



Contribution ID: 46

Type: oral

Environmental Low-level Noble Gas Measurements for Nuclear Non-Proliferation Treaty Verification Purposes

Thursday, 23 October 2014 09:10 (20 minutes)

The measurement of radioactive noble gases has been used since the Manhattan Project in the 1940s and later during the Cold War to monitor other countries' nuclear programmes and progress. In more recent times, it plays an important role as a tool in international nuclear verification regimes.

Various noble gases are created as fission products in nuclear processes such as burn-up of nuclear fuel in nuclear reactors, target irradiation for medical isotope production, and nuclear accidents and explosions. Being chemically inert, noble gases will not react with the ambient environment or deposit on the ground once entered into the atmosphere, but will only disappear due to radioactive decay. They are, therefore, very good tracers for revealing specific nuclear activities and can help in verifying non-proliferation treaties.

Radioxenon isotopes as well as Krypton-85 are anthropogenic isotopes produced through fission of uranium or plutonium. The analysis of krypton in the atmosphere could help in verifying compliance with the Nuclear Non-Proliferation Treaty by monitoring nuclear fuel re-processing activities. The detection of the radioxenon isotopes could give indications e.g. on illicit nuclear fission experiments, a nuclear explosion, clandestine nuclear reactors or other violations of non-proliferation treaties.

Argon-37 is an anthropogenic isotope produced when fission neutrons react with calcium in rock. Its identification in the lower troposphere or in soil gas can be an indication for the detonation of a nuclear device. Other noble gases like argon-41 and various short-lived krypton isotopes may be used for nuclear safety monitoring or reactor operation surveillance.

This paper will describe how these noble gases are created and measured, the history of their use for nuclear verification, and the most modern advancements in the measurement technology and data interpretation.

Country or International Organization

IAEA

EPR Number (required for all IAEA-SG staff)

714

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Session Classification: Noble Gas Measurements in Support of Nuclear Safeguards Implementation