

TIMER – Training Course on Internal Monitoring and Emergency Response

AIM

Internal monitoring is an important measure to assess the radiation exposure of people after intakes of radioactive material. Internal monitoring after radiological emergencies requires specific organisational procedures and metrological methods as compared to its application for occupational exposures: measurements of a large number of persons must be organised, a possible external contamination of the persons must be taken into account, higher activities in the body or in the excreta must be expected, worried persons must be attended to etc.

The course was meant to enable

- those experts that come from the field of radiological emergency response to *organise* such measurements themselves,
- those experts that come from the field of internal monitoring to *conduct* such measurements themselves

taking into account the specific requirements of internal monitoring after radiological emergencies.

AUDIENCE

The intended audience of the course was researchers and professionals from either one of the fields mentioned above. A focus was on early-career experts.

The number of participants was restricted to fewer than 20 persons because of the requirements of the laboratory visits and the practical work.

After the approval of 16 applications, 2 persons had to cancel their application ca. 2 months before the course and 2 others had to cancel on short notice. This resulted in the participation of 12 persons. The participants came from Austria, Germany (4), North Macedonia, Portugal, Slovenia, Spain, Sweden (2) and Switzerland.

LECTURERS

All lecturers and instructors were experienced experts from their respective field of work. The list of lecturers and instructors comprised the following persons:

BfS: Oliver Meisenberg (course director), Cornelius Bartels, Ulrich Buchner, Eike Gericke, Maren Groß, Sven Hartmann, Anne-Kathrin Kuhlmei, Christiane Pözl-Viol, Julius Vogt

CIEMAT: María Inmaculada Sierra Bercedo, Juan Francisco Navarro Amaro

IRSN: Guillaume Drouet

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LECTURES

The course started with an **introduction into internal monitoring** in general and a presentation of the two most important groups of methods (**in-vivo measurements and in-vitro bioassay**). Different metrological and analytical methods were presented and compared with each other. The established methods for occupational monitoring served as a starting point and the specific aspects of emergency response illustrated the required adaptations of these methods. A list of these aspects and requirements served as a checklist of knowledge that is needed by the participants when finishing the course.

In **visits of the in-vivo and the in-vitro laboratories** of BfS, the gained theoretical knowledge was substantiated with practical experiences. In particular in the in-vitro laboratory, the participants were invited to conduct radioanalytical procedures themselves.

A talk on **internal dosimetry** showed the participants how to derive from the measurement results in terms of activity to absorbed, equivalent and effective doses.

Lessons that were learned from previous incidents in which internal monitoring was conducted were presented. These incidents comprised

- the assassination of Mr **Litvinenko** with Po-210 (as an example of a malevolent act against a single person and an example of in-vitro bioassay), presented as the Litvinenko TV series with a subsequent intensive discussion based on selected scenes,
- the **Goiânia** accident (as an example of an accident that affected a large number of persons and an example of in-vivo monitoring),
- and the **Fukushima** accident (as an example of a nuclear accident).

Expert medical doctors presented information on the **medical treatment** of severely affected persons such as the treatment of acute radiation syndrome, external decontamination, decorporation therapy and the pre- and in-hospital organisation of the handling of mass casualty events, also comprising contaminated persons.

The consequences of **external contamination** were also presented, comprising the calculation of the local skin dose, possible uptake of activity through wounds, measurements of the contamination of wounds and the required medical treatment of wounds. This was based on two real cases, one with a severe local skin dose and the other one with a significant uptake and subsequent systemic exposure.

A talk on **risk perception and risk communication** enforced the participants' ability to take care of the affected persons (in particular in in-vivo monitoring where an immediate contact between the experts and the persons exists) and to communicate measurement results and their meaning properly. This talk was followed by a practical exercise in groups of 3, where answers to typical questions by worried persons had to be prepared.

It was presented which measures for the protection of members of the public are provided in **emergency-response plans** (such as evacuation and sheltering) and how the affected areas are

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determined with dispersion-modelling tools. In another talk the organisation of emergency-response centres for **nuclear emergencies**, including decontamination, thyroid measurements and dose assessments, was presented.

The participants were informed how in-vivo and in-vitro **measurements of a large number of persons** are organised: which consumables are required, how soon after a possible intake measurements shall be conducted, how long measurements typically take, how the arrival of many persons at an in-vivo laboratory can be handled etc.

In an presentation from the emergency-response unit of BfS, the participants were informed which **measurement devices** are available for field measurements and what their capabilities are.

