parentheses are the number of samples.

TABLE 4.2.1

Comparison of Laboratory Performance for PAHs in Various Studies

Lab. No.	Study No.	Matrix	Bias			Flags			Average of % Biased and % Flagged	Comment
			No. of Parameters Analyzed	No. of Parameters Biased	% of Parameters Biased	No. of Results Reported	No. of Results Flagged	% of Results Flagged		
U001	QM-2	Ampules	16	7.5	46.9	58	24.0	41.4	44.2	B
	QM-10	Ampules	6	2.5	41.6	12	4.5	37.5	39.6	B
	QM-10	Waters	6	2.0	33.3	24	7.0	29.2	31.3	B
U005	QM-2	Ampules	12	2.5	20.8	38	9.0	23.6	22.2	A
U009	QM-2	Ampules	16	3.0	18.8	64	11.0	17.2	18.0	A
U014	QM-10	Ampules		NA			NA			
	QM-10	Waters	insufficient usable data for evaluation							
U063	QM-2	Ampules	15	8.0	53.3	59	34.0	57.6	55.5	C
	QM-10	Ampules	14	1.5	10.7	28	4.5	16.1	13.4	A
	QM-10	Waters	14	1.0	7.1	56	5.0	8.9	8.0	A
U072	QM-2	Ampules	9	1.0	11.1	34	2.5	7.4	9.3	A
	QM-10	Ampules	10	0.5	5.0	20	3.0	15.0	10.0	A
	QM-10	Waters	10	3.0	30.0	38	16.5	43.4	36.7	B
U075	QM-10	Ampules		NA			NA			
	QM-10	Waters	10	6.0	60.0	39	20.0	51.3	55.7	C

TABLE 4.2.1 (continued)

Lab. No.	Study No.	Matrix	Bias			Flags			Average of % Biased and % Flagged	Comment
			No. of Parameters Analyzed	No. of Parameters Biased	% of Parameters Biased	No. of Results Reported	No. of Results Flagged	% of Results Flagged		
U077	QM-10	Ampules	16	3.5	21.9	27	6.0	22.2	22.1	A
	QM-10	Waters	12	2.5	20.8	40	11.0	27.5	24.2	A
U078	QM-10	Ampules	16	1.5	9.4	32	3.0	9.4	9.4	A
	QM-10	Waters	16	4.5	28.1	64	17.5	27.3	27.7	B
U079	QM-2	Ampules	16	3.5	21.9	62	21.5	34.7	28.3	B
	QM-10	Ampules	16	3.5	21.9	32	5.5	17.2	19.6	A
	QM-10	Waters	15	6.5	43.3	59	22.0	37.3	40.3	B
U085	QM-2	Ampules	16	3.5	21.9	50	18.0	36.0	29.0	B
U093	QM-10	Ampules	16	7.0	43.8	32	13.5	42.2	43.0	B
	QM-10	Waters	15	6.5	43.3	60	25.5	42.5	42.9	B

TABLE 4.2.2a

Summary of Relative Performance of Laboratories for PAHs in Ampules

Lab Code	Average* Performance (%)	Number of Studies	Comment
U078	9.4	1	A
U072	9.7	2	A
U009	18.0	1	A
U077	22.1	1	A
U005	22.2	1	A
U079	24.0	2	A
U085	29.0	1	B
U063	34.5	2	B
U001	41.9	2	B
U093	43.0	1	B

Note: * Average Performance (%) is mean value for the average of % biased and % flagged obtained from QM-2 and QM-10.

TABLE 4.2.2b

Summary of Relative Performance of Laboratories for PAHs in Waters

Lab Code	Average of % biased and % flagged (%)	Number of Studies	Comment
U063	8.0	1	A
U077	24.2	1	A
U078	27.7	1	B
U001	31.3	1	B
U072	36.7	1	B
U079	40.3	1	B
U093	42.9	1	B
U075	55.7	1	C

NOTE FOR FIGURES

Parameter No.	Parameter
1	naphthalene
2	acenaphthylene
3	acenaphthene
4	fluorene
5	phenanthrene
6	anthracene
7	fluoranthene
8	pyrene
9	benzo(a)anthracene
10	chrysene
11	benzo(b)fluoranthene
12	benzo(k)fluoranthene
13	benzo(a)pyrene
14	indeno(1,2,3-Cd)-pyrene
15	dibenzo(a,h)-anthracene
16	benzo(g,h,i)-perylene

Fig. 4.1.1 Percent Recovery for PAHs

(Identical Samples)

