Swipe check: collecting and analysing environmental samples

By Aabha Dixit

"No matter how much you clean a kitchen, a speck of material dust always remains. This is also true in a nuclear facility. This enables environmental sample swipe analysis to detect what elements have been used."

— Stephan Vogt, Head, Environmental Sample Laboratory, IAEA

The air is pressurized, carefully filtered and closely monitored. Scientists and technicians pass through air showers before entering. Welcome to the IAEA Environmental Sample Laboratory, or 'clean laboratory', in Seibersdorf, Austria, where more than 300 samples are analysed every year to verify that nuclear facilities have been used as declared.

The clean laboratory conditions are necessary so that the smallest traces of uranium and/or plutonium can be identified in the swipe samples taken by inspectors at research reactors, enrichment plants and other nuclear facilities for analysis. The machines used are so sensitive that they can pick out uranium and plutonium at weights below one trillionth of a gram in a sample.

Inspectors taking a swipe sample at a nuclear facility.
(Photo: IAEA Department of Safeguards)

"No matter how much you clean a kitchen, a speck of material dust always remains. This is also true in a nuclear facility. This enables environmental sample swipe analysis to detect what elements have been used," said Stephan Vogt, Head of the IAEA Environmental Sample Laboratory.

While many safeguards verification methods aim to check and confirm the type and quantity of nuclear material declared by a State, environmental sampling is used to verify the absence of undeclared nuclear material.

How IAEA swipe sampling began

In the 1990s, a nuclear facility in Iraq was bombed and there was no way for IAEA inspectors to perform conventional verification activities at the destroyed site. Instead, the inspectors innovated. They used cotton cloths to 'swipe' items from the damaged facility and analyzed them to determine what elements were used in the facility prior to its destruction. An entire spectrum of uranium — from depleted to highly enriched — was identified. The contaminated cloths were able to reveal important information about the history of the destroyed nuclear facility. The notion of using swipe sampling as part of IAEA verification activities was born.

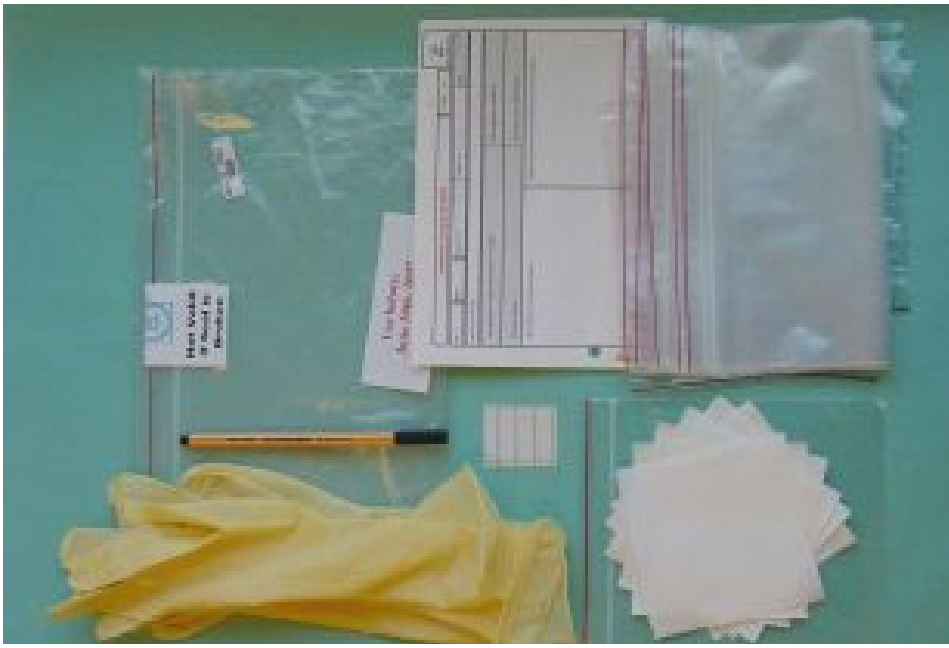
Environmental sampling is now part of the IAEA's standard processes. The environmental sample kits for inspection purposes are all prepared in the laboratory's 'clean room.' The sealed packaged swipes are only opened at the designated area of inspection. The package contains two pairs of latex gloves, 6 to 10 cotton swipes, as well as additional ziplock packets for the swiped samples. These are then placed in an outer sealed bag until they reach the IAEA.

