



UNITED
NATIONS

EP

UNEP/MED WG.492/Inf. 7



UNITED NATIONS
ENVIRONMENT PROGRAMME
MEDITERRANEAN ACTION PLAN

14 April 2021
Original: English

Meeting of the Ecosystem Approach Correspondence Group on Pollution Monitoring

Videoconference, 26-28 April 2021

Agenda item 5: Report on Training Course for Trace Elements (2019)

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UNEP/MAP

Athens, 2021

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**TRAINING COURSE ON THE
ANALYTICAL TECHNIQUES FOR THE DETERMINATION OF
TRACE ELEMENTS IN ENVIRONMENTAL SAMPLES**

Organized by:

**International Atomic Energy Agency-Environment Laboratories
4 Quai Antoine 1^{er}, MC 98000 MONACO**

2 – 13 September 2019

IAEA-EL staff involved:

E. Vasileva-Veleva, Research Scientist
S. Azemard, Laboratory Technician
A-M. Orani, Laboratory Technician
P. Mandjukov, Consultant MESL
S. Sander, MESL Section Head
L. Barilaro-Hamonic, Team assistant

Prepared in collaboration with:



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TRAINING COURSE ON THE ANALYTICAL
TECHNIQUES FOR THE DETERMINATION
OF TRACE ELEMENTS
IN ENVIRONMENTAL SAMPLES

1. Background

A training course on the analysis of trace elements in marine environmental samples was organized in NAEL/MESL on behalf of MEDPOL, for participants from Mediterranean laboratories involved in the UNEP/Mediterranean Action Plan - 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 for the training course from their respective countries.

The selection process of trainees was performed 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. Namely 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 selection process included 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;
- The nominated candidates had to be staff members of the national laboratories that the national focal point would also designate them for participation in 2019 Proficiency Tests.
- The nominated candidates would have to be able to apply knowledge, built during 2019 Training Courses on trace elements analysis, in their regular work related to the sampling and assessment determination of trace elements in marine biota and sediment samples; 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 would need to have sufficiently good English language proficiency as the courses are held in English.

Additional information was requested in the nomination form on the i) education, ii) employment and employer's relation to the MEDPOL programme, iii) English proficiency (again!), iv) country distribution and v) overall merit of the nominees. After the reception of

the nominations and taking into consideration the training capacity of the laboratories, 6 participants from 6 different countries (Albania, Bosnia & Herzegovina, Croatia, Morocco, Syria, Turkey) were invited to attend the Training Course in NAEL, Monaco. Invitation letters to the participants were sent by IAEA/NAEL-MESL on 17 June 2019. The nominee from Syria did not receive his visa in time and the runner up from Montenegro was unable to accept the nomination on the short notice of only 2 weeks. Therefore only 5 participants were able to come to the course.

The course was held from 2 to 13 of September 2019.

Introductions to the basic concepts of trace elements analysis for monitoring studies, as well as, the principles of sample preparation methodology and moisture determination were presented to the participants in the training course. Lectures were dedicated on the analytical techniques (e.g. Flame Atomic Absorption Spectrometry, Graphite Furnace Atomic Absorption Spectrometry, and Inductively Coupled Plasma Mass Spectrometry as well as to the hyphenated technique (Cold Vapour Atomic Fluorescence Spectrometry-CV-AFS), applied for trace elements and mercury speciation analysis in marine samples. The most important concepts of measurement science-metrology in chemistry as validation of measurement procedure, use of certified reference materials, traceability and uncertainty of measurement results were also presented. The exercise on the estimation of measurement uncertainty for the AAS determination of lead in sediment sample using modelling approach was developed and all tutorial materials were provided to the participants. One of the theoretical sessions was dedicated to the sampling, sampling planning and strategies, samples preservation and storage. The uncertainty on samplings, which is the dominating contributor to the total uncertainty was discussed in detail. This was a new topic for most of participants in the training course.

During the practical session of the training course, the complete procedures on marine sample preparation and the quantification of trace elements in sediments and biota samples was demonstrated. All practical exercises were followed by a round-table discussion in order to answer questions from trainees and to compare proposed protocols with protocols applied in trainees' laboratories

A link was provided to the course participants including all lectures, practical sessions and additional information such as recommended methods.

2. Evaluation

A questionnaire was distributed to the trainees to receive feedback on the organization, content and structure of the training. The course was found to be useful and valuable and trainees' needs were met. E.g., 80% of participants indicated that their overall impression of the training course was excellent and 20% declared that it was better than expected. 100% of participants indicated that their needs were met and that they will be better able to do their job after attending this course. The balance between lectures, practical lab and computer sessions was found to be correct. However, some participants expressed to have appreciated more time in the laboratory to apply the newly accrued knowledge. The questionnaires and the summary of the evaluation forms can be found at the end of this report.

3. Conclusion and Recommendations

The theoretical knowledge on the good laboratory practice, sampling, different analytical techniques for trace element analysis and quality assurance principles were presented. Knowledge obtained during the training course was very well accepted from all participants, as their theoretical background was at the level requested for this training.

Practical exercises were also very well accepted by all trainees and they were very actively involved during the practical part of the training course.