The course ended with a **field exercise**, in which the in-vivo laboratory had to be prepared by the participants for measurements after a radiological incident. The participants organised routes for the affected persons through the building, substations with specific measures (measurement of external contamination, changing of clothes, measurement of internal activity, explanation of the measurement result etc.), the time flow of these different measures as well as provisions regarding protective equipment and consumables. 12 mimes played affected persons that appeared at the internal monitoring laboratory for measurement. They featured several specific requirements such as wounds, remaining external contamination, disabilities or worriedness. The participants managed to set up a flow plan which allowed the measurement of one person in approximately each ten minutes.

ORGANISATION

The course was held from Monday, July 1st to Friday, July 5th 2024 at the Berlin Office of the German Federal Office for Radiation Protection. BfS operates an internal monitoring service there, which features in-vivo and in-vitro laboratories and which is accredited according to ISO 17025.

The lecturers were experts of their respective field of BfS, IRSN and CIEMAT.

All course materials were provided online on the BfS cloud. They comprised the presentations and further literature (international recommendations, selected publications, official reports etc.) as well as contact details and short CVs of the lecturers and the participants.

No fee was required for participation. However on the other hand the participants did not receive funding of their travel costs.

A social programme was offered during the evenings: an icebreaker event on the first evening as well as two films: *Dirty War*, a motion picture about the planning of and response to an attack with a dirty bomb in the middle of London, and the *Chernobyl* TV series.

FEEDBACK

	Arithmetic mean	Number of ratings (1: lowest, 5 highest)				
		1	2	3	4	5
General ratings						
General view	4,8	0	0	0	3	9
Matching of expectations	4,7	0	1	0	1	10
Difficulty (theory)	2,1	6	2	1	3	0
Enough basic knowledge	4,3	1	0	2	0	9
More lectures?	1,8	7	2	2	0	1
More practical work?	3,8	2	0	2	3	5
Knowledge acquired	4,2	0	0	3	4	5
Missing subjects	1,7	8	2	1	0	1
Ratings regarding specific lectures						
Introduction into internal monitoring	4,9	0	0	0	1	11
In-vivo	4,3	0	0	2	4	6
In-vitro	4,4	0	0	2	3	7
Lab visit in-vitro	4,9	0	0	0	1	11
Lab visit in-vivo	4,8	0	0	1	1	10
Internal dosimetry	4,3	0	0	1	6	5
Medical treatment	4,9	0	0	0	1	11
Emergency scenarios	3,8	0	2	2	3	4
Litvinenko	4,8	0	0	1	0	11
Goiânia	4,5	0	0	1	4	7
Releases from nuclear facilities	4,4	0	1	0	4	7
Measuring large number of persons	4,4	0	0	1	5	6
Measurement equipment of response unit	4,3	0	1	0	5	6
Lessons learned from Fukushima	4,2	0	0	2	6	4
Communication	4,1	0	1	3	2	6
Fast measurements	4,5	0	1	0	3	8
Wound measurements	4,3	0	1	0	6	5
Field exercise	4,7	0	0	1	2	9

In the free-text responses, no distinct trend emerged. However, few professionals from emergency response found some lectures too theoretical and hardly applicable for their usual work.

