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**Agenda item 5: Report on Training Course for Organic Contaminants (2019)**

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UNEP/MAP  
Athens, 2021

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**TRAINING COURSE  
ON THE ANALYSIS OF ORGANOCHLORINE PESTICIDES AND POLYCHLORINATED  
BIPHENYLS IN ENVIRONMENTAL SAMPLES**

Organized by:

**International Atomic Energy Agency-Environment Laboratories  
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2 - 13 September 2019

**IAEA-EL staff involved:**

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R. Cassi, Laboratory Technician  
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*Prepared in collaboration with:*





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TRAINING COURSE ON THE ANALYSIS  
OF ORGANOCHLORINE PESTICIDES  
AND POLYCHLORINATED BIPHENYLS  
IN ENVIRONMENTAL SAMPLES





## *1. Background*

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A training course on the analysis of Organochlorinated Pesticides (OCs) and Polychlorinated Biphenyls (PCBs) in marine environmental samples was organized in NAEL/MESL on behalf of the UN Environment Programme/Mediterranean Action Plan (UN Environment/MAP) - Programme for the Assessment and Control of Marine Pollution in the Mediterranean Sea (MEDPOL), referred to henceforth as MEDPOL, for participants from Mediterranean laboratories involved in the MEDPOL marine pollution monitoring program in the framework of the Land-based sources (LBS) Protocol of the Barcelona Convention.

A letter describing the course content was sent out beginning of May 2019 to all MEDPOL National Focal Points, inviting them to nominate candidates from their respective countries. MESL received 6 nominations of candidates for analysis of Organochlorinated Pesticides (OCs) and Polychlorinated Biphenyls (PCBs) in marine environmental samples. The selection of the six successful candidates was done jointly by MESL staff and the MEDPOL monitoring and assessment officer, by applying the following criteria:

- The nominated candidates must be staff members of the national laboratories that will be designated for participation in 2019 Proficiency Tests.
- The nominated candidates have to be able to apply knowledge, to be built during 2019 Training Courses on organic contaminants, in their regular work related to sampling and assessment; use and maintenance of analytical equipment, selection of the appropriate reference materials, as well as quality assurance of monitoring data produced by their respective national laboratories participating in the MEDPOL IV/IMAP monitoring programme.
- The nominated candidates need to have sufficiently good English language proficiency as the courses will be held in English. Additionally information was requested in the nomination form on the i) education, ii) employment and employers relation to the MEDPOL programme, iii) English proficiency, iv) country distribution and v) overall merit of the nominees. Invitation letters were sent to the participants by IAEA/NAEL-MESL on 17 June 2019. The selected candidates were from Albania, Bosnia & Herzegovina, Croatia, Lebanon, Morocco and Tunisia. The course took place from 2<sup>nd</sup> to 13<sup>th</sup> September 2019.

The Training Course began with an introduction to the basic concepts and terminology on persistent organic contaminants analysis. Then the principles of sample preparation methodologies for sediments and biological materials were presented to the participants. Several lectures were dedicated to the high-resolution gas chromatography techniques used for organochlorinated and other organic contaminants in marine samples, and on quality assurance/quality control principles. The most important concepts of measurement science - metrology in chemistry -

validation of measurement procedure, use of reference materials, and uncertainty of measurement results, were also discussed.

During the practical session of the Training Course, the procedures of marine samples preparation and quantification of polychlorinated biphenyls and organochlorinated pesticides in sediments and biota, using gas chromatography coupled to the electron capture detector, was demonstrated. Two kinds of unknown samples were used for the laboratory demonstrations: sediment sample (IAEA 417) and biota sample (IAEA 432). To set a working pace that everyone could follow the entire laboratory procedures for both sediment and biota samples were prepared before the training course and the most important phases were highlighted. Intermediate steps and corresponding intermediate samples and solutions were prepared beforehand by the trainers. During the course the trainees were shown the entire procedures, but they focused their attention and performed only the most important phases under strict supervision and with the help of the trainers. This methodology, which avoids long waiting times, was welcomed by all trainees.

At the end of the course the identity of the samples was revealed, and results were compared with Reference Materials assigned values.

A sampling field trip was organized for the demonstration of marine sediment and water sampling techniques. During the sea-going field mission, the procedures for surface sediment (grab sampler), surface water and water profile sampling (Niskin bottle) were shown to the trainees, who could appreciate how samples are collected and handled following the strictest procedures ensuring the highest quality of samples.

Theoretical and practical sessions were also devoted to sample preparation, storage, transport and pre-treatment of the samples. Within the practical section, biological samples, as fish and mussels, were dissected by the participants and they were trained on the precautions to be taken during the removal of soft tissue from the organisms to avoid contamination from dissection tools, reagents, laboratory environment and the person carrying out the procedure.

During both, theoretical lectures and practical exercises in the laboratory, analytical methodologies, instrument optimization, quality assurance and quality control and quantitative calculations were discussed in detail. The details on the practical part of the course are given in the Practical Session section.

Trainees were provided with a certificate stating their participation in the training course. They were supplied with online links to shared folders containing methodologies, useful literature and the computer exercises they finalized during the course (<https://share.iaea.org/pub/index.php/s/iOYQx49Q8J386db> - password: monaco)

The program of the course, trainees' evaluations and examples of data produced are included in this report.

## *2. Evaluation*

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The experience of participants of the 2019 MEDPOL training course on the analysis of Organochlorinated Pesticides (OCs) and Polychlorinated Biphenyls (PCBs) in marine environmental samples in the field of organic contaminant analysis varied greatly within the group of participants, and not all of them were directly involved in sediments and biota matrices or this type of contaminant analyses in their institutions. This year, almost all participants showed the required minimum level of English to follow the entire training course without the need of translating constantly into French or other languages. This has been a big improvement from other years' experience. All participants showed a lot of interest in the laboratory part and had enough laboratory knowledge to understand the different steps of the analytical procedures, including the importance for obtaining accurate results in the analysis of organochlorinated compounds and pesticides in environmental matrices (sediment and biota). All of them were interested in implementing the learned procedures in their home laboratories and were keen to find out different solutions to make it possible. Also, all laboratories' trainees provided results in the 2018 MEDPOL PT for chlorinated compounds, except Lebanon and Tunisia. Nevertheless, Lebanon participated in previous MEDPOL PTs (2015-2017) and Tunisia reported result for PAHs in 2018 MEDPOL PT.

A questionnaire was distributed to the trainees to receive feedback on the organization, content and structure of the training. Overall the course was, rated as excellent by 100% (6/6). 83% (5/6) of participants thought that the course met their needs and another 17% (1/6) considered that to some extent, so in general they felt they will be better able to do their job after attending this course (67% replied yes and 33% to some extent). Although the balance of lectures, group discussions and group exercises were found to be correct, most participants wished to have more practical time in the laboratory to apply the newly learned knowledge. The questionnaires can be found in pages 45-66.

### *3. Conclusion and Recommendations*

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The training course on the analysis of Organochlorinated Pesticides (OCs) and Polychlorinated Biphenyls (PCBs) in marine environmental samples was beneficial for all participating trainees. In the MESL, each participant had a chance to observe and apply validated analytical protocols with a strict quality assurance system in place, following the Eurachem guidelines\* and according to the ISO 17025\*\*. Most participants acknowledged that they will have to improve or modify their laboratory procedures to reach a quality of analysis required for the MEDPOL monitoring program.

Although most participants were familiar with concepts like internal standards, reference materials and quality assurance, they showed genuine interest and commitment to improve the quality of their work. More advanced participants took advantage of discussing specific problems with fellow trainees and MESL staff providing the training. This year, all laboratories trainees participating in the organic contaminants TC had sufficient English proficiency. In this respect, we consider that the nomination process of this year has improved significantly compared to the previous years where laboratories' trainees never provided data results for the PT MEDPOL exercises. It was followed by a selection process of trainees, which was done fully in line with the recommendations and conclusions of the Meeting of CorMon on Pollution Monitoring that was held from 1 to 2 April 2018 in Podgorica, Montenegro, including consultations of MED POL Monitoring and Assessment Officer with the MED POL Focal Points of respective Contracting Parties regarding their need to participate in Training Course; a stricter selection of participants representing the laboratories that are identified by their respective MED POL Focal Points as the competent national entities for IMAP implementation, and that thereby also participate in Proficiency Testing organized by MESL within the cooperation with MED POL; good English proficiency of the participants. Despite these clear criteria one participant of this course was from a laboratory that later on was declared not to be an IMAP laboratory. While MESL and the MEDPOL officer are doing their best to select participants complying with criteria accepted by the COP it is the responsibility of the national focal points to nominate the correct laboratories. Therefore, MEDPOL Focal Points should continue to make all possible efforts to ensure nominated participants of the TC are with adequate background and from laboratories actively participating in national marine environment monitoring programs within the implementation of IMAP/ MEDPOL IV. Similarly, additional efforts are needed to ensure the laboratories participating in TCs are those taking part in PTs in order to make the most of the training received. Focus should be on laboratory experience to benefit most from the capacity building efforts provided. MESL recommends that the list of national IMAP competent laboratories is regularly updated and shared with the MEDPOL Monitoring and Assessment Officer in order for MESL to undertake a simplified selection process that is fully in line with such updated list.