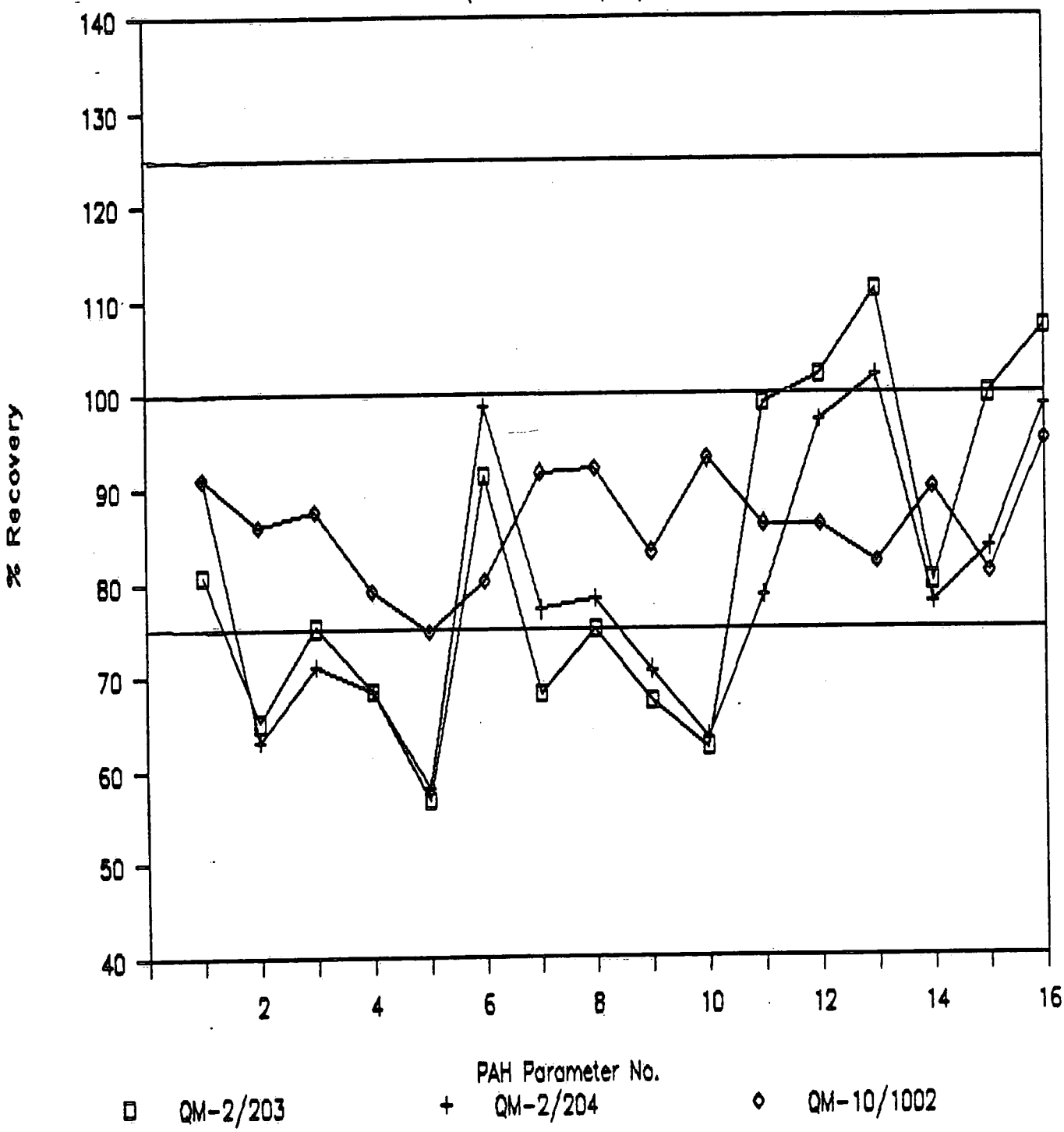


Fig. 4.1.2 Avg. Recovery (%) for PAHs

(Variuos Studies)

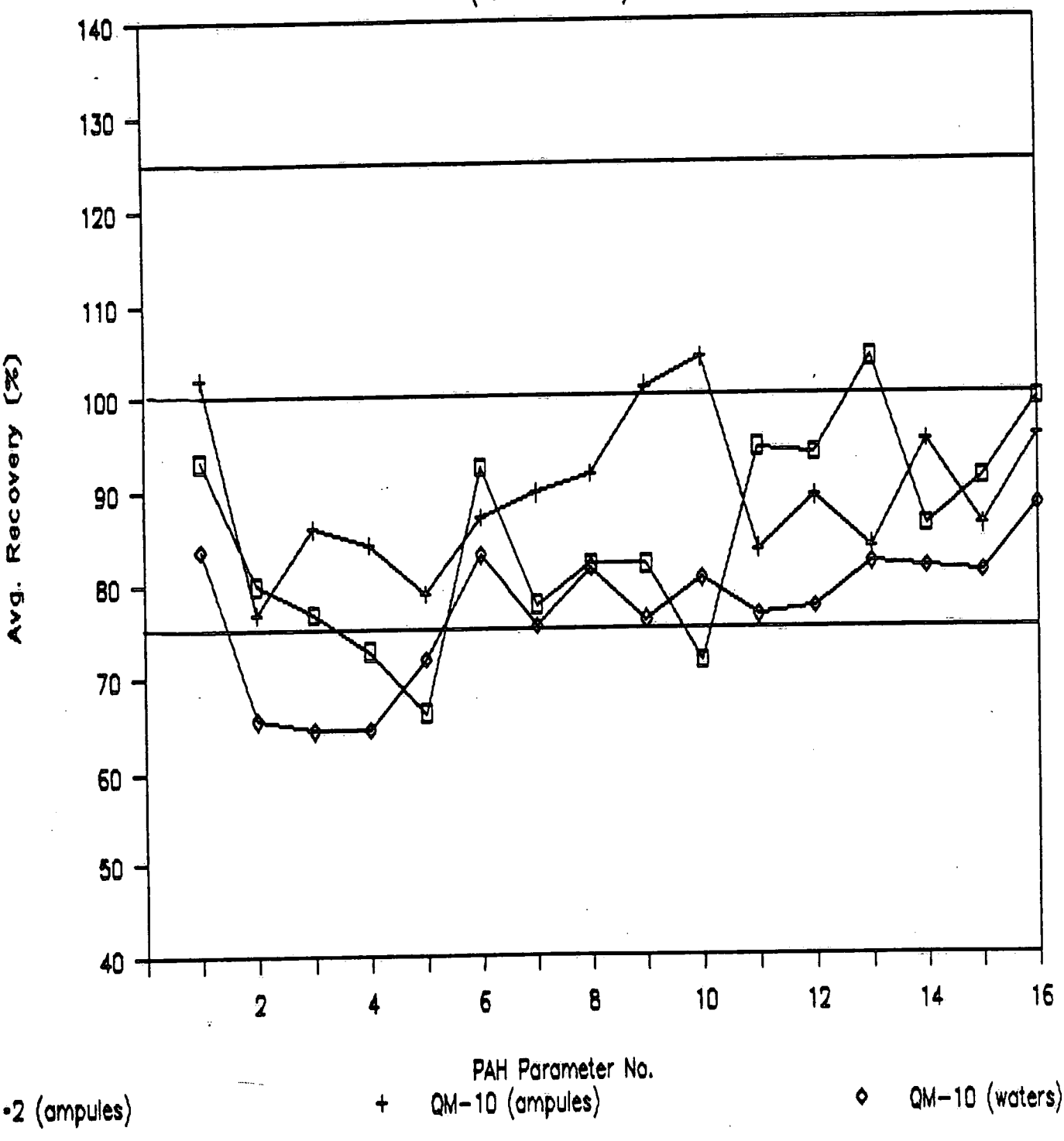
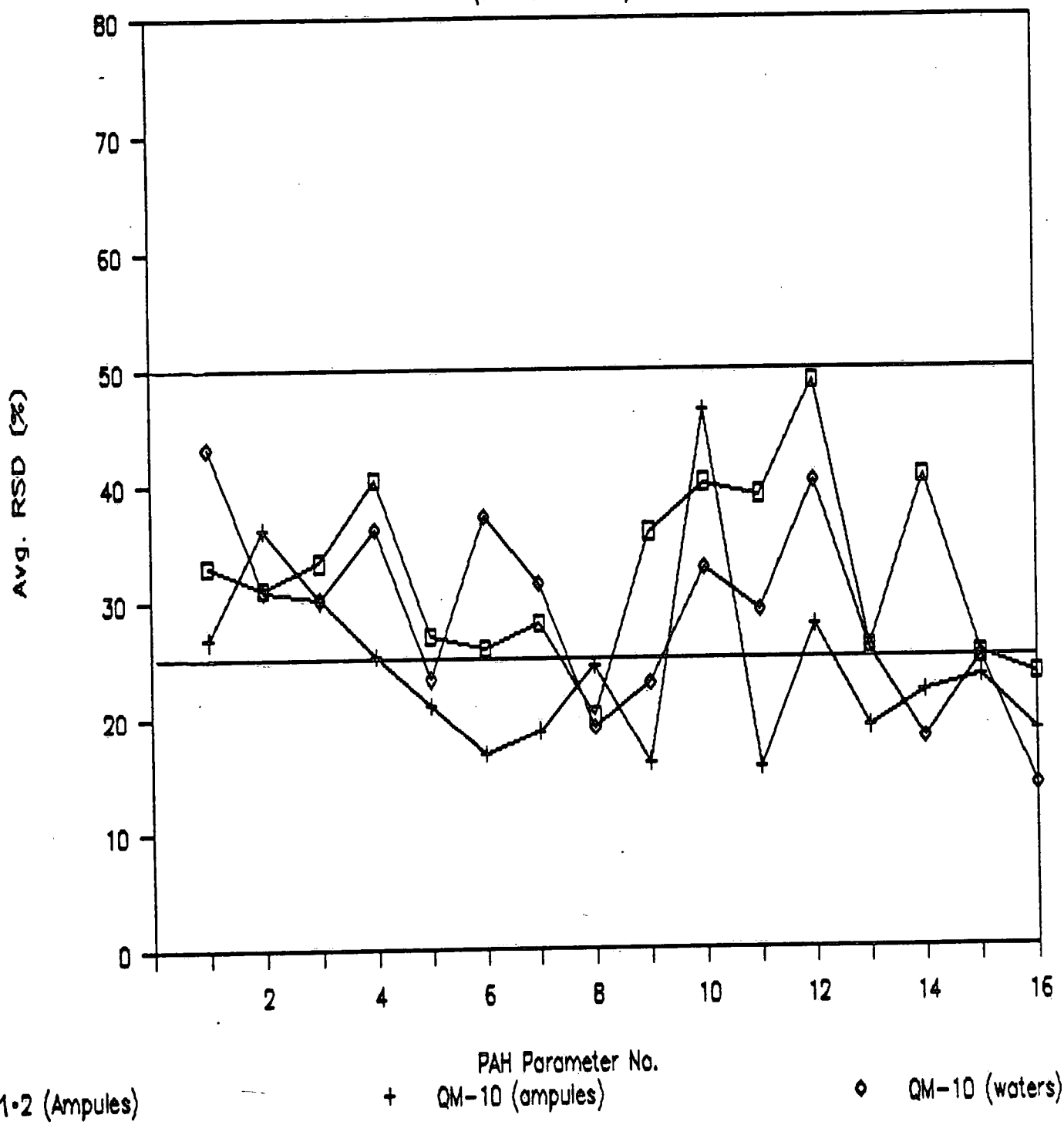