Not all participants had the correct practical background for the training. One trainee reported to only occasionally work on the monitoring of trace elements in marine sediments. A second trainee apparently only worked on biota samples for general for food safety control. Even though most of the participants were familiar with at least one of the analytical techniques discussed during the training course, the fact that their work is mainly focused on non-marine matrices (drinking, waste and fresh waters) makes the training in its actual form questionable. One trainee reported that they only use ICP-OES, an analytical technique not included in the training course. All of this means that the capacity built during the training might not directly be beneficial for the MEDPOL programme.

The insufficient level of English language was a serious obstacle for three of the trainees (60%) to follow lectures and to be fully involved in the practical sessions. Two out of five participants

had a sufficiently high level of English, allowing proper communication during the training. Communication with one of the participants was only possible in French.

Although, in line with the conclusions and recommendations of the Meeting of CorMon on Pollution Monitoring that was held from 1 to 2 April 2018 in Podgorica, Montenegro, it was requested that the national laboratories nominated by focal points had participated in the 2018 MEDPOL PT and that they would be nominated for the 2019 MEDPOL PT, both criteria were not fulfilled for all laboratories. Thus, despite our efforts to link both activities, the training course and the PT in order to have high capacity building impact, this concept was not fully implemented by the national focal points.

Recommendations:

- ✓ The selection procedure for the participants in MEDPOL training course may need to be further improved and selection criteria, as provided in chapter 1, further adjusted.
- ✓ Language tests should be introduced as the integral part of the selection process.
- ✓ The communication with the selected participants, their background, needs and expectations from the training should be done before the training course by the MESL with involvement of MEDPOL Monitoring and Assessment Officer, if need be. This will help in the preparation of more relevant for the selected participants training program.
- ✓ MEDPOL focal points should only nominate candidates that are actively involved in implementation of Pollution and Marine Litter Cluster of IMAP/MEDPOL monitoring programme therefore being staff members of the laboratories responsible for IMAP implementation at national level.
- ✓ Additional efforts are needed to ensure the laboratories participating in the TCs are those taking part in PTs in order to make the most of the training received, as recommended by the Meeting of CorMon on Pollution Monitoring
- ✓ MEDPOL Focal Points should follow up more closely with the nominated national laboratories participating in the implementation of MEDPOL IV/IMAP monitoring programme and experts participating in the TC for trace elements, including a follow up on the results and related recommendations of the Proficiency Testing, with a view

of further supporting national efforts to implement the QA/QC measures for the marine monitoring data reported to MEDPOL.

- ✓ 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.

4. List of participants

**PARTICIPANTS OF THE TRAINING COURSE ON THE ANALYTICAL TECHNIQUES FOR THE
DETERMINATION OF TRACE ELEMENTS IN ENVIRONMENTAL SAMPLES**

ALBANIA

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5. Course outline

MEDPOL training course on the Analytical Techniques for the Determination of Trace Elements 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*

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

*Mr Peter Swarzenski
Section Head-REL*

*Ms Imma Tolosa
Research Scientist*

TUESDAY 3 SEPTEMBER

9:00 – 12:00

THEORETICAL SESSION

*Ms Emilia Vasileva
Research Scientist*

Trace Elements Determination for monitoring studies.

Sample preparation for trace element analysis in sediments and biological samples.

Mineralization techniques. Moisture determination.

13:00 – 17:00

PRACTICAL SESSION

*Ms Sabine Azemard
Ms Anna Maria Orani
Laboratory Technicians*

Inorganic Laboratory Orientation.

Dry oven moisture determination in biota sample.

WEDNESDAY 4 SEPTEMBER

9:00 – 12:00

THEORETICAL SESSION

*Ms Emilia Vasileva
Research Scientist*

ICP-MS Spectrometry - Main principles and application for trace element analysis of Environment Samples.

Reliable Measurement Results.

Proper use of Certified Reference Materials.

13:00 – 17:00

PRACTICAL SESSION

*Ms Sabine Azemard
Laboratory Technician*

Sample preparation: mineralization of biological and sediment samples for trace element analysis.

Dilution of sediment and biota digests to appropriate, specified volumes.

Flame Atomic Absorption Spectrometry and application of the method for determination of trace elements in marine samples. Preparation of calibration curve for Zn by Flame Atomic Absorption Spectrometry.

*Ms Anna Maria Orani
Laboratory Technician*

THURSDAY 5 SEPTEMBER**9:00 – 12:00****THEORETICAL SESSION***Ms Emilia Vasileva
Research Scientist*

Uncertainty of measurement results.

Basic statistics for uncertainty estimation and method validation.

Practical exercise on uncertainty estimation.
Case study: Determination of Pb in soil by GF-AAS.

13:00 – 17:00**PRACTICAL SESSION***Ms Sabine Azemard
Laboratory Technician*

Determination of Zinc by Flame Atomic Absorption Spectrometry in biota and sediment samples. Data treatment.

Determination of Cu by Graphite Furnace Atomic Absorption Spectrometry in biota. Calibration curve. Data treatment.