Several of the participants complained about the lack of funds for buying analytical standards, reference materials and maintaining the good performance of their equipment.

Based on the experience from this training course, expert missions to national designated laboratories participating in national marine environment monitoring programs for IMAP/MEDPOL IV are under preparation as to assist at laboratories with greatest needs to improve their QA/QC and data quality. Given the fact that some laboratories need to build up expertise and infrastructure to be able to provide good quality data especially for organic contaminants, this should include the identification of technical (e.g. acquisition of laboratory equipment, analytical standards, reference materials) and knowledge needs. These missions have been planned in close consultations of MED POL with MEDPOL Focal Points. They should also include direct participation of MED POL Focal Points in expert missions of MESL as to reinforce the importance and motivation.

MEDPOL Focal Points should follow up more closely with national laboratories participating in the implementation of the IMAP MEDPOL IV/monitoring program and experts participating in the TC organized for organic compounds, with a view of further supporting national efforts to implement the QA/QC measures, including results and related recommendations of the Proficiency Testing organized by MESL in close collaboration with MED POL, in order to warrant good quality of monitoring data reported to MEDPOL.

\*B. Magnusson and U. Örnemark (eds) Eurachem Guide : The Fitness for Purpose of Analytical Methods -A laboratory Guide to Method Validation and Related Topics (2<sup>nd</sup> ed. 2014).

\*\*INTERNATIONAL ORGANIZATION FOR STANDARDIZATION, ISO/IEC 17025:2017. General requirements for the competence of testing and calibration laboratories, Geneva, (2017).



#### *4. List of participants*

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**TRAINING WORKSHOP ON THE ANALYSIS OF ORGANOCHLORINE PESTICIDES AND POLYCHLORINATED BIPHENYLS IN ENVIRONMENTAL SAMPLES FOR MEDPOL**

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## *5. Course outline*

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# MEDPOL training course on the Analysis of Organochlorine Pesticides and Polychlorinated Biphenyls in Environmental Samples

IAEA – Environment Laboratories, Monaco  
2 – 13 September 2019



## COURSE OUTLINE

(Note: Owing to parallel scientific meetings at MEL, the chronology of lectures and practical sessions is liable to change)

### MONDAY 2 SEPTEMBER

9:00 – 12:00	<p>Welcome to IAEA Environment Laboratories Monaco.</p> <p>Housekeeping (Health and Safety).</p> <p>Introduction to the MEDPOL IMAP monitoring programme. Presentation of the Marine Environment Laboratories and their activities.</p> <p style="text-align: center;">Coffee/tea break</p> <p>Self-introduction of participants and their laboratory, and expectations from the training course.</p> <p>Group photos.</p> <p>Administrative matters.</p>	<p><i>Mr David Osborn DIR-NAEL</i></p> <p><i>Mr Hussein Ramadan Head - Engineering and Electronics Support (EES)</i></p> <p><i>Ms Sylvia Sander Laboratory Head-MESL</i></p> <p><i>All participants</i></p> <p><i>Ms Leslie Barilaro-Hamonic Team Assistant-MESL</i></p>
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**13:30 – 15:30** Visit of the other Marine Environment Laboratories

**13:30 – 14:15** Visit of the Radiometrics Laboratory (RML).

*Mr Paul Morris  
Acting Section Head-RML*

*Mr Peter Swarzenski  
Section Head-REL*

**14:15 – 15:00** Visit of the Radioecology Laboratory (REL).

*Ms Emilia Vasileva  
Research Scientist*

**15:30 – 16:00** Analytical Methods for Organic Contaminants. Introduction to computer sessions.

*Mr Roberto Cassi  
Laboratory Technician*

**TUESDAY 3 SEPTEMBER****9:00 – 17:00****PRACTICAL SESSION**

*Mr Roberto Cassi  
Mr David Huertas  
Laboratory Technicians*

Extraction of sediment and biological samples with microwave oven. Filtration of samples and blank. Activation of copper. Removal of sulfur from sediment samples and blank.

**THEORETICAL SESSION**

*Ms Imma Tolosa  
Research Scientist*

Sources, properties and fate of organochlorinated compounds (OCs). The past, the present, and the future. Analytical techniques for the determination of OCs. Extraction and clean-up methods.

**WEDNESDAY 4 SEPTEMBER****9:00 – 17:00****PRACTICAL SESSION**

*Mr Roberto Cassi  
Mr David Huertas  
Laboratory Technicians*

Sample concentration: rotatory evaporator, multi-evaporator and nitrogen stream. Solid Phase Extraction (SPE) column chromatography for sediment samples. Elution and concentration of all fractions obtained. Transfer of samples and calibrating standards in auto-injector vials. Spiking of internal standards for Gas Chromatography (GC). Instrumental Injection GC with Electron Capture Detector (ECD).

### THURSDAY 5 SEPTEMBER

09:00 – 12:30	<u>THEORETICAL SESSION</u>	<i>Mr Imma Tolosa Research Scientist</i>
	Quantitative determination of OCs by GC-ECD. Confirmation analyses. Quantitative determination of OCs by GC-MS. Quality assurance/quality control requirements.	
14:00 – 17:00	<u>PRACTICAL SESSION</u>	<i>Mr Roberto Cassi Mr David Huertas Laboratory Technicians</i>
	Determination of lipid content for biological samples. Sample clean-up using sulfuric acid.	

### FRIDAY 6 SEPTEMBER

9:00 – 13:00	<u>PRACTICAL SESSION</u>	<i>Mr Roberto Cassi Mr David Huertas Laboratory Technicians</i>
	Solid Phase Extraction (SPE) column chromatography for biological samples. Elution and concentration of the third fraction. Transfer of samples and calibrating standards in auto-injector vials. Spiking of GC internal standards. Instrumental Injection (GC-ECD).	
14:00 – 17:00	<u>PRACTICAL SESSION</u>	<i>Mr Roberto Cassi Mr David Huertas Laboratory Technicians</i>
	GC-ECD maintenance and troubleshooting. GC-MS confirmation analyses.	<i>Ms Imma Tolosa Research Scientist</i>

### MONDAY 9 SEPTEMBER

9:00 – 12:00	<u>THEORETICAL SESSION</u>	<i>Ms Imma Tolosa Research Scientist</i>
	High resolution gas chromatography (HPLC), theory and instrumentation. Set up of GC-MS for confirmation analyses of organochlorinated compounds.	

14:00 – 17:00

PRACTICAL SESSION

*Mr Roberto Cassi*  
*Mr David Huertas*  
*Laboratory Technicians*

Sampling principles and techniques.  
 Sample storage, transport and pre-treatment.  
 Sample preparation: dissection of biological samples  
 (fish, mussels, oysters).

### TUESDAY 10 SEPTEMBER

9:00 – 13:00

PRACTICAL SESSION

*Mr Roberto Cassi*  
*Mr David Huertas*  
*Laboratory Technicians*

Sampling field trip.  
 Demonstration of sediment and water sampling  
 techniques.  
 Sample storage.

14:00 – 17:00

THEORETICAL SESSION

*Ms Imma Tolosa*  
*Research Scientist*

The stationary phase. Capillary columns.  
 Sample introduction. Detectors. Temperature effects.

### WEDNESDAY 11 SEPTEMBER

9:00 – 12:00

THEORETICAL SESSION

*Ms Sarah Choyke*  
*Associate Chemist*

Quantifying Uncertainty.  
 Assessing Linear Calibration.

13:00 – 17:00

COMPUTER SESSION

*Mr Roberto Cassi*  
*Mr David Huertas*  
*Laboratory Technicians*

Introduction to GC-ECD data retreatment software.  
 Peak identification and integration.  
 Use of spreadsheet for data quantification.



### THURSDAY 12 SEPTEMBER

9:00 – 17:00

#### COMPUTER SESSION

*Mr Roberto Cassi  
Mr David Huertas  
Laboratory Technicians*

Data quantification of organochlorine compounds.  
Determination and use of limits of detection.  
Evaluation of organochlorinated results on sediment samples, QA/QC of data obtained.

#### THEORETICAL SESSION

Uncertainty estimation by the “Nordtest approach”.

*Ms Imma Tolosa  
Research Scientist  
Ms Sarah Choyke  
Associate Chemist*

### FRIDAY 13 SEPTEMBER

9:00 – 12:00

#### CLOSURE OF THE TRAINING COURSE

Presentations by trainees:

*All course participants*

- 1) Reflections on the training course,
  - Theoretical part,
  - Laboratory experiments
- 2) How will the newly gained knowledge be implemented in home laboratory:

Questionnaires.  
Closing remarks.  
Certificates.

*Mr David Osborn  
DIR-NAEL  
(or alternate)*

13:00 – 17:00 Visit of the Oceanographic Museum, Monaco.

*All course participants*



## *6. Theoretical session*

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Within the theoretical sessions, introductions to the basic concepts on terminology, sources, properties and behaviour of organochlorinated compounds in the environment were presented to the participants. Also detailed talks on the principles of sample preparation methodologies for sediments and biological materials for analyzing persistent organic pollutants (POPs) were provided in line with the practical sessions organized in the laboratory. Several lectures were dedicated to the high-resolution gas chromatography techniques, the electron capture detector (ECD) and mass spectrometry (GC-MS) used for organochlorinated and other organic contaminants in marine samples. In the framework of quality assurance/quality control principles, the key concepts of measurement science - metrology in chemistry - validation of measurement procedures, use of reference materials, and uncertainty of measurement results were also presented, discussed and further practiced with the computers.