Fig. 4.1.3 Avg. RSD (%) for PAHs

(Variuos Studies)



APPENDIX I-A

DATA QUALITY MANAGEMENT WORK GROUP

United States

James H. Adams,Jr.
Quality Assurance Office
U.S. Environmental Protection Agency

Warren R. Faust
NOAA-Great Lakes Environmental Research Laboratory

George Jackson
Environmental Services Division
Michigan Department of Natural Resources

James J. Lichtenberg
Environmental Monitoring and Support Lab
U.S. Environmental Protection Agency

Michael Mullin
Large Lakes Research Station
U.S. Environmental Protection Agency

Godfrey Ross
Analytical Laboratory
Detroit Water and Sewerage Department

Canada

A.S.Y. Chau, Chairperson
National Water Research Institute
Environment Canada

Peter Fowlie
Wastewater Technology Centre
Environment Protection
Environment Canada

Donald King
Laboratory Services Branch
Ontario Ministry of Environment

CONSULTANTS

Jerry Zar
Biology Department
Northern Illinois University

Keijo I. Aspila
National Water Research Institute
Environment Canada

Abdel El'Shaarawi
National Water Research Institute
Environment Canada

APPENDIX I-B

UGLCCS - FINAL REPORTS

QM-#	TITLE OF FINAL REPORT	AUTHORS
1	PCBs, OCs and CHs in Ampules	W. Horn, R. Szaviola and H.B. Lee and the QMWG
2	PAHs in Ampules	W. Horn, R. Szaviola and H.B. Lee and the QMWG
3	Trace Metals In Sediments	W. Horn, R. Szaviola and H.B. Lee and the QMWG
4	Major Ions In Surface Water	W.A. Horn, R. Szaviola and D. Takeuchi and the QMWG
4	Revised: Major Ions In Surface Water	W.A. Horn, R. Szaviola, D. Takeuchi and P.D. Leishman and the QMWG
5	Trace Metals In Surface Waters	W.A. Horn, D. Takeuchi and R. Szaviola and the QMWG
6	Chlorinated Hydrocarbons In Sediments And Ampules	H.B. Lee, D. Takeuchi and E. Kokotich and the QMWG
7	Chlorinated Hydrocarbons And PCBs In Ampules And Water	R. Szaviola, W. Horn and H.B. Lee and the QMWG
8	Organochlorines In Ampules And Water	R. Szaviola, W. Horn, P. Leishman and H.B. Lee and the QMWG
9	Total Mercury In Surface Water	R. Szaviola, W. Horn and D. Takeuchi and the QMWG
10	PAHs in Ampules and Water	W.C. Li, H.B. Lee and W.A. Horn and the QMWG
11	Total Cyanide In Water	W.C. Li, H.B. Lee and E. Kokotich and the QMWG
12	Total Phenol In Water	W.C. Li, H.B. Lee and E. Kokotich and the QMWG
13	Chlorophenols In Ampules, Fish Oils and Tissues	W.C. Li, R. Szaviola and H.B. Lee and the QMWG

APPENDIX II

Lab-Specific Appraisal for Bias and Flag Statements

II-A: BIAS

LAB-SPECIFIC APPRAISAL FOR BIAS STATEMENTS
(PAHs)

Lab Code: U001

Parameter	QM-2 (ampules)		QM-10 (ampules)		QM-10 (waters)	
	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias
naphthalene	152	VH	NA	-	NA	-
acenaphthylene	72.4	L	47.2	VL	73.3	L
acenaphthene	68.8	L	52.0	L	62.9	L
fluorene	62.0	L	60.0	L	67.7	L
phenanthrene	60.7	L	74.0	L	71.3	L
anthracene	120	S	NA	-	NA	-
fluoranthene	66.1	L	106	S	79.2	S
pyrene	68.3	L	116	S	80.7	S
benzo(a)anthracene	71.8	L	NA	-	NA	-
chrysene	52.4	L	NA	-	NA	-
benzo(b)fluoranthene	55.5	L	NA	-	NA	-
benzo(k)fluoranthene	58.8	L	NA	-	NA	-
benzo(a)pyrene	48.8	VL	NA	-	NA	-
indeno(1,2,3-cd)pyrene	78.3	S	NA	-	NA	-
dibenzo(a,h)anthracene	100	S	NA	-	NA	-
benzo(g,h,i)perylene	73.3	L	NA	-	NA	-