FRIDAY 6 SEPTEMBER**9:00 – 17:00****PRACTICAL SESSION***Ms Sabine Azemard
Laboratory Technician*

Development of temperature programs for the determination of Cd in sediment by GF-AAS. Optimization of furnace parameters. Standard addition method. Spectral interferences corrections.

MONDAY 9 SEPTEMBER**9:00 – 12:00****THEORETICAL SESSION***M. Petko Mandjukov
Consultant MESL*

Sampling and sample storage in the case of trace element analysis.

Introduction to the determination of trace elements by Flame Atomic Absorption Spectrometry (AAS).

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

THEORITICAL SESSION

*Mr Petko Mandjukov
Consultant MESL*

Introduction to the determination of trace elements by Graphite Furnace-AAS (GF-AAS) and Solid Sampling AAS.

Method validation.
Practical exercise on method validation. Case study: Determination of Pb in soil by GF-AAS.

14:00 – 17:00

PRACTICAL SESSION

*Mr Roberto Cassi
Mr David Huertas
Laboratory Technicians*

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

WEDNESDAY 11 SEPTEMBER

9:00 – 17:00

PRACTICAL SESSION

Development of method for the determination of Cd in biota sample by ICP-MS.

*Ms Anna Maria Orani
Laboratory Technician*

Determination of Cu in sediments and biota samples by Solid sampling CS HR AAS

*Ms Anna Maria Orani
Laboratory Technician
Ms Petko Mandjukov
Consultant MESL*

THURSDAY 12 SEPTEMBER

9:00 – 12:00

PRACTICAL SESSION

*Ms Sabine Azemard
Ms Anna Maria Orani
Laboratory Technicians*

Determination of organic Hg by AMA Calibration curves. Data treatment.
Case study: Determination of organic Hg mass fraction in marine biota sample.

13:00 – 17:00 Determination of Hg in biota samples by CV AFS

*Ms Sabine Azemard
Ms Anna Maria Orani
Laboratory Technicians*

FIRDAY 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:

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 sessions

Introductions to the basic concepts of trace elements analysis for monitoring studies, as well as, the principles of sample preparation methodology and moisture determination were presented to the participants in the training course. Following lectures were dedicated on the analytical techniques (e.g. Flame Atomic Absorption Spectrometry, Graphite Furnace Atomic Absorption Spectrometry, and Inductively Coupled Plasma Mass Spectrometry as well as to the hyphenated technique (Cold Vapour Atomic Fluorescence Spectrometry-CV-AFS), applied for trace elements and mercury speciation analysis in marine samples. The most important concepts of measurement science-metrology in chemistry as validation of measurement procedure, use of certified reference materials, traceability and uncertainty of measurement results were also presented. The exercise on the estimation of measurement uncertainty for the AAS determination of lead in sediment sample using modelling approach was developed and all tutorial materials were provided to the participants. One of the theoretical sessions was dedicated to the sampling, sampling planning and strategies, samples preservation and storage. The uncertainty on samplings, which is the dominating contributor to the total uncertainty was discussed in detail. This was a new topic for most of participants in the training course.

During the practical session of the training course, the complete procedures on marine sample preparation and the quantification of trace elements in sediments and biota samples was demonstrated. More details on the practical part of the course are given in the Practical session section.

A link (<https://share.iaea.org/pub/index.php/s/0YJwmnuEJvucPI3> - Password: monaco) was provided to the course participants including all lectures, practical sessions and additional information such as recommended methods. Please note that this link was only valid for a limited amount of time due to IT security purposes.

7. Practical sessions

The laboratory training was devised in three parts: sample preparation, instrumental measurement and calculation of obtained results.

All practical exercises were followed by a round-table discussion in order to answer questions from trainees and to compare proposed protocols with protocols applied in trainees' laboratories.

1) SAMPLE PREPARATION

The session on sample preparation started with the dissection of fish and mussel, followed by the collection of water and sediment samples during a field trip on a small boat.

Trainees performed a microwave digestion of the biota and sediment samples using a microwave technique. The moisture determination was performed for biota samples and appeared to be done as a routine for all participants performing determination of trace elements in sediment and biota samples.

2) ATOMIC ABSORPTION SPECTROMETRY (AAS)

a) Determination of Zn mass fraction in sediment samples by Flame AAS

This session started with basic calculations of element mass fractions in calibration solutions and analysed samples in order to verify that all participants are familiar with them.

Trainees were requested to prepare standard solutions for Zn, using "matrix matching" approach. The concepts for "matrix matching" of all solutions and calibration blank were not clear for all participants.

b) Determination of Cd mass fraction biological material by graphite furnace AAS (ETAAS)

Basic optimisation of the temperature program for the ETAAS using a matrix modifier was demonstrated. The basic steps of one ETAAS program were discussed and introduced. The aching curve was produced for a sample and a standard, using a conventional program and a matrix modifier.

Biota samples, together with QC samples and procedural blanks were analysed, using the developed temperature program. The possibility for preparation and implementation of automatic quality control (QC) checks in the measurement sequence was demonstrated. The

basic calculation of post-digestion standard addition approach was demonstrated again, as it was not clear for some of the participants in the training.