A link (<https://share.iaea.org/pub/index.php/s/OYJwmnuEJvucPI3> - Password: monaco) was provided to the course participants including the training course laboratory manuals, the practical sessions on quantification data and additional keys guides for working with organic contaminants, gas chromatography techniques and quality assurance.



## *7. Practical session*

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Practical sessions were organized to show the most critical aspects in each step of the analytical procedure and the data analyses. They included and covered the following “hands-on” procedures:

#### Microwave oven extraction and surrogate standards spiking

Special focus was given to the spiking of surrogate standards to increase the accuracy of quantification of the target compounds using the internal standard method. Each trainee was able to repeat the critical step several times until they were confident with the spiking procedure.

#### Evaporation of solvent extract

Rotatory evaporator was demonstrated and applied by the trainees to concentrate the organic extracts of the samples. A multi-vaporator was also introduced to the trainees and careful evaporation under nitrogen gas was done to prepare the final extracts for gas chromatography analyses.

#### Sulphur clean-up in sediment extracts

Sulphur in the sediment extract must be eliminated to avoid interferences before quantification of the final extract, especially if done by gas chromatography coupled to electron capture detector (GC/ECD). The activated copper procedure was used for the removal of Sulphur. The full procedure including the careful activation of the copper, and the complete removal of acid and water was practiced, and critical steps pointed out to the trainees.

#### Separation techniques by solid-phase extraction (SPE)

The fractionation of the different organochlorine compounds was performed by pipetting the concentrated organic extract on the SPE column and eluting the column with sequential volumes of solvents of increasing polarity. Every trainee performed the fractionation of the extracts on individual SPE columns of Florisil and Silica adsorbent.

#### Measurement of lipid content and lipid cleanup in biota samples

The extractable organic matter of the biological samples, mainly consisting of lipids was observed and quantified gravimetrically using a microbalance, in order to calculate the aliquot of sample extract that can be cleaned-up by SPE adsorption chromatography

The extracts were subsequently separated into two aliquots: The first aliquot was treated with sulphuric acid, to destroy the interfering lipids before cleaning up the sample over a Florisil SPE. As some organochlorinated pesticides may degrade with acid, the second aliquot of the extract was cleaned up using an alternative procedure with a Silica SPE column before the Florisil SPE column.

### Preparation of calibration standards and sample vials for instrumental injection

The final purified samples were transferred to vials and appropriate GC-internal standards were carefully spiked by the trainees before the instrumental analyses. Preparation of the calibrating standards were also done. Special care was devoted to the use of the Pasteur pipettes and volumetric syringes.

### Quantitative determination by gas chromatography and electron capture detector (GC-ECD)

The gas chromatography data retreatment software was demonstrated for peak identification and integration. Calibration curves by internal calibration using the appropriate surrogate standards were shown and verified by the trainees. The concepts of method blank, recoveries and detection limits were implemented and tested by the trainees. An example of a typical computer session is shown in figures 1 to 7.

### Confirmation by GC-MS

The set-up of the monitoring program for quantification and confirmation of the organochlorinated compounds by GC/MS using the total scan and selected ion monitoring acquisition was explained within the acquisition program on the equipment.

### Quality control charts and estimation of uncertainties

Guidelines on how to plot the internal quality control charts were provided and the results of the calculated data were assessed by plotting them on the quality control charts of the laboratory (Fig. 8-11), following the Eurochem guidelines (Eurochem 2014). The estimation of the uncertainty of the measurements, which is a requirement of the ISO 17025 for accredited laboratories, was explained in detail during the lectures and practical examples of calculation using the Nordtest approach were performed.

Emphasis was also given to the major problem associated with the PCB results, which can be the lack of separation of several important congeners on the classical stationary phase commonly used in the GC determination of PCBs. Improvements to reduce the risk of erroneous data due to co-elution were shown to be achieved using two capillary columns with different polarities, length and internal diameter.

### Maintenance and troubleshooting of the GC-ECD

The high-resolution gas chromatography, theory and instrumentation, including the stationary phases, the sample injector, detectors and temperature effects were explained in detail during the lectures. A practical demonstration of the maintenance of the GC, including the change of the glass liner, O-ring, septum and gold ring was shown. Also, the procedure on how to cut the capillary columns and install them into the injector and detector was explained. All trainees had the opportunity to practice the cutting of the capillary columns with the appropriate tool and assess their correct cutting using magnifiers.

### Sampling, storage, transport and dissection of samples

As mentioned in the introduction of this report, trainees were also able to participate in a field sampling mission to understand and practice the good use of sampling techniques to obtain better environmental samples to analyze organochlorinated compounds (OCs) and pesticides, as well as PAHs. During the trip they have learned how to sample using different procedures, keep a good storage system and be able to transport safely and in good conditions samples to the laboratory. This is the first critical step in order to obtain better results in their analysis. In addition, also a dissection session was organized to show and let them practice collection of different parts of fish and mussels for the analysis of OCs, pesticides and PAHs. All trainees had the possibility to practice this dissection exercise with one fish and a mussel.



*8. Example of computer session and data  
produced including quality control charts*



**Figure 1.** Description of the calibration strategy and formulas used for quantitative calculations.**INTERNAL CALIBRATION**

This method is based on the use of a *surrogate* which is defined as a non-interfering compound added to a sample in known concentration to eliminate the need to measure the sample size in quantitative analysis and for correction of instrumental variation.

In this method, the surrogate is added to each sample. The ratio of the areas of the surrogate and analyte are then used to construct the calibration curve.

In a multiple point internal calibration each analysis contains the surrogate whose total amount is kept constant and the analyte of interest whose amount covers the range of concentrations expected.

A multiple points relative response factor (RRF) calibration curve is established for analytes of interest for each working batch. A RRF is determined, for each analyte, for each calibration level using the following equation:

$$RRF(X) = \frac{\text{Area}(X)}{\text{Area}(SU)} \times \frac{\text{Qty}(SU)}{\text{Qty}(X)}$$

Where:

Area (X) = the area of the analyte to be measured (target compound)

Area (SU) = the area of the specific surrogate

Qty (X) = the known quantity of the analyte in the calibration solution

Qty (SU) = the known quantity of the surrogate in the calibration solution

The relative response factors determined for each calibration level are averaged to produce a mean relative response factor (mRRF) for each analyte. The percent relative standard deviation (%RSD) for all response factors must be less than or equal to 15%, for each analyte.

$$\%RSD = \frac{\text{Standard deviation of the RRFs}}{\text{Average of the RRFs}} \times 100$$

**SAMPLES QUANTIFICATION**

Sample analyte concentrations are calculated based on the quantity and response of the surrogate.

The following equation gives the amount of analyte in the solution analysed.

$$Qty(X) = Qty(SU) \times \frac{\text{Area}(X)}{\text{Area}(SU)} \times \frac{1}{mRRF(X)}$$

Where:

Qty (X) = the unknown quantity of the analyte in the sample

Qty (SU) = the known quantity of the surrogate added to the sample

Area (X) = the area of the analyte

Area (SU) = the area of the surrogate

mRRF (X) = the average response factor of the analyte

Sample analyte concentrations are then calculated by dividing the amount found (Qty) by the grams of samples extracted

**Figure 2.** Example of quantitative calculation of relative response factors (RRF) for fractions 1, 2 and 3. At F1: HCB, PCB-28, PCB-52 and PCB-101 were calculated using PCB-29 SU. The others using PCB-198 SU.

## OCs - F1

	CALIBRATION CURVE-1				
	Conc. (pg/μl)	Volume (μl)	Qty Spiked (pg)	Area	RRF
<b>TCMX (GC-IS)</b>	1000	10	10000	16724	
HCB	10	100	1000	1730	2.97
<b>PCB-29 SU</b>	25	100	2500	1456	0.35
PCB-28	10	100	1000	743	1.28
PCB-52	10	100	1000	558	0.96
PCB-101	10	100	1000	797	1.37
ppDDE	10	100	1000	1345	1.14
PCB-118	10	100	1000	1000	0.85
PCB-153	10	100	1000	917	0.78
ppDDT	10	100	1000	938	0.79
PCB-138	10	100	1000	1124	0.95
PCB-180	10	100	1000	1307	1.11
<b>PCB-198 SU</b>	25	100	2500	2950	0.71

## OCs - F2

	CALIBRATION CURVE-1				
	Conc. (pg/μl)	Volume (μl)	Qty Spiked (pg)	Area	RRF
<b>TCMX (GC-IS)</b>	1000	10	10000	16965	
Lindane	10	100	1000	1523	1.53
<b>E-HCH - SU</b>	25	100	2500	2491	0.59
ppDDD	10	100	1000	1157	1.16

## OCs - F3

	CALIBRATION CURVE-1				
	Conc. (pg/μl)	Volume (μl)	Qty Spiked (pg)	Area	RRF
<b>TCMX (GC-IS)</b>	1000	10	10000	18251	
<b>Endosulfan LD40 - SU</b>	25	100	2500	3703	0.81
a-Endosulfan	10	100	1000	1454	0.98
Dieldrin	10	100	1000	1766	1.19
Endrin	10	100	1000	1343	0.91
b-Endosulfan	10	100	1000	1653	1.12



**Figure 3.** Average of relative response factors (RRFs) from the 3 calibration levels (10, 50 and 100 pg/ $\mu$ l) and percentage relative standard deviation (%RSD) for fractions 1, 2 and 3. At F1: HCB, PCB-28, PCB-52 and PCB-101 were calculated using PCB-29 SU. The others using PCB-198 SU.