LAB-SPECIFIC APPRAISAL FOR BIAS STATEMENTS
(PAHs)

Lab Code: U005

Parameter	QM-2 (ampules)		QM-10 (ampules)		QM-10 (waters)	
	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias
naphthalene	85.7	S				
acenaphthylene	72.2	L				
acenaphthene	67.9	L				
fluorene	66.1	L				
phenanthrene	74.2	L				
anthracene	69.5	L				
fluoranthene	81.4	S				
pyrene	90.0	S				
benzo(a)anthracene	NS	-				
chrysene	NS	-				
benzo(b)fluoranthene	NS	-				
benzo(k)fluoranthene	NS	-				
benzo(a)pyrene	124	S				
indeno(1,2,3-cd)pyrene	83.3	S				
dibenzo(a,h)anthracene	79.5	S				
benzo(g,h,i)perylene	91.7	S				

LAB-SPECIFIC APPRAISAL FOR BIAS STATEMENTS
(PAHs)

Lab Code: U009

Parameter	QM-2 (ampules)		QM-10 (ampules)		QM-10 (waters)	
	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias
naphthalene	83.7	S				
acenaphthylene	74.3	L				
acenaphthene	79.5	S				
fluorene	74.5	L				
phenanthrene	59.6	L				
anthracene	94.0	S				
fluoranthene	93.2	S				
pyrene	81.4	S				
benzo(a)anthracene	92.1	S				
chrysene	64.8	L				
benzo(b)fluoranthene	89.8	S				
benzo(k)fluoranthene	78.9	S				
benzo(a)pyrene	110	S				
indeno(1,2,3-cd)pyrene	67.5	L				
dibenzo(a,h)anthracene	70.6	L				
benzo(g,h,i)perylene	82.5	S				

LAB-SPECIFIC APPRAISAL FOR BIAS STATEMENTS
(PAHs)

Lab Code: U014

Parameter	QM-2 (ampules)		QM-10 (ampules)		QM-10 (waters)	
	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias
naphthalene			NA	-	ND	-
acenaphthylene			NA	-	ND	-
acenaphthene			NA	-	ND	-
fluorene			NA	-	ND	-
phenanthrene			NA	-	ND	-
anthracene			NA	-	ND	-
fluoranthene			NA	-	ND	-
pyrene			NA	-	ND	-
benzo(a)anthracene			NA	-	ND	-
chrysene			NA	-	ND	-
benzo(b)fluoranthene			NA	-	ND	-
benzo(k)fluoranthene			NA	-	ND	-
benzo(a)pyrene			NA	-	ND	-
indeno(1,2,3-cd)pyrene			NA	-	ND	-
dibenzo(a,h)anthracene			NA	-	ND	-
benzo(g,h,i)perylene			NA	-	ND	-

LAB-SPECIFIC APPRAISAL FOR BIAS STATEMENTS
(PAHs)

Lab Code: U063

Parameter	QM-2 (ampules)		QM-10 (ampules)		QM-10 (waters)	
	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias
naphthalene	161	VH	133	H	82.3	S
acenaphthylene	162	VH	104	S	79.2	S
acenaphthene	139	H	106	S	84.5	S
fluorene	121	S	100	S	77.2	S
phenanthrene	115	S	104	S	82.1	S
anthracene	295	VH	101	S	83.0	S
fluoranthene	114	S	101	S	84.2	S
pyrene	102	S	102	S	85.4	S
benzo(a)anthracene	96.6	S	101	S	81.1	S
chrysene	99.7	S	101	S	88.9	S
benzo(b)fluoranthene	401	VH	NS	-	NS	-
benzo(k)fluoranthene	NA	-	NS	-	NS	-
benzo(a)pyrene	228	VH	110	S	82.6	S
indeno(1,2,3-cd)pyrene	200	VH	120	S	67.8	L
dibenzo(a,h)anthracene	141	H	126	H	67.3	L
benzo(g,h,i)perylene	213	VH	126	H	77.1	S

LAB-SPECIFIC APPRAISAL FOR BIAS STATEMENTS
(PAHs)

Lab Code: U072

Parameter	QM-2 (ampules)		QM-10 (ampules)		QM-10 (waters)	
	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias
naphthalene	NA	-	NA	-	NA	-
acenaphthylene	420	VH	NA	-	NA	-
acenaphthene	NS	-	NS	-	NS	-
fluorene	NS	-	NS	-	NS	-
phenanthrene	90.0	S	78.8	S	72.9	L
anthracene	90.6	S	80.9	S	52.6	L
fluoranthene	93.0	S	72.9	L	51.4	L
pyrene	94.0	S	76.1	S	75.7	S
benzo(a)anthracene	NS	-	NS	-	NS	-
chrysene	NS	-	NS	-	NS	-
benzo(b)fluoranthene	108	S	83.4	S	62.7	L
benzo(k)fluoranthene	113	S	84.2	S	57.0	L
benzo(a)pyrene	104	S	86.5	S	58.8	L
indeno(1,2,3-cd)pyrene	NS	-	101	S	79.0	S
dibenzo(a,h)anthracene	104	S	82.5	S	81.5	S
benzo(g,h,i)perylene	NS	-	95.1	S	82.8	S

LAB-SPECIFIC APPRAISAL FOR BIAS STATEMENTS
(PAHs)

Lab Code: U075

Parameter	QM-2 (ampules)		QM-10 (ampules)		QM-10 (waters)	
	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias
naphthalene			NA	-	94.7	S
acenaphthylene			NA	-	57.7	L
acenaphthene			NA	-	57.3	L
fluorene			NA	-	64.1	L
phenanthrene			NA	-	74.8	L
anthracene			NA	-	NA	-
fluoranthene			NA	-	68.8	L
pyrene			NA	-	67.7	L
benzo(a)anthracene			NA	-	40.9	VL
chrysene			NA	-	47.6	VL
benzo(b)fluoranthene			NA	-	ND	-
benzo(k)fluoranthene			NA	-	37.4	VL
benzo(a)pyrene			NA	-	ND	-
indeno(1,2,3-cd)pyrene			NA	-	ND	-
dibenzo(a,h)anthracene			NA	-	ND	-
benzo(g,h,i)perylene			NA	-	ND	-

LAB-SPECIFIC APPRAISAL FOR BIAS STATEMENTS
(PAHs)

Lab Code: U077

Parameter	QM-2 (ampules)		QM-10 (ampules)		QM-10 (waters)	
	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias
naphthalene			101	S	73.3	L
acenaphthylene			59.9	L	64.6	L
acenaphthene			62.9	L	67.6	L
fluorene			69.7	L	69.4	L
phenanthrene			88.8	S	76.4	S
anthracene			84.6	S	NA	-
fluoranthene			110	S	71.8	L
pyrene			108	S	105	S
benzo(a)anthracene			112	S	97.3	S
chrysene			127	H	117	S
benzo(b)fluoranthene			122	S	88.9	S
benzo(k)fluoranthene			150	VH	114	S
benzo(a)pyrene			131	H	80.5	S
indeno(1,2,3-cd)pyrene			120	S	ND	-
dibenzo(a,h)anthracene			105	S	ND	-
benzo(g,h,i)perylene			111	S	ND	-

