European Metrology
Research Programme
Delivering Impact


The CEGAM transportable air-sampling system

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Improving Europe's response to nuclear incidents

Worldwide, since 1952, 100 incidents at nuclear plants have resulted in loss of life or more than US$50,000 of property damage per incident. Accurate data on types and amounts of radiation present is vital for appropriate responses. Permanent monitors at plants can fail and current mobile detectors offer short-term solutions. A mobile monitor for long-term monitoring has now been developed, strengthening Europe's preparedness for nuclear incidents.

Europe's National Measurement Institutes working together

The European Metrology Programme for Innovation and Research (EMPIR) has been developed as part of Horizon 2020, the EU Framework Programme for Research and Innovation. EMPIR funding is drawn from 28 participating EURAMET member states to support collaborative research between Measurement Institutes, academia and industry both within and outside Europe to address key metrology challenges and ensure that measurement science meets the future.

Challenge

Major nuclear disasters are rare but when they occur large amounts of radionuclides, are released. In 1986 explosions at the Chernobyl nuclear power plant (NPP) covered an area of Europe greater than 200 000 km^2 with radioactive caesium and other radioactive nucleotides. Twenty-five years later, in 2011, a tsunami disrupted the Fukushima plant sending radioactive iodine and caesium into the atmosphere and ocean, contaminating 3000 km^2.

All NPPs are equipped with static radiation detectors but in the case of Fukushima delays in evacuating civilians were partially blamed on the failure of 23 of the 24 monitoring stations at the reactor – leaving authorities with no knowledge of the level or type of radiation present.

In addition, many static systems rely on pre-programmed criteria for measurements and are unable to provide real-time data, limiting functionality in response to an incident.

Portable detectors provide excellent, rapid responses but are short-term and labour intensive for long-term follow-up monitoring of a site – especially when large areas have become contaminated. A mobile monitor capable of long-term, autonomous monitoring would allow faster and more timely response following an incident, protecting civilians and the environment.

Solution

In the EMPIR project Preparedness the Czech Metrology Institute (CMI) and NUVIA, an international company specialising in radiation protection and detection instruments, developed a new transportable air-sampling system - the Continuous Environmental Gas Aerosol Monitor (CEGAM).

Containing a high purity Germanium (HPGe) gamma detector, surrounded by 10cm of lead shielding to reduce environmental effects, air-borne radionuclides are captured on filters which are analysed automatically with used filters stored internally allowing later re-analysis to ensure the accuracy of the data. Sampling time can be adjusted remotely to allow long-term monitoring or shortened for the capture and analysis of radionuclides with short half-lives.

Using an embedded programmable logic controller, the CEGAM software subtracts the background contribution of natural radionuclides and sends data wirelessly in real-time to a control station. This includes data filtering, spectrometric analysis, and information on minimum detectable radionuclide activities with associated measurement uncertainties.

The system was calibrated using radionuclide standard sources traceable to the primary standards of CMI and NPL, the NMI of the UK, before transferring to the NPP Dukovany, where it was field trialled for over a year.

During this time hundreds of filters were analysed and the CEGAM system demonstrated full capability for autonomous data collection on the type and level of 20 different artificial radionuclides generated by a nuclear reactor.

Impact

The metrologically validated CEGAM monitor developed by NUVIA and CMI can be easily transported by vehicle to a location once the site of an incident is confirmed. Capable of long-term, autonomous monitoring it can support data from static radiation monitors and hand-held, backpack or drone mounted detectors.

It can use different types of HPGe detectors, enabling easy identification of gamma emitting radionuclides present in the environment and the detector can easily be changed without necessity of recalibration, reducing the cost of maintenance.

The CEGAM is equipped with a modem allowing remote access and control of such elements as sampling time and data acquisition, reducing the need of human intervention and increasing the functionality in response to an incident

The introduction of these types of mobile monitors will help minimise the societal, economic, and environmental damage caused by a radiological incident, allowing the prompt determination of exclusion and off-site emergency zones by Governments based on sound, trustworthy metrologically obtained data.

Protecting the public from radiation exposure

The Preparedness project extended metrology for mobile detection of ionising radiation. Two new dose rate detectors were validated and three transportable systems for the monitoring of gamma-ray emitting radioactivity in the air were developed, calibrated and tested with industrial partners.

The ability of unmanned aerial drones to accurately detect natural and artificial radiation levels was investigated. Two intercomparison exercises were carried out at drone centres resulting in a good practice guide. New unmanned aerial detection systems were designed and prepared for production, realising novel concepts in ground radioactivity monitoring for nuclear or radiological emergency response.

The reliability of sixty-four passive dosimetry detectors systems used by 38 European dosimetry services was investigated for their capability to long-term monitoring of contaminated environmental areas. In addition, the largest ever analysis on monitoring radioactivity and ionizing radiation by non-governmental networks was performed, potentially complimenting results from Governmental detection networks. The results of the project will support timely, effective action that protects the public and environment against the effects of ionising radiation in the aftermath of nuclear and radiological emergencies.

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