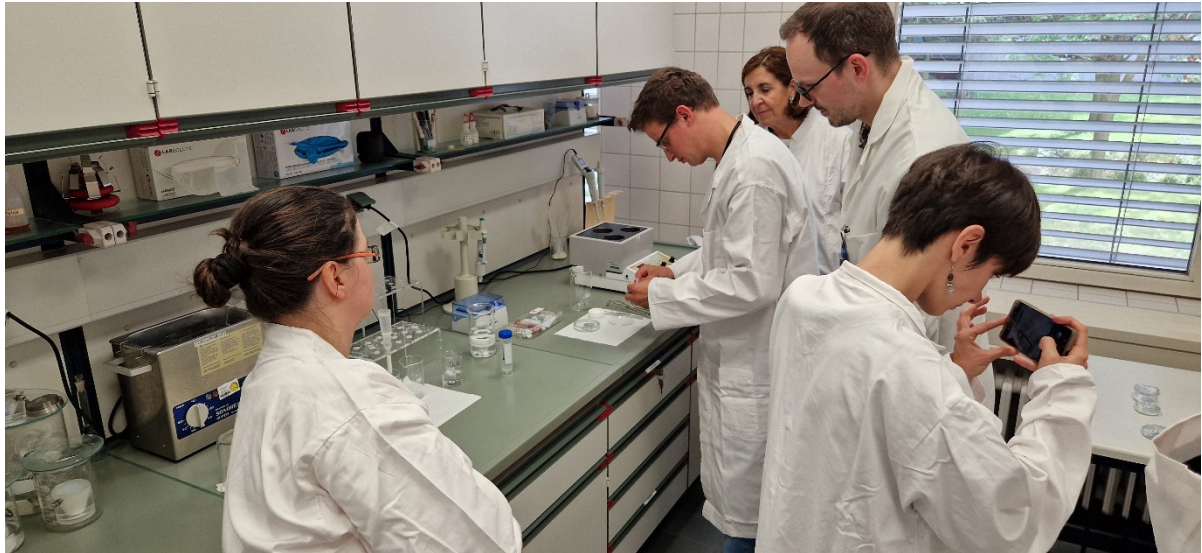
FUTHER ACTIONS

The participants were informed about the possibility to organise a reunion with funding by PIANOFORTE for networking activities and travel.

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The preparation of a manuscript about the content of the training course and the lessons learned for publication in a peer-reviewed scientific journal is planned for the next months.

IMPRESSIONS



Visit of the in-vitro laboratory with hands-on work under the guidance of in-vitro experts from BfS and CIEMAT



Group work during the exercise on risk communication

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During the field exercise: measurement of external contamination, which required particular explanation to the affected person (middle) by the participant who played the member of staff at this station (right)

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SCHEDULE

MONDAY		TUESDAY	
	1		2
08		08	
09		09	6 Internal dosimetry 09:00-10:00, G. Drouet, IRSN
10		10	7 In-vivo/in-vitro measurements 10:05-11:20, lab
11		11	
12	Arrival 12:00-13:30	12	8 Medical treatment 11:30-12:15, C. Bartels, A.-K. Kuhlmeij, BFS
13	1 Introduction into the course; 13:30-14:00, O. Meisenb	13	9 Decontamination, decorporation 13:15-14:15, C. Bartels, A.-K. Kuhlmeij, BFS
14	2 Introduction into internal monitoring; 14:00-14:30, O.	14	10 Emergency scenarios, emergency response plans 14:15-15:00, U. Buchner, BFS
15	3 In-vivo measurements (theory) 14:45-15:30, J.F. Navarro, CIEMAT	15	11 Film: Litvinenko 15:15-18:15
16	4 In-vitro bioassay (theory) 15:30-16:15, I. Sierra, CIEMAT	16	
17	5 In-vivo/in-vitro measurements 16:20-17:40, lab	17	
18	Icebreaker event 18:00	18	
19	Film: Dirty War until ca. 21:00, part of the social programme -> voluntary	19	
20		20	
21		21	

WEDNESDAY		THURSDAY	
	3		4
08		08	
09	12 Discussion of the film 09:00-10:00, O. Meisenberg, BFS	09	17 Lessons learned from Fukushima 09:00-10:00, O. Meisenberg, BFS
10	13 The Goiânia accident 10:00-11:00, O. Meisenberg, BFS	10	18 Communication with affected persons, risk perception 10:00-11:00, M. Gruß, BFS
11	14 Provisions for releases from nuclear facilities 11:15-12:15, O. Meisenberg, BFS	11	19 Exercise: Communication with affected persons 11:00-12:00, M. Gruß, BFS
12	15 Organising measurements of a large number of persons 12:15-13:15, O. Meisenberg, BFS	12	
13	16 Presentation of measurement equipment of the BfS emergency-response team 13:30-16:00	13	20 Fast in-vivo measurements with mobile detectors 13:00-14:00, O. Meisenberg, BFS
14		14	21 Wound measurements 14:00-14:45, O. Meisenberg, BFS
15		15	22 Field exercise: Organising measurements of a large number of persons (in-vivo) 15:00-17:30, O. Meisenberg, BFS
16		16	
17		17	
18		18	
19	TV series: Chernobyl 18:30-21:30, part of the social programme -> voluntary	19	TV series: Chernobyl 18:30-20:30, part of the social programme -> voluntary
20		20	
21		21	

FRIDAY	
5	
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09	23 Discussion of the exercise 09:00-09:45, O. Meisenberg, BfS
10	24 Short exam 09:45-10:30, O. Meisenberg, BfS
11	25 Discussion of the exam and of the week 10:45-12:15
12	Departure 12:15
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