LAB-SPECIFIC APPRAISAL FOR BIAS STATEMENTS
(PAHs)

Lab Code: U078

Parameter	QM-2 (ampules)		QM-10 (ampules)		QM-10 (waters)	
	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias
naphthalene			89.8	S	168	VH
acenaphthylene			121	S	157	VH
acenaphthene			95.4	S	126	H
fluorene			100	S	117	S
phenanthrene			37.0	VL	42.0	VL
anthracene			96.9	S	111	S
fluoranthene			90.5	S	75.6	S
pyrene			93.9	S	99.1	S
benzo(a)anthracene			87.5	S	76.0	S
chrysene			117	S	98.2	S
benzo(b)fluoranthene			92.3	S	104	S
benzo(k)fluoranthene			85.3	S	90.3	S
benzo(a)pyrene			56.4	L	40.6	VL
indeno(1,2,3-cd)pyrene			94.7	S	87.1	S
dibenzo(a,h)anthracene			84.3	S	85.0	S
benzo(g,h,i)perylene			93.3	S	90.7	S

LAB-SPECIFIC APPRAISAL FOR BIAS STATEMENTS
(PAHs)

Lab Code: U079

Parameter	QM-2 (ampules)		QM-10 (ampules)		QM-10 (waters)	
	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias
naphthalene	115	S	155	VH	27.8	VL
acenaphthylene	53.6	L	88.8	S	27.7	VL
acenaphthene	54.9	L	114	S	35.3	VL
fluorene	110	S	107	S	39.8	VL
phenanthrene	54.2	L	85.1	S	64.9	L
anthracene	83.7	S	75.3	L	NA	-
fluoranthene	58.9	L	89.6	S	57.0	L
pyrene	75.7	S	88.0	S	61.4	L
benzo(a)anthracene	74.6	L	169	VH	69.0	L
chrysene	85.2	S	138	H	70.5	L
benzo(b)fluoranthene	86.7	S	72.6	L	88.1	S
benzo(k)fluoranthene	194	VH	103	S	79.1	S
benzo(a)pyrene	88.6	S	81.9	S	85.9	S
indeno(1,2,3-cd)pyrene	95.4	S	121	S	89.7	S
dibenzo(a,h)anthracene	88.5	S	94.5	S	83.7	S
benzo(g,h,i)perylene	108	S	91.4	S	96.5	S

LAB-SPECIFIC APPRAISAL FOR BIAS STATEMENTS
(PAHs)

Lab Code: U085

Parameter	QM-2 (ampules)		QM-10 (ampules)		QM-10 (waters)	
	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias
naphthalene	72.3	L				
acenaphthylene	76.7	S				
acenaphthene	106	S				
fluorene	37.4	VL				
phenanthrene	59.1	L				
anthracene	86.3	S				
fluoranthene	65.3	L				
pyrene	76.6	S				
benzo(a)anthracene	60.2	L				
chrysene	52.4	L				
benzo(b)fluoranthene	94.2	S				
benzo(k)fluoranthene	86.0	S				
benzo(a)pyrene	79.2	S				
indeno(1,2,3-cd)pyrene	93.9	S				
dibenzo(a,h)anthracene	86.0	S				
benzo(g,h,i)perylene	92.4	S				

LAB-SPECIFIC APPRAISAL FOR BIAS STATEMENTS
(PAHs)

Lab Code: U093

Parameter	QM-2 (ampules)		QM-10 (ampules)		QM-10 (waters)	
	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias	Avg. Rec. (%)	Bias
naphthalene			87.2	S	89.4	S
acenaphthylene			65.8	L	58.3	L
acenaphthene			76.4	S	71.1	L
fluorene			67.1	L	57.3	L
phenanthrene			53.7	L	44.3	VL
anthracene			73.4	L	NA	-
fluoranthene			70.1	L	46.6	VL
pyrene			54.2	L	57.3	L
benzo(a)anthracene			78.6	S	71.2	L
chrysene			26.5	VL	61.2	L
benzo(b)fluoranthene			68.1	L	67.0	L
benzo(k)fluoranthene			62.6	L	87.1	S
benzo(a)pyrene			72.6	L	88.1	S
indeno(1,2,3-cd)pyrene			76.7	S	63.9	L
dibenzo(a,h)anthracene			47.5	VL	72.5	L
benzo(g,h,i)perylene			53.9	L	82.0	S

II-B: FLAGS

LAB-SPECIFIC APPRAISAL FOR FLAG STATEMENTS
(PAHs)

Lab Code: U001

Parameter	QM-2 (ampules)	QM-10 (ampules)	QM-10 (waters)
naphthalene	2 VH	NA	NA
acenaphthylene	2 VL	2 VL	2 L
acenaphthene	2 L	2 L	4 L
fluorene	2 VL	2 L	3 L
phenanthrene	2 VL	1 L	3 L
anthracene	-	NA	NA
fluoranthene	2 L	-	1 L
pyrene	2 L	-	1 L
benzo(a)anthracene	2 VL	NA	NA
chrysene	2 VL	NA	NA
benzo(b)fluoranthene	2 VL	NA	NA
benzo(k)fluoranthene	2 VL	NA	NA
benzo(a)pyrene	2 VL	NA	NA
indeno(1,2,3-cd)pyrene	2 VL	NA	NA
dibenzo(a,h)anthracene	-	NA	NA
benzo(g,h,i)perylene	2 L	NA	NA

LAB-SPECIFIC APPRAISAL FOR FLAG STATEMENTS
(PAHs)

Lab Code: U005

Parameter	QM-2 (ampules)	QM-10 (ampules)	QM-10 (waters)
naphthalene	-		
acenaphthylene	2 L		
acenaphthene	4 L		
fluorene	4 L		
phenanthrene	4 L		
anthracene	2 L		
fluoranthene	-		
pyrene	-		
benzo(a)anthracene	NS		
chrysene	NS		
benzo(b)fluoranthene	NS		
benzo(k)fluoranthene	NS		
benzo(a)pyrene	1 H		
indeno(1,2,3-cd)pyrene	-		
dibenzo(a,h)anthracene	1 L		
benzo(g,h,i)perylene	-		

LAB-SPECIFIC APPRAISAL FOR FLAG STATEMENTS
(PAHs)

