Publishable Summary for 16ENV04 Preparedness Metrology for mobile detection of ionising radiation following a nuclear or radiological incident

Overview

The protection of the public against ionising radiation and radioactive contaminations caused by nuclear or other radiologically relevant incidents or accidents (i.e. events), including terrorist attacks, is of major importance and may affect thousands of people. Following a radiological event, radiation protection authorities and other decision makers need quick and credible information on affected areas. Therefore, this project will develop reliable instrumentation and methods needed in the field of preparedness, so that correct decisions on countermeasures will be possible. In addition, new measuring devices and methods will be developed to quickly gather quantitative data on contaminated areas and dose rate levels by aerial measurements, and to analyse contamination of the air by flexible transportable systems. This project will further work on improved methods for long-term monitoring of contaminated areas and will investigate whether non-governmental networks could support official data or undermine it. The results of this project will enable an adequate response for the protection of the public and the environment against dangers arising from ionising radiation during and in the aftermath of a nuclear or radiological event.

Need

Following a nuclear or radiological event, fast and appropriate radiation protection measures, based on reliable radiological data, are of high priority for decision makers worldwide. The nuclear accidents in Chernobyl (1986) and Fukushima (2011) are major examples where such protection measures were crucial. But also a number of smaller accidents and incidents caused severe problems, e.g. the Tokaimura nuclear accident (1999). According to the IAEA Safety Standard No. GSR Part 7 ‘Preparedness and Response for a Nuclear or Radiological Emergency’, safety and security measures have in common the aim of protecting human life and health and protecting the environment. It also emphasises the importance of adequate protective measures in the aftermath of nuclear and radiological emergencies. Reliable radiological data, available at the earliest possible stage, are a prerequisite to protect people effectively from such unexpected but potentially highly dangerous events.

In the vicinity of a nuclear or radiological accident, as well as for large-area ground contaminations, monitoring by unmanned airborne monitoring systems, which consist of unmanned aerial vehicles (UAVs) with spectrometric detectors, are the best solution to protect operators against contaminations and irradiation. However, advanced calibration procedures based on reference materials and standard radionuclide sources must be elaborated for these systems and verified by Monte Carlo simulations. For airborne radioactivity monitoring, transportable field stations equipped with high-resolution spectrometric detectors and appropriate shielding are needed to allow the measurement of radioactivity concentration levels in affected areas.

During a large nuclear or radiological emergency with the release of a radioactive plume to the atmosphere, the levels of ambient dose equivalent rate and activity concentrations provide essential information about the progression of the radioactive cloud. This information is important to decision makers in order to be able to take timely and adequate counter measures to protect the members of the public against the dangers of ionising radiation.

After a major release of radionuclides, a short-term decontamination may not be possible. Hence, concepts for long-term measurements have to be developed. Metrologically sound data is needed in this field too, because decisions on e.g. decontamination measures or release of restricted areas are of crucial importance. Passive dosemeters must therefore be studied with regard to their suitability to be used for this purpose.

Objectives

The overall objective of this project is the establishment of a metrological basis to support adequate protective measures in the aftermath of nuclear and radiological emergencies. To achieve this, the specific objectives of this project are:

1. To develop unmanned aerial detection systems installed on aerial vehicles[1] and helicopters for the remote measurement of dose rates and radioactivity concentrations. In addition, to establish novel methods applicable to core and remote areas of a nuclear or radiological incident for air-based radiological measurements including dose rates, radioactivity concentrations, traceable calibrations for the determination of ground surface activities and interpretation methodologies for rotary-wing unmanned airborne monitoring system or helicopter based radiological measurements.
2. To develop transportable air-sampling systems for immediate information on radioactive contamination levels in air. This will include generating industry appropriate pre-production models of modular and portable air-sampling systems based on gamma spectrometric detectors that can be quickly transported to places of interest.
3. To investigate the metrological relevance of 'crowd sourced monitoring' data on dose rates and provide recommendations on the usability of such data. In addition, to develop handy detector systems with the potential to be used as dose rate measuring instruments in governmental and non-governmental applications.
4. To establish stable and reproducible procedures to measure ambient dose equivalent rates using passive dosimetry in order to harmonise passive dosimetry for environmental radiation monitoring across Europe.
5. To facilitate the take up of the technology and measurement infrastructure developed in the project by the measurement supply chain (instrument manufacturers, accredited laboratories), standards developing organisations (ISO, IEC) and end users (national nuclear regulatory bodies, decision/policy makers e.g. IAEA, European Community Urgent Radiological Information Exchange (ECURIE), OECD/NEA, EURADOS, UNEP, WHO, WMO).

Progress beyond the state of the art

This project will establish traceable calibration procedures, so that a sound interpretation of measured data from unmanned aerial detection systems is possible, prepare new unmanned aerial detection systems for serial production, develop mobile systems with on-line measurement capability that can be easily and timely transferred to areas of interest, evaluate the metrological possibilities and limits of data published by non-governmental networks, and develop recommendations and guidelines, which will serve as a basis for the development of international standards.

Results

Unmanned aerial vehicles for dose rate and activity concentration measurements

The staff of manned aerial detection systems, which are foreseen in the national emergency planning of several European countries, can be exposed to contaminations in air (when radionuclides are spread in the air) or to high levels of ionising radiation. The use of UAVs equipped with appropriate detector systems for the measurement of ionising radiation avoids this risk and allows the assessment even of core centres of affected areas in the case of a radiological emergency. To facilitate the deployment of such unmanned vehicles, this project aims to develop novel and optimised measuring procedures for the mobile detection of ionising radiation. This project will establish traceable calibration procedures, so that a sound interpretation of measured data will become possible. Investigations will be performed at dedicated aerial test sites by using radioactive reference sources. Procedures to calibrate UAV based radiation monitoring systems will be developed and validated using metrologically sound approaches, for the first time. The correct aerial measurement of dose rates and ground contamination levels is a highly scientific and metrological challenge considerably beyond the state-of-the-art.