Surfaces at various locations at a nuclear or related facility are swiped a number of times. Back at the laboratory, these samples are subject to highly sophisticated analyses using advanced technology (see box).

Samples are analysed at the IAEA laboratory as well as at the 19 accredited laboratories in eight IAEA Member States and the European Atomic Energy Community (Euratom). Labs in Australia, Brazil, France, Germany, Japan, Russia, the Republic of Korea, the United Kingdom and the United States are part of the IAEA's network of affiliated laboratories.

To maintain the confidentiality of the process, all collected swipe samples are subjected to a rigorous labelling system that removes the identity of the country and the place of collection. Anonymized samples undergo an initial investigative screening for radioactive signatures and major elemental composition and are then sent to the designated laboratories in Member States, Vogt said. Among the samples the IAEA sends are also blind quality control samples so that measurements can be assessed against the standards set by the IAEA and a consistent high quality maintained.

Careful collection and thorough analysis of environmental samples is now an essential element of the IAEA's safeguards work. "These activities enable the IAEA to verify that nuclear facilities have been used as declared and to build confidence in the peaceful uses of nuclear technology," said Tero Varjoranta, Deputy Director General and Head of the IAEA Department of Safeguards.



Sample kit for environmental sampling.
(Photo: IAEA Department of Safeguards)

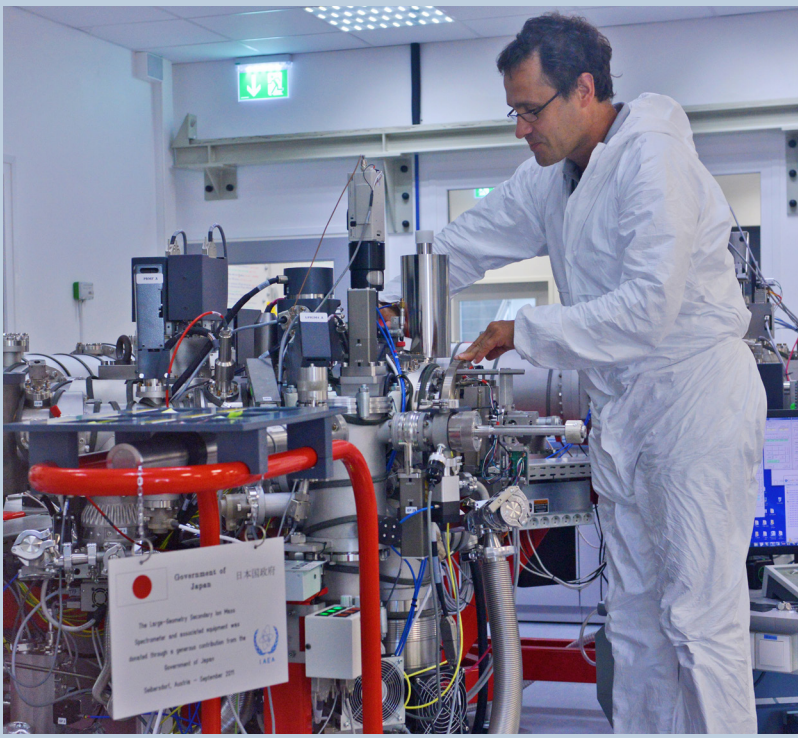
THE SCIENCE

Tracking signature elements and isotopes

All swipe samples are screened using gamma and X-ray spectrometry that can detect the type of element and radioisotope present. "The methodology for the swipe screening is non-destructive, which means that the samples are not destroyed or decomposed prior to screening and they do not get compromised throughout the examination process," Vogt said.

Mass spectrometers are used to determine the isotopic composition of uranium or plutonium contained in the swipe samples. The method is so sensitive, it can identify a single particle that is 100 times smaller than the width of a strand of hair.

The large geometry secondary ion mass spectrometer measures the uranium isotopic composition in micrometre-sized particles. It provides a powerful analytical tool for 'isotopic fingerprinting' of individual uranium particles. Another method to analyse samples is bulk analysis, looking at the uranium and plutonium content and the isotopic composition of the combined material on a swipe. Typically samples are sent out simultaneously for bulk and particle analysis, Vogt added.



Swipe samples being analysed at the IAEA Environmental Sample Laboratory in Seibersdorf, Austria.
(Photo: D. Calma/IAEA)