Lab Code: U009

Parameter	QM-2 (ampules)	QM-10 (ampules)	QM-10 (waters)
naphthalene	-		
acenaphthylene	2 L		
acenaphthene	-		
fluorene	3 L		
phenanthrene	4 L		
anthracene	-		
fluoranthene	-		
pyrene	-		
benzo(a)anthracene	-		
chrysene	4 L		
benzo(b)fluoranthene	1 L		
benzo(k)fluoranthene	2 L		
benzo(a)pyrene	-		
indeno(1,2,3-cd)pyrene	3 L		
dibenzo(a,h)anthracene	3 L		
benzo(g,h,i)perylene	-		

LAB-SPECIFIC APPRAISAL FOR FLAG STATEMENTS
(PAHs)

Lab Code: U014

Parameter	QM-2 (ampules)	QM-10 (ampules)	QM-10 (waters)
naphthalene		NA	ND
acenaphthylene		NA	ND
acenaphthene		NA	ND
fluorene		NA	ND
phenanthrene		NA	ND
anthracene		NA	ND
fluoranthene		NA	ND
pyrene		NA	ND
benzo(a)anthracene		NA	ND
chrysene		NA	ND
benzo(b)fluoranthene		NA	ND
benzo(k)fluoranthene		NA	ND
benzo(a)pyrene		NA	ND
indeno(1,2,3-cd)pyrene		NA	ND
dibenzo(a,h)anthracene		NA	ND
benzo(g,h,i)perylene		NA	ND

LAB-SPECIFIC APPRAISAL FOR FLAG STATEMENTS
(PAHs)

Lab Code: U063

Parameter	QM-2 (ampules)	QM-10 (ampules)	QM-10 (waters)
naphthalene	3 VH	1 VH	-
acenaphthylene	1 VH;2 H	-	1 L
acenaphthene	1 VH;2 H	-	-
fluorene	1 VH;1 H	-	1 L
phenanthrene	-	-	-
anthracene	3 VH	-	-
fluoranthene	1 VH;1 H;1 L	-	-
pyrene	1 H;1 L	-	-
benzo(a)anthracene	1 H;1 L	-	-
chrysene	1 H;1 L	-	-
benzo(b)fluoranthene	4 VH	NS	NS
benzo(k)fluoranthene	NA	NS	NS
benzo(a)pyrene	3 VH;1 H	1 H	-
indeno(1,2,3-cd)pyrene	3 VH;1 H	1 VH	4 L
dibenzo(a,h)anthracene	3 VH	1 VH	3 L
benzo(g,h,i)perylene	3 VH;1 H	1 VH	1 L

LAB-SPECIFIC APPRAISAL FOR FLAG STATEMENTS
(PAHs)

Lab Code: U072

Parameter	QM-2 (ampules)	QM-10 (ampules)	QM-10 (waters)
naphthalene	NA	NA	NA
acenaphthylene	2 VH	NA	NA
acenaphthene	NS	NS	NS
fluorene	NS	NS	NS
phenanthrene	-	1 L	2 L
anthracene	-	1 L	1 L;2 VL
fluoranthene	-	2 L	1 L;2 VL
pyrene	-	1 L	1 L
benzo(a)anthracene	NS	NS	NS
chrysene	NS	NS	NS
benzo(b)fluoranthene	-	-	4 L
benzo(k)fluoranthene	1 H	1 L	1 L;2 VL
benzo(a)pyrene	-	-	1 L;2 VL
indeno(1,2,3-cd)pyrene	NS	-	2 L
dibenzo(a,h)anthracene	-	-	1 L;1 VL
benzo(g,h,i)perylene	NS	-	1 L

LAB-SPECIFIC APPRAISAL FOR FLAG STATEMENTS
(PAHs)

Lab Code: U075

Parameter	QM-2 (ampules)	QM-10 (ampules)	QM-10 (waters)
naphthalene		NA	1 L
acenaphthylene		NA	4 L
acenaphthene		NA	4 L
fluorene		NA	3 L
phenanthrene		NA	2 L
anthracene		NA	NA
fluoranthene		NA	3 L
pyrene		NA	3 L
benzo(a)anthracene		NA	4 L
chrysene		NA	2 L;2 VL
benzo(b)fluoranthene		NA	1 VL
benzo(k)fluoranthene		NA	2 VL
benzo(a)pyrene		NA	-
indeno(1,2,3-cd)pyrene		NA	-
dibenzo(a,h)anthracene		NA	-
benzo(g,h,i)perylene		NA	-

LAB-SPECIFIC APPRAISAL FOR FLAG STATEMENTS
(PAHs)

Lab Code: U077

Parameter	QM-2 (ampules)	QM-10 (ampules)	QM-10 (waters)
naphthalene		-	3 L
acenaphthylene		2 L	4 L
acenaphthene		2 L	3 L
fluorene		1 L	3 L
phenanthrene		-	3 L
anthracene		1 L	NA
fluoranthene		1 H	3 L
pyrene		-	1 H
benzo(a)anthracene		-	-
chrysene		1 H	2 H
benzo(b)fluoranthene		1 H	-
benzo(k)fluoranthene		1 VH	-
benzo(a)pyrene		1 H	-
indeno(1,2,3-cd)pyrene		-	-
dibenzo(a,h)anthracene		-	-
benzo(g,h,i)perylene		-	-

LAB-SPECIFIC APPRAISAL FOR FLAG STATEMENTS
(PAHs)

Lab Code: U078

Parameter	QM-2 (ampules)	QM-10 (ampules)	QM-10 (waters)
naphthalene		-	3 VH;1 H
acenaphthylene		1 H	3 VH;1 H
acenaphthene		-	2 H
fluorene		-	-
phenanthrene		1 L;1 VL	2 L;2 VL
anthracene		-	1 H
fluoranthene		-	2 L
pyrene		-	-
benzo(a)anthracene		-	2 L
chrysene		-	-
benzo(b)fluoranthene		-	-
benzo(k)fluoranthene		-	-
benzo(a)pyrene		2 L	4 VL
indeno(1,2,3-cd)pyrene		-	-
dibenzo(a,h)anthracene		-	-
benzo(g,h,i)perylene		-	-

LAB-SPECIFIC APPRAISAL FOR FLAG STATEMENTS
(PAHs)

Lab Code: U079

Parameter	QM-2 (ampules)	QM-10 (ampules)	QM-10 (waters)
naphthalene	1 VH;1 H;1 L	1 VH;1 H	1 L;3 VL
acenaphthylene	2 L;2 VL	-	4 VL
acenaphthene	1 L;2 VL	-	1 L;2 VL
fluorene	1 H	-	2 L;2 VL
phenanthrene	2 L;2 VL	-	4 L
anthracene	2 L	1 L	NA
fluoranthene	2 L;1 VL	-	2 VL
pyrene	1 H;2 L;1 VL	-	1 L;1 VL
benzo(a)anthracene	2 L	1 VH	1 L;1 VL
chrysene	2 L	1 VH	2 L
benzo(b)fluoranthene	-	1 L	-
benzo(k)fluoranthene	2 VH	-	1 L
benzo(a)pyrene	-	-	-
indeno(1,2,3-cd)pyrene	-	1 VH	-
dibenzo(a,h)anthracene	1 L	-	1 L
benzo(g,h,i)perylene	1 H	-	-