Mean RRF	SD	%RSD	Compound	Mean RRF
2.6	0.32	12.3	HCB	2.6
0.4	0.01	4.1	PCB-29 SU	0.4
1.1	0.14	12.9	PCB-28	1.1
0.8	0.16	20.8	PCB-52	0.8
1.1	0.25	23.4	PCB-101	1.1
1.1	0.05	4.3	ppDDE	1.1
0.7	0.14	19.6	PCB-118	0.7
0.6	0.13	21.6	PCB-153	0.6
0.8	0.07	8.4	ppDDT	0.8
0.8	0.12	14.6	PCB-138	0.8
1.0	0.13	14.0	PCB-180	1.0
0.7	0.03	4.1	PCB-198 SU	0.7

Mean RRF	SD	%RSD	Compound	Mean RRF
1.5	0.07	4.5	Lindane	1.5
0.6	0.02	2.9	E-HCH - SU	0.6
1.0	0.13	12.6	ppDDD	1.0

Mean RRF	SD	%RSD	Compound	Mean RRF
0.8	0.02	2.6	Endosulfan LD40 - SU	0.8
0.9	0.06	7.0	a-Endosulfan	0.9
1.1	0.07	6.3	Dieldrin	1.1
0.8	0.11	13.8	Endrin	0.8
1.0	0.08	8.0	b-Endosulfan	1.0

**Figure 4.** Example of quantitative calculation of the procedural blank sample for fractions 1, 2 and 3.

	BLANK					SU % REC
	Conc. (pg/μl)	Vol. (μl)	Qty Spiked (pg)	Area	Qty Found (pg)	
<b>TCMX (GC-IS)</b>	1000	10	10000	10091		
HCB				168	333	
<b>PCB-29 SU</b>	100	100	10000	1942	5330	53
PCB-28				90	418	
PCB-52				101	668	
PCB-101				128	608	
ppDDE				198	297	
PCB-118				681	1622	
PCB-153				89	234	
ppDDT				156	329	
PCB-138				165	332	
PCB-180				82	142	
<b>PCB-198 SU</b>	100	100	10000	6077	8180	82

	BLANK					SU % REC
	Conc. (pg/μl)	Vol. (μl)	Qty Spiked (pg)	Area	Qty Found (pg)	
<b>TCMX (GC-IS)</b>	1000	10	10000	7620		
Lindane				23	46	
<b>E-HCH - SU</b>	100	100	10000	3392	7407	74
ppDDD				74	214	

	BLANK					SU % REC
	Conc. (pg/μl)	Vol. (μl)	Qty Spiked (pg)	Area	Qty Found (pg)	
<b>TCMX (GC-IS)</b>	1000	10	10000	7407		
<b>Endosulfan LD40 - SU</b>	100	100	10000	3990	6821	68
a-Endosulfan				40	109	
Dieldrin				44	100	
Endrin				52	168	
b-Endosulfan				35	85	

**Figure 5.** Example of quantitative calculation of a reference material sample (IAEA-417) for fractions 1, 2 and 3.

grams extracted 8.11								
SAMPLE-1 FRACTION 1								
	Conc. (pg/ $\mu$ l)	Vol. ( $\mu$ l)	Qty Spiked (pg)	Area	Qty Found (pg)	Blank- substr (pg)	Conc. (ng/g)	SU % REC
TCMX (GC-IS)	1000	10	10000	9727				
HCB				6095	8600	8268	1.02	
PCB-29 SU	100	100	10000	2724	7759			78
PCB-28				11547	38078	37660	4.64	
PCB-52				26269	124263	123595	15.24	
PCB-101				89030	301914	301306	37.15	
ppDDE				106779	174410	174113	21.47	
PCB-118				135480	350872	349249	43.06	
PCB-153				108475	311347	311113	38.36	
ppDDT				66709	209849	209520	25.83	
PCB-138				198725	435619	435287	53.67	
PCB-180				73023	136829	136687	16.85	
PCB-198 SU	100	100	10000	5590	7807			78
SAMPLE-1 FRACTION 2								
	Conc. (pg/ $\mu$ l)	Vol. ( $\mu$ l)	Qty Spiked (pg)	Area	Qty Found (pg)	Blank- substr (pg)	Conc. (ng/g)	SU % REC
TCMX (GC-IS)	1000	10	10000	8527				
Lindane				1026	1736	1689	0.21	
E-HCH - SU	100	100	10000	4070	7942			79
ppDDD				76500	185366	185152	22.83	
SAMPLE-1 FRACTION 3								
	Conc. (pg/ $\mu$ l)	Vol. ( $\mu$ l)	Qty Spiked (pg)	Area	Qty Found (pg)	Blank- substr (pg)	Conc. (ng/g)	SU % REC
TCMX (GC-IS)	1000	10	10000	6068				
Endosulfan LD40 - SU	100	100	10000	3332	6955			70
a-Endosulfan				690	2270	2270	0.28	
Dieldrin				3903	10538	10538	1.30	
Endrin				954	3655	3655	0.45	
b-Endosulfan				5383	15781	15781	1.95	

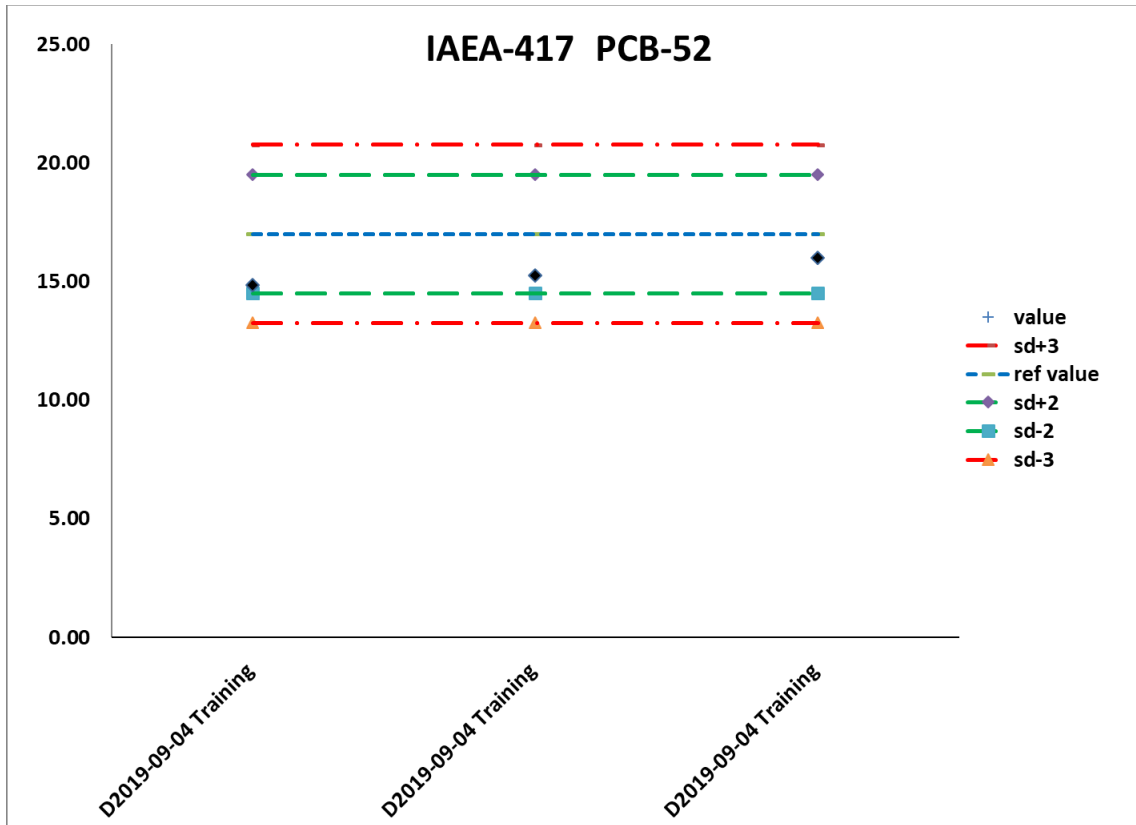
**Figure 6.** Table of quantitative calculation of a sediment reference material sample (IAEA-417) performed by the trainees. Results include mean, standard deviation and relative standard deviation (ng/g d.w.)