[1] In the public, multi-rotor aerial vehicles are often called 'drones'.

Transportable air-sampling systems

Airborne radioactivity monitoring in Europe mainly uses the stationary field stations of the national early warning networks. Their average distance is considerable (up to some hundreds of kilometres) and hence the collected data are not representative for localised nuclear or radiological accidents. Therefore in this project, mobile systems will be developed that can be transferred easily and in a timely manner to areas of interest, especially contaminated zones or other places where an accident happened. A pre-production version of a modular and mobile air sampling system will be developed and tested for the first time.

Non-governmental networks

After the Fukushima accident, non-governmental networks, which collect and disseminate dose rate data, appeared worldwide e.g. the Safecast network. These networks are operated by laypersons who run cheap, non-professional instruments under undefined measuring conditions. Although the metrological quality of these data is questionable, the increasing density of these networks as well as the high availability of the measured data may have a strong political impact in case of an emergency. Therefore, the metrological relevance of data from such networks and the feasibility of including such data into that reported by governmental networks will be investigated.

Passive dosimetry

In Europe, there are approximately 100 dosimetry services e.g. governmental offices, companies, and institutions associated with a research facility or a hospital. They have in common that they use passive area dosemeters (dosemeters without inbuilt electronics) for environmental monitoring. A survey by the European Radiation Dosimetry Group showed that some of these services are neither traceable to primary dosimetric standards nor accredited. Due to the lack of international standards, a variety of different measurement procedures and uncertainty calculation methods are used. The application of passive detectors for radiation protection is not trivial. Due to the natural background radiation, it is difficult to verify the compliance of measured data with the limits of the effective dose defined by the European Basic Safety Standards for radiation protection, e.g. 1 mSv per year for the public. As harmonisation is urgently needed even in routine monitoring, recommendations and guidelines will be elaborated, which will serve as a basis for the development of international standards. For nuclear and radiological accidents, the feasibility of follow-up surveillance using passive dosemeters will be investigated and conclusions will be drawn.

Impact

Impact on industrial and other user communities

Reliable radiological data is of key importance for the protection of the public against dangers arising from ionising radiation. In line with that, the relevance of dose rate data provided by non-governmental networks and the feasibility of using such data for the European Data Exchange Platform (EURDEP) will be investigated for the first time. Reliable radiological data will allow appropriate countermeasures and reduce the risk of exaggerated actions and preventable follow-up costs. Appropriate and accurate radiological data on radiation levels and environmental damage will strengthen the confidence and credibility of the public in the decisions of the legal authorities (a goal which is in line with of EC DG ENER).

Environmental damages will be minimised as a result of early and correct decisions of national nuclear regulators based on quick accurate data about ground surface contamination and airborne radioactivity levels. Timely data transfer between national regulators, in case of the release of radioactive material with trans-boundary implications, will be possible.

The development and test of radiation detection systems, together with a good practice guide on the measurement of dose rates and radioactivity concentrations using measurement systems that will have been developed in the project, will be useful both for the metrological community working in this field and for end users (e.g. regulatory authorities, supervisory authorities, civil protection or official measuring bodies) and for manufacturers of dosemeters, contamination monitors or other radiation meters.

To promote the uptake of the project's outputs, these will be disseminated to a network of stakeholders and end-users, formally organised with the assistance of a stakeholder committee.

Impact on the metrological and scientific communities

The progress in measurement technologies to be achieved in this project will improve early identification of affected areas including identification of radionuclides, e.g. Cs-137, I-131, Ba-140, Ce-141, Ru-103 and Np-239 as well as the determination of contamination levels. Such novel instrumentation is essential for a quick and adequate response by nuclear regulatory bodies and other decision makers, e.g. of local authorities or aid organisations, during and in the aftermath of a nuclear or radiological accident.

After establishing aerial calibration and test sites for airborne dosimetric and spectrometric instruments, standardised procedures will be available for European measuring services and governmental bodies. In this scope of application, the verification of methods to measure absolute dose rates and activity concentrations on a metrological basis will be a major step forward in quality assurance. In addition, harmonised procedures will result in a mutual recognition of calibrations, with transparency and significant cost saving for the customers. As a further direct impact of this project, more reliable dose values in routine monitoring using passive dosimetry systems will become available on a European scale. This and other goals of the project are in line with the policy of the EC DG ENER.

The results of this project will be disseminated to the interested community via several conference presentations and will be available at the project website and publications in peer-reviewed journals. In addition, communities such as EURADOS will serve as a platform to share results of this project with experts in this field.

Impact on relevant standards

The project also aims at an international harmonisation, by providing guidance for stakeholders and by providing input to international standardisation bodies (ISO, IEC), as far as nuclear and radiological emergency preparedness is concerned. The project will help to fulfil the IAEA requirements listed in the Convention on *Early Notification of a Nuclear Accident and in the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency* of the European Commission.

Members of the consortium are involved in the following committees: ISO/TC85 (Nuclear Energy), IEC/TC45 (Nuclear Instrumentation), EURAMET TC-IR (Technical Committee for Ionizing Radiation), ICRM (Gamma and Beta Spectrometry WG, Alpha Spectrometry WG and Low Level WG) and BIPM CCRI I and II. This will ensure that the harmonised procedures and methods developed in this project will input directly into European and international standardisation.

List of publications

There are no publications at this early stage of the project.

Project start date and duration:	1 August 2017, 36 months	
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