The calculation of characteristic mass as a routine check for sensitivity of the method was performed.

c) Demonstration of permanent modification and rapid temperature program

The demonstration of permanent matrix modification was done for the determination of cadmium in a biota sample. The use of permanent modification with iridium followed by “rapid temperature program” was explained and shown to the participants. None of the trainees were familiar with this type of program.

The mass fraction of cadmium in the biota sample was also determined with a “conventional” matrix modifier and “conventional” four stage temperature program. The results for mass fraction of Cd in biota sample obtained with “rapid” and “conventional” programs were compared.

d) Determination of Cu in sediments and biota samples by Solid Sampling CS HR AAS

This practical session was intended to get the participants familiar with the analysis of trace elements in solid sediments and biota samples, by High Resolution Continuous Source AAS. The advantages of direct analysis on solid sample, the use of fast programs and of a new approach based on calibration using a solid CRMs, were discussed with the trainees. The participants had the opportunity to perform analysis by themselves, comment the obtained high-resolution spectra and learn about the advantages/disadvantages of this approach compared with conventional AAS analyses. None of the participant was familiar with this specific approach and all of them appeared to be rather interested.

3) COLD VAPOR ATOMIC FLUORESCENT SPECTROMETRY (CV-AFS)

Determination of total mercury by CV- AFS

The cold vapor AFS, with double gold trap amalgamation was demonstrated with standard solutions and digested sediment samples. The exercise was mainly based on discussion of different type of instrument available for cold vapor and on specific sample preparation (mainly on preservation limitation) that should be applied.

4) SOLID MERCURY ANALYSER (AMA)

Total and organic mercury mass fractions in marine biota samples using solid mercury analyser (AMA)

One half day was dedicated to the determination of total mercury mass fraction in fish samples, using a solid mercury analyser. Calibration using liquid standard and solid CRM were demonstrated. The application of specific extraction method for organic mercury in biota was explained in detail but not demonstrated as majority of trainees did not have solid mercury analyser.

5) INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY (ICP-MS)

Development of method for the determination of Cd in biota by ICP-MS and external calibration

During this practical session an example of the determination of cadmium in different replicates of one fish sample and one biota CRM was used to demonstrate the method development and application of ICP-MS technique for trace elements monitoring studies. The optimization of the measurement method covered: checking the general instrument condition, selection of proper internal standard, selection of proper Cd isotopes, explanation of different types of spectral interferences and their correction, checking the procedural blanks, analysis of certified reference materials as QC samples.

The ICP-MS session included proper gravimetric dilution of digested samples and gravimetric preparation of standard solution for external calibration. Additionally, simple calculation of the exact dilution factors and conversion of results from $\mu\text{g}/\text{kg}$ (in the digested solutions) to mg/kg (in dry samples) was also included. The results obtained with different Cd isotopes were discussed and compared. The importance of possible contamination in trace elements analysis by ICP-MS and the evaluation of detection limits were underlined. None of the

participants had experience with ICP-MS technique as they do not have this kind of instrumentation in their respective laboratories.

6) CALCULATIONS AND REPORTING OF RESULTS

Basic calculations of obtained results in mg/kg mass fraction were performed and the concept of procedural and instrumental blanks, recovery and detection limits discussed and applied. As the use of modelling approach, prescribed by ISO Guide 17025, for the Expression of Uncertainty in Measurement (GUM) was explained in detail during the theoretical session, the estimation of uncertainty using control chart and validation parameter was applied on results obtained from the practical sessions.

8. Certificates of participation



Mediterranean Action Plan
Barcelona Convention

CERTIFICATE OF PARTICIPATION

Sabrie PICARI

National Environment Agency (NEA)