LAB-SPECIFIC APPRAISAL FOR FLAG STATEMENTS
(PAHs)

Lab Code: U085

Parameter	QM-2 (ampules)	QM-10 (ampules)	QM-10 (waters)
naphthalene	1 VL		
acenaphthylene	2 L		
acenaphthene	1 H;1 L		
fluorene	4 VL		
phenanthrene	2 L;1 VL		
anthracene	-		
fluoranthene	1 L;1 VL		
pyrene	1 L;1 VL		
benzo(a)anthracene	1 L;2 VL		
chrysene	2 L;2 VL		
benzo(b)fluoranthene	-		
benzo(k)fluoranthene	-		
benzo(a)pyrene	1 L		
indeno(1,2,3-cd)pyrene	-		
dibenzo(a,h)anthracene	-		
benzo(g,h,i)perylene	-		

LAB-SPECIFIC APPRAISAL FOR FLAG STATEMENTS
(PAHs)

Lab Code: U093

Parameter	QM-2 (ampules)	QM-10 (ampules)	QM-10 (waters)
naphthalene		-	-
acenaphthylene		1 L	4 L
acenaphthene		1 L	3 L
fluorene		2 L	4 L
phenanthrene		2 L	1 L;3 VL
anthracene		1 L	NA
fluoranthene		1 L	1 L;2 VL
pyrene		1 L;1 VL	3 L;1 VL
benzo(a)anthracene		-	3 L
chrysene		2 VL	4 L
benzo(b)fluoranthene		2 L	3 L
benzo(k)fluoranthene		2 L	1 VH;1 L;1 VL
benzo(a)pyrene		1 L	-
indeno(1,2,3-cd)pyrene		1 L	3 L
dibenzo(a,h)anthracene		2 VL	3 L
benzo(g,h,i)perylene		2 L	2 L

APPENDIX III

Within-lab Precision

Within-lab Precision for PAHs
(Avg. RSD)

Lab Code: U001

Parameter	QM-2 (ampules)	QM-10 (waters)
	%	
naphthalene	0.0 (1)	NA
acenaphthylene	0.0 (2)	9.7 (2)
acenaphthene	0.0 (2)	8.8 (2)
fluorene	0.0 (2)	8.4 (2)
phenanthrene	0.0 (2)	7.2 (2)
anthracene	0.0 (1)	NA
fluoranthene	0.0 (2)	6.4 (2)
pyrene	0.0 (2)	7.6 (2)
benzo(a)anthracene	0.0 (2)	NA
chrysene	0.0 (2)	NA
benzo(b)fluoranthene	0.0 (2)	NA
benzo(k)fluoranthene	0.0 (2)	NA
benzo(a)pyrene	0.0 (2)	NA
indeno(1,2,3-cd)pyrene	0.0 (2)	NA
dibenzo(a,h)anthracene	0.0 (1)	NA
benzo(g,h,i)perylene	0.0 (2)	NA

Note: The numbers in parentheses are the number of duplicate pairs.

Within-lab Precision for PAHs
(Avg. RSD)

Lab Code: U005

Parameter	QM-2 (ampules)	QM-10 (waters)
	%	
naphthalene	1.3 (2)	
acenaphthylene	16.9 (2)	
acenaphthene	5.7 (2)	
fluorene	0.5 (2)	
phenanthrene	0.4 (2)	
anthracene	0.0 (1)	
fluoranthene	4.2 (2)	
pyrene	3.8 (2)	
benzo(a)anthracene	NS	
chrysene	NS	
benzo(b)fluoranthene	NS	
benzo(k)fluoranthene	NS	
benzo(a)pyrene	2.2 (1)	
indeno(1,2,3-cd)pyrene	1.9 (1)	
dibenzo(a,h)anthracene	15.1 (1)	
benzo(g,h,i)perylene	15.9 (1)	

Note: The numbers in parentheses are the number of duplicate pairs.

Within-lab Precision for PAHs
(Avg. RSD)

Lab Code: U009

Parameter	QM-2 (ampules)	QM-10 (waters)
	%	
naphthalene	2.3 (2)	
acenaphthylene	2.9 (2)	
acenaphthene	2.3 (2)	
fluorene	3.2 (2)	
phenanthrene	2.7 (2)	
anthracene	4.2 (2)	
fluoranthene	2.6 (2)	
pyrene	1.5 (2)	
benzo(a)anthracene	2.6 (2)	
chrysene	2.4 (2)	
benzo(b)fluoranthene	4.5 (2)	
benzo(k)fluoranthene	2.4 (2)	
benzo(a)pyrene	5.5 (2)	
indeno(1,2,3-cd)pyrene	1.8 (2)	
dibenzo(a,h)anthracene	1.6 (2)	
benzo(g,h,i)perylene	6.8 (2)	

Note: The numbers in parentheses are the number of duplicate pairs.

Within-lab Precision for PAHs
(Avg. RSD)

Lab Code: U014

Parameter	QM-2 (ampules)	QM-10 (waters)
	%	
naphthalene		ND
acenaphthylene		ND
acenaphthene		ND
fluorene		ND
phenanthrene		ND
anthracene		ND
fluoranthene		ND
pyrene		ND
benzo(a)anthracene		ND
chrysene		ND
benzo(b)fluoranthene		ND
benzo(k)fluoranthene		ND
benzo(a)pyrene		ND
indeno(1,2,3-cd)pyrene		ND
dibenzo(a,h)anthracene		ND
benzo(g,h,i)perylene		ND

Note: The numbers in parentheses are the number of duplicate pairs.

Within-lab Precision for PAHs
(Avg. RSD)

Lab Code: U063

Parameter	QM-2 (ampules)	QM-10 (waters)
	%	
naphthalene	16.0 (2)	4.6 (2)
acenaphthylene	24.8 (2)	6.7 (2)
acenaphthene	18.1 (2)	3.1 (2)
fluorene	21.5 (2)	4.5 (2)
phenanthrene	8.4 (2)	3.9 (2)
anthracene	4.8 (1)	3.5 (2)
fluoranthene	35.2 (2)	2.1 (2)
pyrene	29.2 (2)	0.0 (2)
benzo(a)anthracene	26.1 (2)	0.4 (2)
chrysene	22.3 (2)	3.4 (2)
benzo(b)fluoranthene	26.7 (2)	NS
benzo(k)fluoranthene	NA	NS
benzo(a)pyrene	28.3 (2)	4.0 (2)
indeno(1,2,3-cd)pyrene	22.4 (2)	1.9 (2)
dibenzo(a,h)anthracene	22.0 (2)	3.5 (2)
benzo(g,h,i)perylene	27.6 (2)	5.4 (2)

Note: The numbers in parentheses are the number of duplicate pairs.