Compound	IAEA-417 Sample 1	IAEA-417 Sample 2	IAEA-417 Sample 3	Mean (ng/g)	Standard Deviation (ng/g)	Relative Standard Deviation (%)	Reference Value (ng/g)	Expanded Uncertainty (ng/g)
PCB-28	4.50	4.64	4.81	4.65	0.13	3%	5.70	1.00
PCB-52	14.85	15.24	15.98	15.36	0.47	3%	17.00	2.50
PCB-101	36.00	37.15	38.73	37.29	1.12	3%	42.00	4.90
PCB-118	39.16	43.06	42.65	41.62	1.75	4%	43.00	5.60
PCB-138	49.91	53.67	51.74	51.77	1.54	3%	45.00	6.60
PCB-153	36.20	38.36	37.57	37.38	0.89	2%	39.00	5.80
PCB-180	18.19	16.85	18.06	17.70	0.60	3%	16	2.2
HCB	0.97	1.02	1.03	1.01	0.03	3%	1.20	0.30
Lindane	0.20	0.21	0.22	0.21	0.01	4%	0.54	0.15
ppDDE	19.63	21.47	21.01	20.70	0.78	4%	14.00	1.90
ppDDD	22.86	22.83	28.68	24.79	2.75	11%	21.00	2.90
ppDDT	16.25	25.83	18.43	20.17	4.10	20%	19.00	3.20

**Figure 7.** Table of quantitative calculation of a biota reference material sample (IAEA-432) performed by the trainees. Results include mean, standard deviation and relative standard deviation (ng/g d.w.)

Compound	IAEA-432 Sample 1	IAEA-432 Sample 2	IAEA-432 Sample 3	Mean (ng/g)	Standard Deviation (ng/g)	Relative Standard Deviation (%)	Reference Value (ng/g)	Standard Deviation (ng/g)
PCB-28	0.20	0.29	0.21	0.23	0.04	17%	0.3	0.3
PCB-52	0.36	0.50	0.48	0.45	0.06	13%	1.2	1.2
PCB-101	1.40	1.45	1.46	1.44	0.03	2%	1.2	0.5
PCB-118	1.27	1.23	1.28	1.26	0.02	2%	1.1	0.4
PCB-138	2.69	2.59	2.61	2.63	0.04	2%	2.2	0.8
PCB-153	3.77	3.72	3.64	3.71	0.05	1%	2.8	1.0
PCB-180	0.15	0.17	0.20	0.17	0.02	11%	0.2	0.1
HCB	0.36	0.37	0.33	0.35	0.02	5%	0.2	0.1
Lindane	0.15	0.14	0.14	0.14	0.01	5%	0.58	0.54
ppDDE	2.89	3.12	3.03	3.01	0.10	3%	2.1	1.0
ppDDD	0.94	0.83	0.79	0.86	0.06	7%	0.88	0.49
ppDDT	0.39	0.74	0.36	0.50	0.17	34%	0.7	0.5

**Figure 8.** Quality control chart (QC) for PCB-52 in IAEA-417 sediment reference material (ng/g d.w).



**Figure 9.** Quality control chart (QC) for p,p'-DDD in IAEA-417 sediment reference material (ng/g d.w).

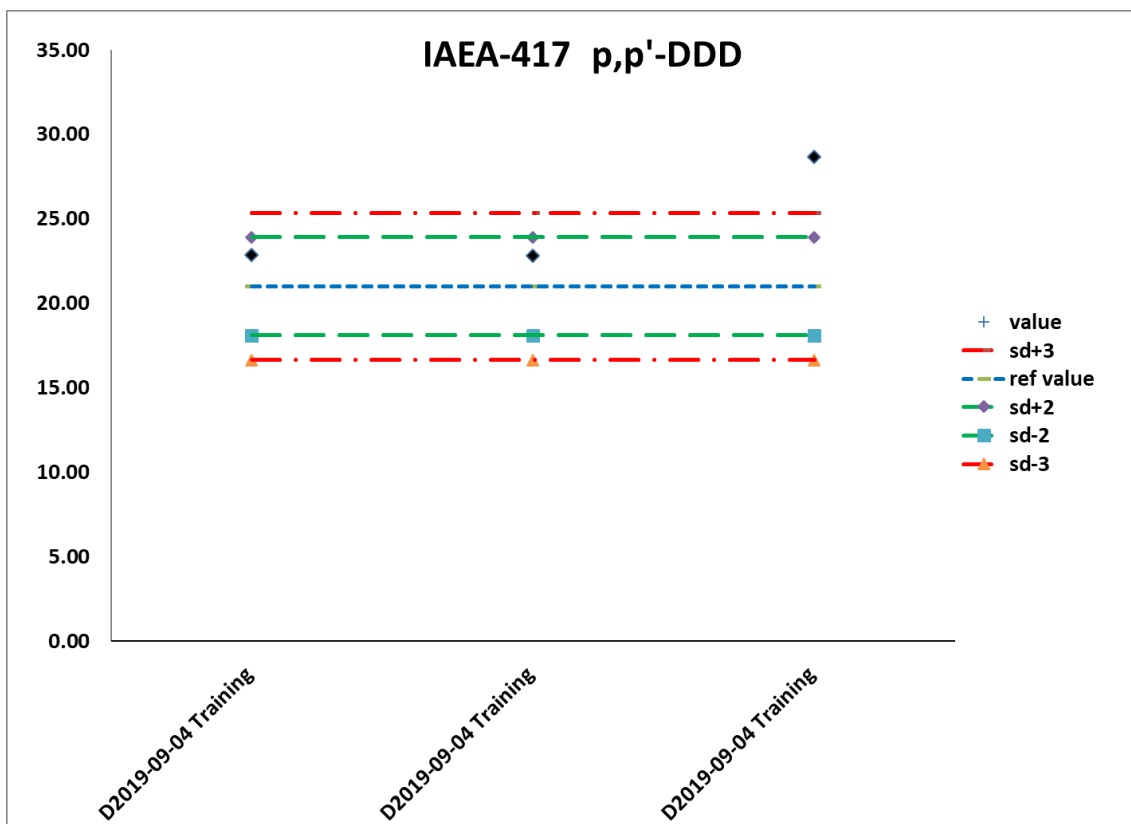


Figure 10. Quality control chart (QC) for PCB-101 in IAEA-432 biota reference material (ng/g d.w).

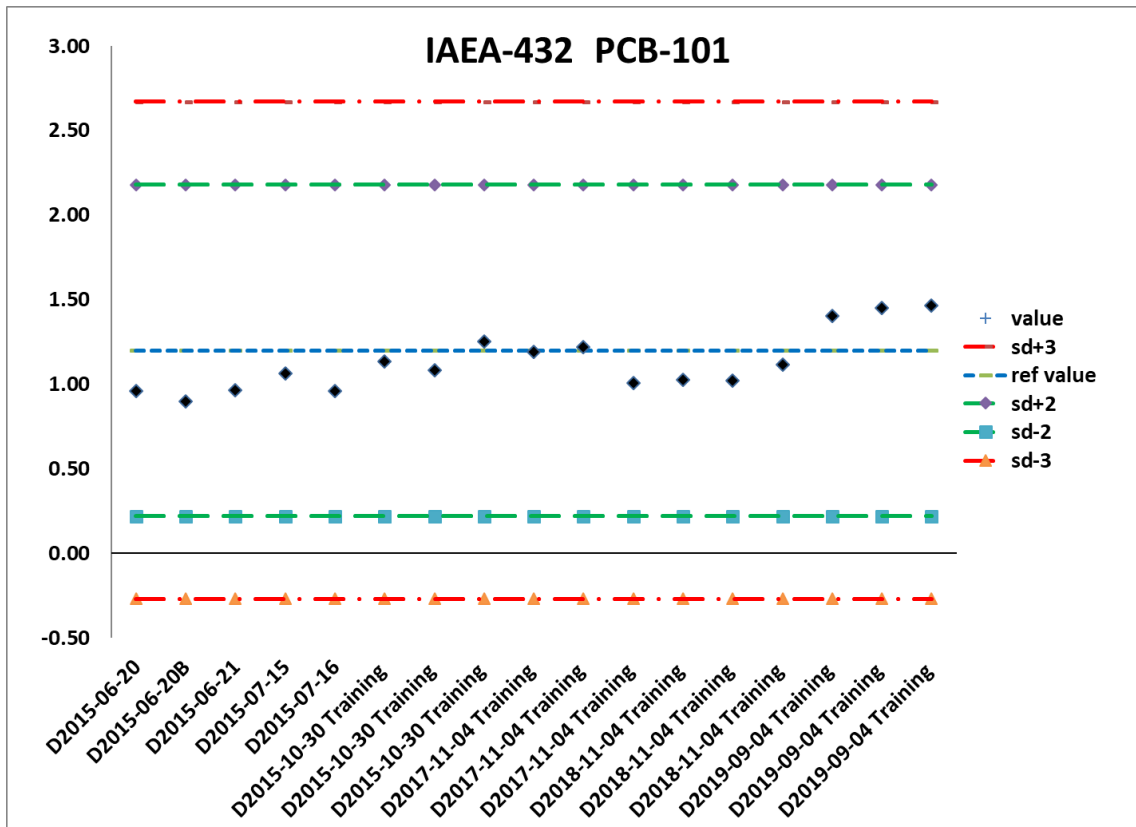
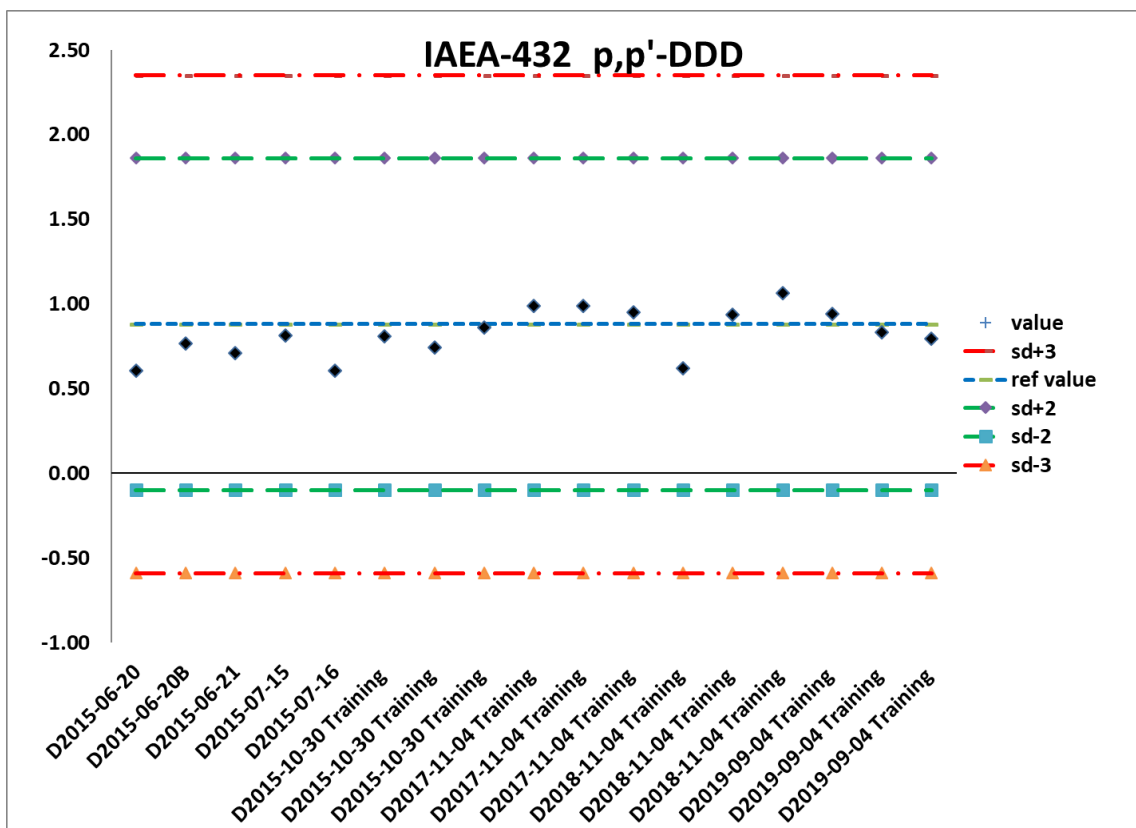