Tirana, Albania

attended the training course

**Analytical Techniques for the Determination of
Trace Elements in Environmental Samples**

2 - 13 September 2019

IAEA MONACO

Organized by

UNEP/MAP - MED POL & IAEA-NAEL

Marine Environmental Studies Laboratory

Trainers

Ms S. Azemard
Ms A.M. Orani

Ms E. Vasileva
Mr P. Mandjukov

David Osborn
Director - IAEA Environment Laboratories



Mediterranean Action Plan
Barcelona Convention

CERTIFICATE OF PARTICIPATION

Branimir DRINOVAC

Institute for Public Health

Mostar, Bosnia & Herzegovina

attended the training course

**Analytical Techniques for the Determination of
Trace Elements in Environmental Samples**

2 - 13 September 2019

IAEA MONACO

Organized by

UNEP/MAP - MED POL & IAEA-NAEL

Marine Environmental Studies Laboratory

Trainers

Ms S. Azemard
Ms A.M. Orani

Ms E. Vasileva
Mr P. Mandjukov

David Osborn

Director - IAEA Environment Laboratories



Mediterranean Action Plan
Barcelona Convention

CERTIFICATE OF PARTICIPATION

Ozren GROZDANIC

Public Health Institute of County of Istria
Pula, Croatia

attended the training course

**Analytical Techniques for the Determination of
Trace Elements in Environmental Samples**

2 - 13 September 2019

IAEA MONACO

Organized by

UNEP/MAP - MED POL & IAEA-NAEL

Marine Environmental Studies Laboratory

Trainers

Ms S. Azemard
Ms A.M. Orani

Ms E. Vasileva
Mr P. Mandjukov

David Osborn

Director - IAEA Environment Laboratories



Mediterranean Action Plan
Barcelona Convention

CERTIFICATE OF PARTICIPATION

Rajaa ESSAIDI

National Laboratory of Environment

Rabat, Morocco

attended the training course

**Analytical Techniques for the Determination of
Trace Elements in Environmental Samples**

2 - 13 September 2019

IAEA MONACO

Organized by

UNEP/MAP - MED POL & IAEA-NAEL

Marine Environmental Studies Laboratory

Trainers

Ms S. Azemard
Ms A.M. Orani

Ms E. Vasileva
Mr P. Mandjukov

David Osborn

Director - IAEA Environment Laboratories



Mediterranean Action Plan
Barcelona Convention

CERTIFICATE OF PARTICIPATION

Ilknur SIRIMOGLU

Environmental Reference Laboratory

Ankara, Turkey

attended the training course

**Analytical Techniques for the Determination of
Trace Elements in Environmental Samples**

2 - 13 September 2019

IAEA MONACO

Organized by

UNEP/MAP - MED POL & IAEA-NAEL

Marine Environmental Studies Laboratory

Trainers

Ms S. Azemard
Ms A.M. Orani

Ms E. Vasileva
Mr P. Mandjukov

David Osborn

Director - IAEA Environment Laboratories

9. Training course evaluation questionnaires



INTERNATIONAL ATOMIC ENERGY AGENCY
MARINE ENVIRONMENT LABORATORIES
 MARINE ENVIRONMENTAL STUDIES LABORATORY



TRAINING EVALUATION QUESTIONNAIRE

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. Thank you.

Participant's name: SABRIE PICARI

Participant's nationality: ALBANIA

Institute Name & Address: The National ENVIRONMENT AGENCY (AKM)

What is your overall impression of the training course?

- Excellent Satisfactory Poor Better than expected

Do you feel that this training met your needs? (if NOT, please, explain)

- Yes To some extent Uncertain No

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

- Yes To some extent Uncertain No

Do you have a better attitude to your job having completed this course?

- Yes To some extent Uncertain No

Would you recommend that others in your field should attend this course?

- Yes To some extent Uncertain No

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

- Yes No

If YES, please indicate relevant topics:

- Trace elements by ICP-OES Trace elements by ICP-MS
 Others (specify)

GF-AAS

TRAINING CONTENT

How do you rate the balance of theoretical and practical material in the workshop?

- Too theoretical Good balance Too practical

How do you rate the balance of lectures, group discussions, and group exercises?

- Good Too many lectures Too many discussion sessions

How do you rate the training's length?

- Too short Just right Too long

How did you feel about the pacing of the course?

- Too fast Just right Too slow

How do you rate the training's sequence?

- Very well sequenced Suitable Poorly sequenced

How helpful were the group exercises?

- Very helpful Helpful Not helpful

Did you have enough skills practice time?

- Yes No Uncertain

How valuable was the training content to your current job?

- Very valuable Of some value No real value

What did you like best about the training course? (Strongest aspects)

.....sampling and sample preparation for my.....

What did you like least about the training course? (Weakest aspects)

.....Uncertainty, calculator.....

What do you think should be dropped from this course?

~~You are very very good.~~

Comments about the course contents:

you are very, very good together (INORG)
Groups

INSTRUCTIONAL MATERIAL (on CD ROM)

In your opinion, was the number of handouts you received during the course sufficient?

Just right Too few Too many

How do you rate the quality of the handout material?

High quality Sufficient Below expectation

LABORATORIES AND FACILITIES

Did you like the seating arrangements of the conference room?

Yes No No opinion

How do you rate the practical sessions?

Excellent Very good Fair Poor

Do you think the number of participants in the workshop was:

Too many Too few Just right

Comments about laboratory sessions:

This is very interesting.
work in the lab.
I prefer work in the lab and practicals:
- sampling.
- sample preparation etc.

What is your overall evaluation of the course?

Excellent Very good Fair Poor

QUESTIONS FOR THE CERTIFICATE OF PROFICIENCY

1. Which of the following statements regarding CRMs is NOT correct?

- CRMs should be used for calibration only
- CRMs should be stored according to the manufacturer' instructions
- Sampling of CRMs should take into account prescribed minimum amounts, if stated
- Degradation of CRMs due to bioactivity should be avoided
- CRMs should always be accompanied by a certificate

2. A CRM does NOT necessarily need to have:

- low cost
- stability
- stated uncertainty
- values assigned to the material
- demonstrated homogeneity

3. Which (of the following) information is NOT necessarily included in the certificate of a CRM?

- Prescribed experimental protocol
- A statement of traceability
- Uncertainty of the certified value
- Signature or name of certifying officer
- Sample number

4. In order to provide evidence of the traceability of a measurement result it is sufficient to:

- Document the traceability of the result to a stated reference
- Report the result in SI unit
- Participate successfully in a Proficiency Testing Scheme
- Use a Reference Material
- Calibrate the critical measurement equipment once a year

5. What is your definition for trace element?

.....