Within-lab Precision for PAHs
(Avg. RSD)

Lab Code: U072

Parameter	QM-2 (ampules)	QM-10 (waters)
	%	
naphthalene	NA	NA
acenaphthylene	0.0 (1)	NA
acenaphthene	NS	NS
fluorene	NS	NS
phenanthrene	2.8 (2)	12.3 (2)
anthracene	0.9 (2)	7.8 (2)
fluoranthene	3.1 (2)	15.0 (2)
pyrene	1.6 (2)	16.6 (1)
benzo(a)anthracene	NS	NS
chrysene	NS	NS
benzo(b)fluoranthene	1.3 (2)	15.2 (2)
benzo(k)fluoranthene	4.2 (2)	15.8 (2)
benzo(a)pyrene	5.4 (2)	9.3 (2)
indeno(1,2,3-cd)pyrene	NS	9.4 (2)
dibenzo(a,h)anthracene	3.4 (2)	13.7 (2)
benzo(g,h,i)perylene	NS	9.7 (2)

Note: The numbers in parentheses are the number of duplicate pairs.

Within-lab Precision for PAHs
(Avg. RSD)

Lab Code: U075

Parameter	QM-2 (ampules)	QM-10 (waters)
	%	
naphthalene		39.7 (2)
acenaphthylene		0.0 (2)
acenaphthene		5.5 (2)
fluorene		17.7 (2)
phenanthrene		0.0 (2)
anthracene		NA
fluoranthene		8.7 (2)
pyrene		5.7 (2)
benzo(a)anthracene		7.9 (2)
chrysene		0.0 (2)
benzo(b)fluoranthene		ND
benzo(k)fluoranthene		0.0 (1)
benzo(a)pyrene		ND
indeno(1,2,3-cd)pyrene		ND
dibenzo(a,h)anthracene		ND
benzo(g,h,i)perylene		ND

Note: The numbers in parentheses are the number of duplicate pairs.

Within-lab Precision for PAHs
(Avg. RSD)

Lab Code: U077

Parameter	QM-2 (ampules)	QM-10 (waters)
	%	
naphthalene		14.9 (2)
acenaphthylene		7.8 (2)
acenaphthene		22.5 (2)
fluorene		14.7 (2)
phenanthrene		14.1 (2)
anthracene		NA
fluoranthene		17.1 (2)
pyrene		8.4 (2)
benzo(a)anthracene		15.8 (2)
chrysene		6.0 (2)
benzo(b)fluoranthene		ND
benzo(k)fluoranthene		2.5 (1)
benzo(a)pyrene		ND
indeno(1,2,3-cd)pyrene		ND
dibenzo(a,h)anthracene		ND
benzo(g,h,i)perylene		ND

Note: The numbers in parentheses are the number of duplicate pairs.

Within-lab Precision for PAHs
(Avg. RSD)

Lab Code: U078

Parameter	QM-2 (ampules)	QM-10 (waters)
	%	
naphthalene NA		7.9 (2)
acenaphthylene		12.2 (2)
acenaphthene		12.8 (2)
fluorene		5.8 (2)
phenanthrene		2.6 (2)
anthracene		11.9 (2)
fluoranthene		4.5 (2)
pyrene		3.1 (2)
benzo(a)anthracene		4.5 (2)
chrysene		3.2 (2)
benzo(b)fluoranthene		2.7 (2)
benzo(k)fluoranthene		3.9 (2)
benzo(a)pyrene		3.0 (2)
indeno(1,2,3-cd)pyrene		4.0 (2)
dibenzo(a,h)anthracene		3.5 (2)
benzo(g,h,i)perylene		7.5 (2)

Note: The numbers in parentheses are the number of duplicate pairs.

Within-lab Precision for PAHs
(Avg. RSD)

Lab Code: U079

Parameter	QM-2 (ampules)	QM-10 (waters)
	%	
naphthalene	45.5 (2)	58.2 (2)
acenaphthylene	30.5 (2)	70.6 (2)
acenaphthene	51.2 (2)	69.8 (1)
fluorene	44.6 (1)	53.6 (2)
phenanthrene	1.3 (2)	12.5 (2)
anthracene	28.1 (2)	NA
fluoranthene	22.2 (2)	95.6 (2)
pyrene	46.9 (2)	77.5 (2)
benzo(a)anthracene	7.7 (2)	17.3 (2)
chrysene	18.4 (2)	19.2 (2)
benzo(b)fluoranthene	11.4 (2)	8.1 (2)
benzo(k)fluoranthene	11.4 (2)	6.2 (2)
benzo(a)pyrene	8.6 (2)	6.0 (2)
indeno(1,2,3-cd)pyrene	6.5 (2)	3.6 (2)
dibenzo(a,h)anthracene	22.7 (2)	7.7 (2)
benzo(g,h,i)perylene	8.3 (2)	1.5 (2)

Note: The numbers in parentheses are the number of duplicate pairs.

Within-lab Precision for PAHs
(Avg. RSD)

Lab Code: U085

Parameter	QM-2 (ampules)	QM-10 (waters)
	%	
naphthalene	20.6 (2)	
acenaphthylene	7.2 (2)	
acenaphthene	21.2 (2)	
fluorene	0.6 (2)	
phenanthrene	13.7 (2)	
anthracene	2.0 (1)	
fluoranthene	14.9 (2)	
pyrene	22.1 (2)	
benzo(a)anthracene	29.3 (2)	
chrysene	11.0 (2)	
benzo(b)fluoranthene	4.0 (1)	
benzo(k)fluoranthene	12.3 (1)	
benzo(a)pyrene	8.5 (1)	
indeno(1,2,3-cd)pyrene	2.6 (1)	
dibenzo(a,h)anthracene	9.9 (1)	
benzo(g,h,i)perylene	8.9 (1)	

Note: The numbers in parentheses are the number of duplicate pairs.

Within-lab Precision for PAHs
(Avg. RSD)

Lab Code: U093

Parameter	QM-2 (ampules)	QM-10 (waters)
	%	
naphthalene		15.4 (2)
acenaphthylene		6.4 (2)
acenaphthene		8.2 (2)
fluorene		4.4 (2)
phenanthrene		20.5 (2)
anthracene		NA
fluoranthene		17.3 (2)
pyrene		49.0 (2)
benzo(a)anthracene		12.6 (2)
chrysene		7.7 (2)
benzo(b)fluoranthene		10.6 (2)
benzo(k)fluoranthene		45.5 (2)
benzo(a)pyrene		3.5 (2)
indeno(1,2,3-cd)pyrene		7.8 (2)
dibenzo(a,h)anthracene		26.6 (2)
benzo(g,h,i)perylene		5.1 (2)

Note: The numbers in parentheses are the number of duplicate pairs.