Figure 11. Quality control chart (QC) for p,p'-DDD in IAEA-432 biota reference material (ng/g d.w).



## *9. Certificates of participation*

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Mediterranean Action Plan  
Barcelona Convention

# CERTIFICATE OF PARTICIPATION

**Gjystina FUSHA**

*National Environment Agency (NEA)*

**Tirana, Albania**

attended the training course

**Analysis of Organochlorine Pesticides and  
Polychlorinated Biphenyls in Environmental Samples**

**2 - 13 September 2019**

**IAEA MONACO**

Organized by

**UNEP/MAP - MED POL & IAEA-NAEL**

**Marine Environmental Studies Laboratory**

Trainers

Ms I. Tolosa  
Ms E. Vasileva

Mr R. Cassi  
Ms S. Choyke  
Mr D. Huertas

David Osborn  
Director - IAEA Environment Laboratories



Mediterranean Action Plan  
Barcelona Convention

# CERTIFICATE OF PARTICIPATION

**Aleksandar ELEZ**

*Institut for Water*

**Biejljina, Bosnia & Herzegovina**

attended the training course

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Mediterranean Action Plan  
Barcelona Convention

# CERTIFICATE OF PARTICIPATION

**Iva FINDERLE**

*Public Health Institute of County of Istria*

**Pula, Croatia**

attended the training course

**Analysis of Organochlorine Pesticides and  
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Director - IAEA Environment Laboratories



Mediterranean Action Plan  
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# CERTIFICATE OF PARTICIPATION

**Carol SUKHN**

*American University of Beirut*

**Beirut, Lebanon**

attended the training course

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David Osborn

Director - IAEA Environment Laboratories





Mediterranean Action Plan  
Barcelona Convention

# CERTIFICATE OF PARTICIPATION

**Nassima LAMBARKI EL ALLIOUI**

*Office National de l'Electricité et de l'Eau (ONEE-EAU)*

**Rabat, Morocco**

attended the training course

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Mr D. Huertas

David Osborn

Director - IAEA Environment Laboratories



Mediterranean Action Plan  
Barcelona Convention

# CERTIFICATE OF PARTICIPATION

**Lasaad CHOUBA**

*Institut National des Sciences et Technologies de la Mer (INSTM)*

**La Goulette, Tunisia**

attended the training course

**Analysis of Organochlorine Pesticides and  
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Ms S. Choyke  
Mr D. Huertas

David Osborn

Director - IAEA Environment Laboratories

*10. Training course evaluation  
questionnaires*

---







**INTERNATIONAL ATOMIC ENERGY AGENCY**  
**ENVIRONMENT LABORATORIES**  
MARINE ENVIRONMENTAL STUDIES LABORATORY

**TRAINING COURSE EVALUATION QUESTIONNAIRE**

Training Course organized for MED POL program on the  
Analysis of Organochlorine Pesticides and Polychlorinated Biphenyls in Environmental Samples  
MONACO  
(2-13 September 2019)

Dear Participant,  
The purpose of this evaluation form is to collect the participants' opinions about the entire programme.  
This information will be very helpful in planning future courses. Please do not leave any question unanswered.

Participant's name: GJYSTINA

Participant's country: ALBANIA

1. What is your overall reaction to the workshop?

Excellent       Better than expected       Satisfactory       Poor

2. Do you feel that the workshop met your needs? (If NOT, please explain)

Yes       To some extent       Uncertain       No

.....  
.....

3. Do you feel that you will be better able to do your job after attending this course ?

---

Yes       To some extent       Uncertain       No

4. Do you have a better attitude about your job thanks to this course ?

---

Yes       To some extent       Uncertain       No

5. Would you recommend to others in your field to attend this course?

---

Yes       To some extent       Uncertain       No

6. In your opinion, the number of participants in the workshop was:

---

Just right       Too few       Too many

7. Do you think that similar workshops with other topics would be useful?

---

Yes       No

If YES, please recommend topics:

Other pesticides       Heavy metals       Others (specify).....

8. How do you rate the balance of lectures, group discussion, and group exercises ?

---

Too many lectures       Too many discussions       Good

9. How helpful were the group exercises ?

---

Very helpful       Helpful       Not helpful

10. What do you think of the speed of the course ?

---

Too fast       Just right       Too slow

11. Did you have enough skills practice time ?

---

Yes       No       Uncertain

WORKSHOP CONTENT

12. What did you like best about the workshop course ? (strongest aspects)

Practical session.

13. What did you like least about the workshop course ? (weakest aspects)

Two weeks is very short keeping especially for practical sessions.

14. What do you think should be dropped from this workshop course ?

Nothing.

15. How do you rate the workshop length ?

Just right       Too short       Too long

16. What's your opinion on the workshop content sequence ?

Very well sequenced       Suitable       Poorly sequenced

17. How valuable was the workshop content to your current job ?

Very valuable       Some value       No real value

18. How do you rate the balance of theoretical and practical sessions ?

Too theoretical       Good balance       Too practical

19. Comments about the course contents :

.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....



**INSTRUCTIONAL MATERIAL**

20. In your opinion, was the number of handouts you received sufficient ?

---

Just right       Too few       Too many

21. How do you rate the quality of the handout material ?

---

High quality       Sufficient       Below expectations

**LABORATORY AND FACILITIES**

22. How do you rate the laboratory sessions ?

---

Excellent       Very good       Good       Fair       Poor

23. Comments about laboratory sessions:

---

.....

.....

.....

24. Did you like the seating arrangements of the class room ?

---

Yes       No       Uncertain

25. How do you rate the service (breaks, lunch, etc.) ?

---

Excellent       Very good       Good       Fair       Poor

26. What is your overall evaluation of the course ?

---

Excellent       Very good       Good       Fair       Poor

<p><i>Thank you for taking the time to answer this questionnaire. Your input is really valuable to us!</i></p>
--



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Dear Participant,  
The purpose of this evaluation form is to collect the participants' opinions about the entire programme.  
This information will be very helpful in planning future courses. Please do not leave any question unanswered.

Participant's name: ALEKSANDAR FLEK

Participant's country: BOSNIA AND HERZEGOVINA

1. What is your overall reaction to the workshop?

- Excellent       Better than expected       Satisfactory       Poor

2. Do you feel that the workshop met your needs? (If NOT, please explain)

- Yes       To some extent       Uncertain       No

.....  
.....