.....

.....

.....

*Thank you for taking the time to respond to this survey.
Your input is very valuable to us!*



INTERNATIONAL ATOMIC ENERGY AGENCY
MARINE ENVIRONMENT LABORATORIES
MARINE ENVIRONMENTAL STUDIES LABORATORY



TRAINING EVALUATION QUESTIONNAIRE

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. Thank you.

Participant's name: Branimir Drinovec

Participant's nationality: Bosnia and Herzegovina (Croatian)

Institute Name & Address: Institute for Public Health Federation of Bosnia and Herzegovina

What is your overall impression of the training course?

- Excellent Satisfactory Poor Better than expected

Do you feel that this training met your needs? (if NOT, please, explain)

- Yes To some extent Uncertain No
-

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

- Yes To some extent Uncertain No

Do you have a better attitude to your job having completed this course?

- Yes To some extent Uncertain No

Would you recommend that others in your field should attend this course?

- Yes To some extent Uncertain No

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

- Yes No

If YES, please indicate relevant topics:

- Trace elements by ICP-OES Trace elements by ICP-MS
- Others (specify)
-

TRAINING CONTENT

How do you rate the balance of theoretical and practical material in the workshop?

- Too theoretical Good balance Too practical

How do you rate the balance of lectures, group discussions, and group exercises?

- Good Too many lectures Too many discussion sessions

How do you rate the training's length?

- Too short Just right Too long

How did you feel about the pacing of the course?

- Too fast Just right Too slow

How do you rate the training's sequence?

- Very well sequenced Suitable Poorly sequenced

How helpful were the group exercises?

- Very helpful Helpful Not helpful

Did you have enough skills practice time?

- Yes No Uncertain

How valuable was the training content to your current job?

- Very valuable Of some value No real value

What did you like best about the training course? (Strongest aspects)

Correlation between theoretical and practical training was very good. Instructors and consultants did great job.

What did you like least about the training course? (Weakest aspects)

In my opinion there are no weak aspects of the training course.

What do you think should be dropped from this course?

Nothing should be dropped for this course.

Comments about the course contents:

Course contents are constructed so well and allow expansion of knowledge and improvement of analytical skills.

INSTRUCTIONAL MATERIAL (on CD ROM)

In your opinion, was the number of handouts you received during the course sufficient?

- Just right Too few Too many

How do you rate the quality of the handout material?

- High quality Sufficient Below expectation

LABORATORIES AND FACILITIES

Did you like the seating arrangements of the conference room?

- Yes No No opinion

How do you rate the practical sessions?

- Excellent Very good Fair Poor

Do you think the number of participants in the workshop was:

- Too many Too few Just right

Comments about laboratory sessions:

Laboratory is very well equipped. Technicians and consultant possess great knowledge and experience and it was pleasure to cooperate with them.

What is your overall evaluation of the course?

- Excellent Very good Fair Poor

QUESTIONS FOR THE CERTIFICATE OF PROFICIENCY

1. Which of the following statements regarding CRMs is NOT correct?

- CRMs should be used for calibration only
- CRMs should be stored according to the manufacturer' instructions
- Sampling of CRMs should take into account prescribed minimum amounts, if stated
- Degradation of CRMs due to bioactivity should be avoided
- CRMs should always be accompanied by a certificate

2. A CRM does NOT necessarily need to have:

- low cost
- stability
- stated uncertainty
- values assigned to the material
- demonstrated homogeneity

3. Which (of the following) information is NOT necessarily included in the certificate of a CRM?

- Prescribed experimental protocol
- A statement of traceability
- Uncertainty of the certified value
- Signature or name of certifying officer
- Sample number

4. In order to provide evidence of the traceability of a measurement result it is sufficient to:

- Document the traceability of the result to a stated reference
- Report the result in SI unit
- Participate successfully in a Proficiency Testing Scheme
- Use a Reference Material
- Calibrate the critical measurement equipment once a year

5. What is your definition for trace element?

From the health safety point of view trace element is a
 nutrient which can damage human health if it occurs in
 large concentration in ~~the~~ environmental and food samples.

*Thank you for taking the time to respond to this survey.
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Participant's name: OZREN GROZDANIC

Participant's nationality: CROATIAN

Institute Name & Address: INSTITUTE OF PUBLIC HEALTH OF
COUNTY OF ISTRIA (IZI) PULA

What is your overall impression of the training course?

- Excellent Satisfactory Poor Better than expected

Do you feel that this training met your needs? (if NOT, please, explain)

- Yes To some extent Uncertain No

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

- Yes To some extent Uncertain No

Do you have a better attitude to your job having completed this course?

- Yes To some extent Uncertain No

Would you recommend that others in your field should attend this course?

- Yes To some extent Uncertain No

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

- Yes No

If YES, please indicate relevant topics:

- Trace elements by ICP-OES Trace elements by ICP-MS

Others (specify)

TRACE METALS IN SEAWATER

TRAINING CONTENT

How do you rate the balance of theoretical and practical material in the workshop?

- Too theoretical Good balance Too practical

How do you rate the balance of lectures, group discussions, and group exercises?

- Good Too many lectures Too many discussion sessions

How do you rate the training's length?

- Too short Just right Too long

How did you feel about the pacing of the course?

- Too fast Just right Too slow

How do you rate the training's sequence?

- Very well sequenced Suitable Poorly sequenced

How helpful were the group exercises?

- Very helpful Helpful Not helpful

Did you have enough skills practice time?

- Yes No Uncertain

How valuable was the training content to your current job?

- Very valuable Of some value No real value

What did you like best about the training course? (Strongest aspects)

THE OPPORTUNITY TO LEARN FROM PEOPLE IN THE LABS THAT ARE REAL EXPERTS IN THEIR FIELD AND THEIR WILL TO SHARE WITH US VERY VALUABLE "TIPS AND TRICKS"

What did you like least about the training course? (Weakest aspects)

UNCERTAINTY BUDGET WAS ONLY THEORETICAL, IT MIGHT BE BETTER IF HAD THE CHANCE TO BUILD OUR OWN UNDER SUPERVISION

What do you think should be dropped from this course?

NOTHING

Comments about the course contents:

EVERYTHING WAS EXTREMELY WELL ORGANIZED AND THOUGHT-THROUGH.

INSTRUCTIONAL MATERIAL (on CD ROM)

In your opinion, was the number of handouts you received during the course sufficient?

- Just right Too few Too many

How do you rate the quality of the handout material?

- High quality Sufficient Below expectation

LABORATORIES AND FACILITIES

Did you like the seating arrangements of the conference room?

- Yes No No opinion

How do you rate the practical sessions?

- Excellent Very good Fair Poor

Do you think the number of participants in the workshop was:

- Too many Too few Just right

Comments about laboratory sessions:

SIMPLY GREAT SABINE AND ANNA-MARIA HELPED A LOT WITH THE PROBLEMS IN OUR LABS AND CLARIFIED MANY THINGS

What is your overall evaluation of the course?

- Excellent Very good Fair Poor

QUESTIONS FOR THE CERTIFICATE OF PROFICIENCY

1. Which of the following statements regarding CRMs is NOT correct?

- CRMs should be used for calibration only
- CRMs should be stored according to the manufacturer' instructions
- Sampling of CRMs should take into account prescribed minimum amounts, if stated
- Degradation of CRMs due to bioactivity should be avoided
- CRMs should always be accompanied by a certificate

2. A CRM does NOT necessarily need to have:

- low cost
- stability
- stated uncertainty
- values assigned to the material
- demonstrated homogeneity

3. Which (of the following) information is NOT necessarily included in the certificate of a CRM?

- Prescribed experimental protocol
- A statement of traceability
- Uncertainty of the certified value
- Signature or name of certifying officer
- Sample number

4. In order to provide evidence of the traceability of a measurement result it is sufficient to:

- Document the traceability of the result to a stated reference
- Report the result in SI unit
- Participate successfully in a Proficiency Testing Scheme
- Use a Reference Material
- Calibrate the critical measurement equipment once a year

5. What is your definition for trace element?

ELEMENTS PRESENT IN THE SAMPLE IN LOW CONCENTRATION.
.....
.....
.....

*Thank you for taking the time to respond to this survey.
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TRAINING EVALUATION QUESTIONNAIRE

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Participant's name:Rajaa ESSAID.....

Participant's nationality:Morocco.....

Institute Name & Address:the national laboratory for
.....studies and monitoring of pollution.....

What is your overall impression of the training course?

- Excellent Satisfactory Poor Better than expected

Do you feel that this training met your needs? (if NOT, please, explain)

- Yes To some extent Uncertain No

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

- Yes To some extent Uncertain No

Do you have a better attitude to your job having completed this course?

- Yes To some extent Uncertain No

Would you recommend that others in your field should attend this course?

- Yes To some extent Uncertain No

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

- Yes No

If YES, please indicate relevant topics:

- Trace elements by ICP-OES Trace elements by ICP-MS
 Others (specify)

TRAINING CONTENT

How do you rate the balance of theoretical and practical material in the workshop?

- Too theoretical Good balance Too practical

How do you rate the balance of lectures, group discussions, and group exercises?

- Good Too many lectures Too many discussion sessions

How do you rate the training's length?

- Too short Just right Too long

How did you feel about the pacing of the course?

- Too fast Just right Too slow

How do you rate the training's sequence?

- Very well sequenced Suitable Poorly sequenced

How helpful were the group exercises?

- Very helpful Helpful Not helpful

Did you have enough skills practice time?

- Yes No Uncertain

How valuable was the training content to your current job?

- Very valuable Of some value No real value

What did you like best about the training course? (Strongest aspects)

j'ai bien aimé la partie pratique

What did you like least about the training course? (Weakest aspects)

R.A.S

What do you think should be dropped from this course?

..... R A S

Comments about the course contents:

..... 'été très bénéfique et riches des informations.....

INSTRUCTIONAL MATERIAL (on CD ROM)

In your opinion, was the number of handouts you received during the course sufficient?

- Just right Too few Too many

How do you rate the quality of the handout material?