3. Do you feel that you will be better able to do your job after attending this course ?

Yes       To some extent       Uncertain       No

4. Do you have a better attitude about your job thanks to this course ?

Yes       To some extent       Uncertain       No

5. Would you recommend to others in your field to attend this course?

Yes       To some extent       Uncertain       No

6. In your opinion, the number of participants in the workshop was:

Just right       Too few       Too many

7. Do you think that similar workshops with other topics would be useful?

Yes       No

If YES, please recommend topics:

Other pesticides       Heavy metals       Others (specify) BROMINATED FCAME  
RETARDANTS, AQUATIC  
ECOSYSTEM TOXICITY ASSESSMENT

8. How do you rate the balance of lectures, group discussion, and group exercises ?

Too many lectures       Too many discussions       Good

9. How helpful were the group exercises ?

Very helpful       Helpful       Not helpful

10. What do you think of the speed of the course ?

Too fast       Just right       Too slow

11. Did you have enough skills practice time ?

Yes       No       Uncertain



WORKSHOP CONTENT

12. What did you like best about the workshop course ? (strongest aspects)

THE PRACTICAL SESSIONS.

13. What did you like least about the workshop course ? (weakest aspects)

14. What do you think should be dropped from this workshop course ?

NOTHING SHOULD BE DROPPED, THE CONTENT OF THE WORKSHOP IS EXCELLENT.

15. How do you rate the workshop length ?

Just right       Too short       Too long

16. What's your opinion on the workshop content sequence ?

Very well sequenced       Suitable       Poorly sequenced

17. How valuable was the workshop content to your current job ?

Very valuable       Some value       No real value

18. How do you rate the balance of theoretical and practical sessions ?

Too theoretical       Good balance       Too practical

19. Comments about the course contents :

1. EXCELLENT COMMUNICATION BEFORE THE START OF THE WORKSHOP.
  2. LECTURERS (FOR PRACTICAL EXERCISE AND THEORETICAL LECTURES) KIND AND READY TO COOPERATE.
  3. ALL OTHER STAFF KIND AND READY TO COOPERATE.
- THANKS FOR EVERYTHING. I ENJOYED THIS WORKSHOP!

THE VIEW FROM KITCHEN IS  
AMAZING! ☺

THE PARTICIPANTS WHO PARTICIPATED  
IN THE WORK SHOP ARE FRIENDLY.  
I HOPE TO VISIT YOU IN THE  
FUTURE.



**INSTRUCTIONAL MATERIAL**

20. In your opinion, was the number of handouts you received sufficient ?

Just right       Too few       Too many

21. How do you rate the quality of the handout material ?

High quality       Sufficient       Below expectations

**LABORATORY AND FACILITIES**

22. How do you rate the laboratory sessions ?

Excellent       Very good       Good       Fair       Poor

23. Comments about laboratory sessions:

STAFF FRIENDLY, ANSWERED FOR ALL QUESTIONS.  
THEIR PRACTICAL WORK IS EXCELLENT.

24. Did you like the seating arrangements of the class room ?

Yes       No       Uncertain

25. How do you rate the service (breaks, lunch, etc.) ?

Excellent       Very good       Good       Fair       Poor

26. What is your overall evaluation of the course ?

Excellent       Very good       Good       Fair       Poor

*Thank you for taking the time to answer this questionnaire.  
Your input is really valuable to us!*



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*MARINE ENVIRONMENTAL STUDIES LABORATORY*

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(2-13 September 2019)

Dear Participant,  
The purpose of this evaluation form is to collect the participants' opinions about the entire programme.  
This information will be very helpful in planning future courses. Please do not leave any question unanswered.

Participant's name: IVA FINDERLE

Participant's country: CROATIA

1. What is your overall reaction to the workshop?

- Excellent       Better than expected       Satisfactory       Poor

2. Do you feel that the workshop met your needs? (If NOT, please explain)

- Yes       To some extent       Uncertain       No

EVEN THOUGH WE HAVE NO ACCESS TO SOME INSTRUMENTS AT HOME, YOU'VE EXPLAINED THE BASICS SO WE CAN DO THE BEST WITH WHAT WE HAVE.

3. Do you feel that you will be better able to do your job after attending this course ?

- Yes       To some extent       Uncertain       No

4. Do you have a better attitude about your job thanks to this course ?

- Yes       To some extent       Uncertain       No

5. Would you recommend to others in your field to attend this course?

- Yes       To some extent       Uncertain       No

6. In your opinion, the number of participants in the workshop was:

- Just right       Too few       Too many

7. Do you think that similar workshops with other topics would be useful?

- Yes       No

If YES, please recommend topics:

- Other pesticides       Heavy metals       Others (specify).....

8. How do you rate the balance of lectures, group discussion, and group exercises ?

- Too many lectures       Too many discussions       Good

9. How helpful were the group exercises ?

- Very helpful       Helpful       Not helpful

10. What do you think of the speed of the course ?

- Too fast       Just right       Too slow

11. Did you have enough skills practice time ?

- Yes       No       Uncertain

I KNOW THERE IS NO TIME, BUT MAYBE I WOULD LIKE  
IF WE DID OUR OWN PARALEL SO WE CAN COMPARE  
OUR OWN RESULTS AND TALK ABOUT IT.





**INSTRUCTIONAL MATERIAL**

20. In your opinion, was the number of handouts you received sufficient ?

Just right       Too few       Too many

21. How do you rate the quality of the handout material ?

High quality       Sufficient       Below expectations

**LABORATORY AND FACILITIES**

22. How do you rate the laboratory sessions ?

Excellent       Very good       Good       Fair       Poor

23. Comments about laboratory sessions:

EVERYTHING WAS EXPLAINED IN DETAILS, ALL MY QUESTIONS  
WAS ANSWERED, AND WE HAD A LOT OF EXAMPLES  
IN REAL LIFE → WHAT COULD HAPPEN AND HOW TO SOLVE THE  
PROBLEM.

24. Did you like the seating arrangements of the class room ?

Yes       No       Uncertain

25. How do you rate the service (breaks, lunch, etc.) ?

Excellent       Very good       Good       Fair       Poor

26. What is your overall evaluation of the course ?

Excellent       Very good       Good       Fair       Poor

Thank you for taking the time to answer this questionnaire.  
Your input is really valuable to us!

THANK YOU FOR INVITING US! :)



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**ENVIRONMENT LABORATORIES**  
MARINE ENVIRONMENTAL STUDIES LABORATORY

**TRAINING COURSE EVALUATION QUESTIONNAIRE**

Training Course organized for MED POL program on the  
Analysis of Organochlorine Pesticides and Polychlorinated Biphenyls in Environmental Samples  
MONACO  
(2-13 September 2019)

Dear Participant,  
The purpose of this evaluation form is to collect the participants' opinions about the entire programme.  
This information will be very helpful in planning future courses. Please do not leave any question unanswered.

Participant's name: ..... CAROL SUKHN .....  
.....

Participant's country: ..... LEBANON .....  
.....

**1. What is your overall reaction to the workshop?**

Excellent       Better than expected       Satisfactory       Poor

**2. Do you feel that the workshop met your needs? (If NOT, please explain)**

Yes       To some extent       Uncertain       No

.....  
.....



WORKSHOP CONTENT

12. What did you like best about the workshop course ? (strongest aspects)

latest information of OCP + PCB in sediment and biota re-emphasizing what I already knew and extra tips from here and there to correct few procedure.

13. What did you like least about the workshop course ? (weakest aspects)

The handouts were small, in some instances we could not see much of some important slides but I covered this by taking photos.

14. What do you think should be dropped from this workshop course ?

No dropping

15. How do you rate the workshop length ?

Just right       Too short       Too long

16. What's your opinion on the workshop content sequence ?

Very well sequenced       Suitable       Poorly sequenced

17. How valuable was the workshop content to your current job ?

Very valuable       Some value       No real value

18. How do you rate the balance of theoretical and practical sessions ?

Too theoretical       Good balance       Too practical

19. Comments about the course contents :

I liked the overall structure. I would recommend to do the sampling in first week just in case weather gets bad in last weeks and sustains for few days. People then might mess out completely on a very important aspect of the training. I am grateful for invitation and for

hosting us, I will use the 8 hours of  
sampling theoretical, Dissection and outlay  
in my renovation of my international  
certificate of sampling. I felt so welcome  
and everybody was nice. Thank you all.  
for being such good host and for  
your courtesy. I personally would like  
to be back for work include to try on ICAMS.  
Suggestions: Lockers outside so  
we can put our stuff everyday



**INSTRUCTIONAL MATERIAL**

20. In your opinion, was the number of handouts you received sufficient ?

Just right       Too few       Too many

21. How do you rate the quality of the handout material ?

High quality       Sufficient       Below expectations

**LABORATORY AND FACILITIES**

22. How do you rate the laboratory sessions ?

Excellent       Very good       Good       Fair       Poor

23. Comments about laboratory sessions:

Well done, asked all the questions I  
wanted to ask, liked the dissection part.

24. Did you like the seating arrangements of the class room ?

Yes       No       Uncertain

25. How do you rate the service (breaks, lunch, etc.) ?

Excellent       Very good       Good       Fair       Poor

26. What is your overall evaluation of the course ?

Excellent       Very good       Good       Fair       Poor

Thank you

Thank you for taking the time to answer this questionnaire.  
Your input is really valuable to us!



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**ENVIRONMENT LABORATORIES**  
*MARINE ENVIRONMENTAL STUDIES LABORATORY*

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This information will be very helpful in planning future courses. Please do not leave any question unanswered.

Participant's name: Massima LATIBARKI EL ALLIQUI.....

Participant's country: MAROC.....

**1. What is your overall reaction to the workshop?**

Excellent       Better than expected       Satisfactory       Poor

**2. Do you feel that the workshop met your needs? (If NOT, please explain)**

Yes       To some extent       Uncertain       No

.....  
.....