- High quality Sufficient Below expectation

LABORATORIES AND FACILITIES

Did you like the seating arrangements of the conference room?

- Yes No No opinion

How do you rate the practical sessions?

- Excellent Very good Fair Poor

Do you think the number of participants in the workshop was:

- Too many Too few Just right

Comments about laboratory sessions:

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

What is your overall evaluation of the course?

- Excellent Very good Fair Poor

QUESTIONS FOR THE CERTIFICATE OF PROFICIENCY

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- Sample number

4. In order to provide evidence of the traceability of a measurement result it is sufficient to:

- Document the traceability of the result to a stated reference
- Report the result in SI unit
- Participate successfully in a Proficiency Testing Scheme
- Use a Reference Material
- Calibrate the critical measurement equipment once a year

5. What is your definition for trace element?

Les éléments trace sont des éléments très
sensible, on doit les analyser avec précaution
on utilise cette connaissance acquise durant
cette formation (partie pratique)

Thank you for taking the time to respond to this survey.
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TRAINING EVALUATION QUESTIONNAIRE

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Participant's name: ILKAYIR SIRINCÖLU

Participant's nationality: TURKEY

Institute Name & Address: MINISTRY OF ENVIRONMENT AND URBANISATION
THE ENVIRONMENT REFERENCE LABORATORY - ANKARA /TURKEY

What is your overall impression of the training course?

- Excellent
- Satisfactory
- Poor
- Better than expected

Do you feel that this training met your needs? (if NOT, please, explain)

- Yes
- To some extent
- Uncertain
- No

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

- Yes
- To some extent
- Uncertain
- No

Do you have a better attitude to your job having completed this course?

- Yes
- To some extent
- Uncertain
- No

Would you recommend that others in your field should attend this course?

- Yes
- To some extent
- Uncertain
- No

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

- Yes
- No

If YES, please indicate relevant topics:

- Trace elements by ICP-OES
- Trace elements by ICP-MS

Others (specify)
Validation, Verification, Uncertainty

TRAINING CONTENT

How do you rate the balance of theoretical and practical material in the workshop?

- Too theoretical Good balance Too practical

How do you rate the balance of lectures, group discussions, and group exercises?

- Good Too many lectures Too many discussion sessions

How do you rate the training's length?

- Too short Just right Too long

How did you feel about the pacing of the course?

- Too fast Just right Too slow

How do you rate the training's sequence?

- Very well sequenced Suitable Poorly sequenced

How helpful were the group exercises?

- Very helpful Helpful Not helpful

Did you have enough skills practice time?

- Yes No Uncertain

How valuable was the training content to your current job?

- Very valuable Of some value No real value

What did you like best about the training course? (Strongest aspects)

The helpful attitude of all instructors

What did you like least about the training course? (Weakest aspects)

.....
.....

What do you think should be dropped from this course?

Comments about the course contents:

INSTRUCTIONAL MATERIAL (on CD ROM)

In your opinion, was the number of handouts you received during the course sufficient?

- Just right Too few Too many

How do you rate the quality of the handout material?

- High quality Sufficient Below expectation

LABORATORIES AND FACILITIES

Did you like the seating arrangements of the conference room?

- Yes No No opinion

How do you rate the practical sessions?

- Excellent Very good Fair Poor

Do you think the number of participants in the workshop was:

- Too many Too few Just right

Comments about laboratory sessions:

What is your overall evaluation of the course?

- Excellent Very good Fair Poor

QUESTIONS FOR THE CERTIFICATE OF PROFICIENCY

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- Report the result in SI unit
- Participate successfully in a Proficiency Testing Scheme
- Use a Reference Material
- Calibrate the critical measurement equipment once a year

5. What is your definition for trace element?

The element which concentration is low.
.....
.....
.....

*Thank you for taking the time to respond to this survey.
Your input is very valuable to us!*

10. *Evaluation of participants' questionnaire*

1. What is your overall impression of the training course ?

80% Excellent Satisfactory Poor 20% Better than expected

2. Do you feel that this training met your needs ? (if NOT, please, explain)

100% Yes To some extent Uncertain No

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

100% Yes To some extent Uncertain No

4. Do you have a better attitude to your job having completed this course ?

100% Yes To some extent Uncertain No

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

100% Yes To some extent Uncertain No

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

100% Yes No

If YES, please indicate relevant topics:

20% Trace elements by ICP-MS
20% Trace elements by ICP-OES
20% GF-AAS
20% Trace elements in seawater
20% Validation, verification, uncertainty

7. How do you rate the balance of theoretical and practical material in the workshop ?

Too theoretical 100% Good balance Too practical

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

100% Good 1 x Too many lectures Too many discussion sessions

9. How do you rate the training's length ?

Too short 100% Just right Too long

10. How did you feel about the pacing of the course ?

20% Too fast 80% Just right Too slow

11. How do you rate the training's sequence ?

20% Very well sequenced 80% Suitable Poorly sequenced

12. How helpful were the group exercises ?

100% Very helpful Helpful Not helpful

13. Did you have enough skills practice time ?

100% Yes No Uncertain

14. How valuable was the training content to your current job ?

100% Very valuable Of some value No real value