3. Do you feel that you will be better able to do your job after attending this course ?

Yes                       To some extent                       Uncertain                       No

4. Do you have a better attitude about your job thanks to this course ?

Yes                       To some extent                       Uncertain                       No

5. Would you recommend to others in your field to attend this course?

Yes                       To some extent                       Uncertain                       No

6. In your opinion, the number of participants in the workshop was:

Just right                       Too few                       Too many

7. Do you think that similar workshops with other topics would be useful?

Yes                       No

If YES, please recommend topics:

Other pesticides                       Heavy metals                       Others (specify)..... *organophosphore, HAP et les résidus de médicaments.*

8. How do you rate the balance of lectures, group discussion, and group exercises ?

Too many lectures                       Too many discussions                       Good

9. How helpful were the group exercises ?

Very helpful                       Helpful                       Not helpful

10. What do you think of the speed of the course ?

Too fast                       Just right                       Too slow

11. Did you have enough skills practice time ?

Yes                       No                       Uncertain



WORKSHOP CONTENT

12. What did you like best about the workshop course ? (strongest aspects)

La qualité de la présentation de formateur et bonne  
La compétence de formateurs qui est très excellente

13. What did you like least about the workshop course ? (weakest aspects)

R.A.S.

14. What do you think should be dropped from this workshop course ?

R.A.S.

15. How do you rate the workshop length ?

Just right       Too short       Too long

16. What's your opinion on the workshop content sequence ?

Very well sequenced       Suitable       Poorly sequenced

17. How valuable was the workshop content to your current job ?

Very valuable       Some value       No real value

18. How do you rate the balance of theoretical and practical sessions ?

Too theoretical       Good balance       Too practical

19. Comments about the course contents :

Le programme de cette formation a été bien étudié et préparé.  
Il contient la partie théorique et expérimentale  
de la préparation des échantillons, Dosage et la  
maintenance d'équipement  
Je souhaite pour cette formation contient une séance  
concernant LC/MS/MS.

ainsi je vous demande de envoyer les échantillons  
intercomparaison avec un matériau de référence.

je vous demande de former par groupe  
~~français~~ qui parle en français (francophone)

cette formation m'a permis d'acquies de bonnes connaissances  
concernant l'extraction du sédiment et la suite ainsi  
le calcul des résultats.

En conclusion: je tiens à remercier ~~les formateurs~~ l'ensemble  
des formateurs pour leur accueil, assistance et effort  
fourni durant la période de la formation.

**INSTRUCTIONAL MATERIAL**

20. In your opinion, was the number of handouts you received sufficient ?

Just right       Too few       Too many

21. How do you rate the quality of the handout material ?

High quality       Sufficient       Below expectations

**LABORATORY AND FACILITIES**

22. How do you rate the laboratory sessions ?

Excellent       Very good       Good       Fair       Poor

23. Comments about laboratory sessions:

Les séances de laboratoire ont été effectuées dans de bonnes conditions. Ils ont été animés par des professeurs qui ont bien expliqué toutes les étapes d'analyse des sédiments et la maintenance de GC.

24. Did you like the seating arrangements of the class room ?

Yes       No       Uncertain

25. How do you rate the service (breaks, lunch, etc.) ?

Excellent       Very good       Good       Fair       Poor

26. What is your overall evaluation of the course ?

Excellent       Very good       Good       Fair       Poor

Thank you for taking the time to answer this questionnaire.  
Your input is really valuable to us!





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This information will be very helpful in planning future courses. Please do not leave any question unanswered.

Participant's name: ..... CHOUBA .....

Participant's country: ..... TUNISIA .....

1. What is your overall reaction to the workshop? \_\_\_\_\_

- Excellent       Better than expected       Satisfactory       Poor

2. Do you feel that the workshop met your needs? (If NOT, please explain) \_\_\_\_\_

- Yes       To some extent       Uncertain       No

.....  
.....

3. Do you feel that you will be better able to do your job after attending this course ?

Yes       To some extent       Uncertain       No

4. Do you have a better attitude about your job thanks to this course ?

Yes       To some extent       Uncertain       No

5. Would you recommend to others in your field to attend this course?

Yes       To some extent       Uncertain       No

6. In your opinion, the number of participants in the workshop was:

Just right       Too few       Too many

7. Do you think that similar workshops with other topics would be useful?

Yes       No

If YES, please recommend topics:

Other pesticides       Heavy metals       Others (specify)..... *Organophosphorus HAP*

8. How do you rate the balance of lectures, group discussion, and group exercises ?

Too many lectures       Too many discussions       Good

9. How helpful were the group exercises ?

Very helpful       Helpful       Not helpful

10. What do you think of the speed of the course ?

Too fast       Just right       Too slow

11. Did you have enough skills practice time ?

Yes       No       Uncertain



WORKSHOP CONTENT

12. What did you like best about the workshop course ? (strongest aspects)

Good competence of staff.

13. What did you like least about the workshop course ? (weakest aspects)

Better to have all presentation (manuals)

14. What do you think should be dropped from this workshop course ?

No things specially.

15. How do you rate the workshop length ?

Just right       Too short       Too long

16. What's your opinion on the workshop content sequence ?

Very well sequenced       Suitable       Poorly sequenced

17. How valuable was the workshop content to your current job ?

Very valuable       Some value       No real value

Preparation: Sample

18. How do you rate the balance of theoretical and practical sessions ?

Too theoretical       Good balance       Too practical

19. Comments about the course contents :

- 1) Better to access for maintenance equipment
- 2) Use the same equipments in our laboratory if a possible.
- 3) This periode is very difficult to found hotels etc.
- 4) Thank you for all Secretariat Training course

**INSTRUCTIONAL MATERIAL**

20. In your opinion, was the number of handouts you received sufficient ?

Just right       Too few       Too many

21. How do you rate the quality of the handout material ?

High quality       Sufficient       Below expectations

**LABORATORY AND FACILITIES**

22. How do you rate the laboratory sessions ?

Excellent       Very good       Good       Fair       Poor

23. Comments about laboratory sessions:

.....  
*Thank you for all staff.*  
.....  
.....

24. Did you like the seating arrangements of the class room ?

Yes       No       Uncertain

25. How do you rate the service (breaks, lunch, etc.) ?

Excellent       Very good       Good       Fair       Poor

26. What is your overall evaluation of the course ?

Excellent       Very good       Good       Fair       Poor

*Thank you for taking the time to answer this questionnaire.  
Your input is really valuable to us!*

*11. Evaluation of participants'  
questionnaire*

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**1. What is your overall reaction to the workshop?**

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[100%] Excellent     Better than expected     Satisfactory     Poor

**2. Do you feel that the workshop met your needs? (If NOT, please explain)**

---

[83%] Yes    [17%] To some extent     Uncertain     No

**3. Do you feel that you will be better able to do your job after attending this course?**

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[67%] Yes    [33%] To some extent     Uncertain     No

**4. Do you have a better attitude about your job thanks to this course?**

---

[67%] Yes    [33%] To some extent     Uncertain     No

**5. Would you recommend to others in your field to attend this course?**

---

[100%] Yes     To some extent     Uncertain     No

**6. In your opinion, the number of participants in the workshop was:**

---

[100%] Just right     Too few     Too many

**7. Do you think that similar workshops with other topics would be useful?**

---

[100%] Yes     No

If YES, please recommend topics:

[4] Other pesticides    [2] Heavy metals    [3] Others (specify): PAH, BFRs

**8. *How do you rate the balance of lectures, group discussion, and group exercises?***

---

Too many lectures       Too many discussions      [83%] Good

**9. *How helpful were the group exercises?***

---

[67%] Very helpful      [17%] Helpful       Not helpful

**10. *What do you think of the speed of the course?***

---

[17%] Too fast      [83%] Just right       Too slow

**11. *Did you have enough skills practice time?***

---

[66%] Yes      [17%] No      [17%] Uncertain

**WORKSHOP CONTENT**

**15. *How do you rate the workshop length?***

---

[83%] Just right      [17%] Too short       Too long

**16. *What's your opinion on the workshop content sequence?***

---

[33%] Very well sequenced      [67%] Suitable       Poorly sequenced

**17. *How valuable was the workshop content to your current job?***

---

[50%] Very valuable      [50%] Some value       No real value

**18. How do you rate the balance of theoretical and practical sessions?**

---

Too theoretical       [100%] Good balance       Too practical

**INSTRUCTIONAL MATERIAL**

**20. In your opinion, was the number of handouts you received sufficient?**

---

[83%] Just right       [17%] Too few       Too many

**21. How do you rate the quality of the handout material?**

---

[67%] High quality       [33%] Sufficient       Below expectations

**LABORATORY AND FACILITIES**

**22. How do you rate the laboratory sessions?**

---

[67%] Excellent       [33%] Very good       Good       Fair       Poor

**24. Did you like the seating arrangements of the class room?**

---

[100%] Yes       No       Uncertain

**25. How do you rate the service (breaks, lunch, etc.)?**

---

[33%] Excellent       [50%] Very Good       [17%] Good       Fair       Poor

**26. What is your overall evaluation of the course?**

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[83%] Excellent       [17%] Very good       Good       Fair       Poor

Note: Questions that required comments were not reported.

