VERIFICATION SCIENCE

Joining forces to reduce radioxenon emissions

While monitoring the globe for signs of a nuclear explosion, experts at the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) frequently detect radioxenon – a radioactive form of the chemical element xenon.

Since radioxenon isotopes are produced in large quantities during fission in a nuclear explosion, they play a major role in confirming whether or not an underground explosion was nuclear in nature.

XENON EMISSIONS FROM A SURPRISING SOURCE

Many people assume that the main sources of this noble gas are the 400-plus nuclear power reactors around the world that produce electricity. However, this is not the case: nuclear plants emit only small quantities of xenon because they have effective retention systems. In 2002 monitoring scientists from Health Canada discovered an unlikely source – facilities that produce life-saving medicines. The isotopes produced by these facilities play an important role in diagnostics, for example, and are used in nuclear medicine worldwide for more than 30 million diagnostic procedures a year. Production facilities are operated in about 10 countries today, with most producers in Europe, North America and Australia. Radioisotopes in healthcare are in high demand, especially an element called technetium-99m.

"Medical isotopes must be produced continually and used efficiently in order to meet demands. The medical isotope production facility in Serpong in western Java, Indonesia – Pt. BATAN Teknologi – serves 16 hospitals in Indonesia," explained Yudiutomo Imardjoko, the facility's Chief Executive Officer. "We also export to medical centres in Bangladesh, Thailand, Malaysia and Vietnam. We are planning to expand exports of medical isotopes to India and Japan. The growth rate of medical isotope production in Asia is about 10% per year so we need to increase our production because Pt. BATAN Teknologi is the only producer in the region."

For the CTBTO, it is of great importance to understand the sources of environmental radioxenon to be able to distinguish civil sources from those of a nuclear explosion. The CTBTO's global network of stations – the International Monitoring System (IMS) – will comprise 337 facilities when complete, including 40 radionuclide stations capable of detecting radioxenon. Thirty-one of these radionuclide stations are already equipped with noble gas capabilities.

HIGH STAKE CHALLENGES

While medical sources of radioxenon do not pose any health risk, they are a cause for concern because the readings from these emissions resemble those of a nuclear explosion.

At a large scientific conference organized in Vienna in June 2013, the *CTBT: Science and Technology 2013 Conference*, a special panel was dedicated to the issue of emissions by radiopharmaceutical plants. CTBTO radionuclide expert Mika Nikkinen explained that the impact on IMS stations varies greatly, with up to 400 detections per year at one station and only a single one at others.

At the CTBTO's headquarters in Vienna, analysts scrutinize about 18,000 samples of xenon a year, which are registered by IMS stations

Medical isotopes play an important role in medicine, for example in diagnostics.

around the world. Multiple civil sources of radioxenon that can mask signals from a nuclear explosion mean that stakes are high.

Even small quantities of xenon can affect the reliable detection of nuclear explosions. In order to address this challenge, the CTBTO is collaborating with scientists and medical isotope producers in an attempt to improve xenon monitoring and reduce emissions. Producers are exploring different methods to achieve reductions. Joint work seeks to establish a voluntary threshold for xenon emissions, and to improve scientific understanding of background levels in the air.

MONITORING AT THE SOURCE

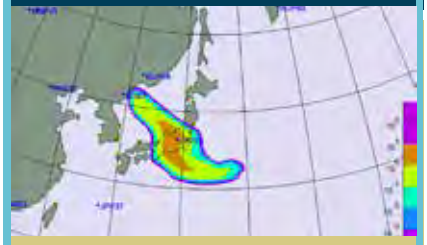
"As the production of medical isotopes increases, so does the prospect of radioxenon emissions into the environment, which is why we agreed to take part in a background radioactive xenon measurement campaign," said Yudiutomo Imardjoko. "In October 2012, a stack monitoring system was installed at the Serpong facility with the support of the CTBTO and the United States. By monitoring radioxenon that is released into the environment, this system plays a key role in controlling emissions in an industrial setting. As it stands right now, the maximum xenon release should not exceed 5 x 10^9 Becquerel (Bq) per day (Recommendation from the Workshop on Signatures of Medical and Industrial Isotope Production, Strassoldo, Italy, July 2012). Radioxenon releases from PT. Batan Teknologi are nowhere near as high as that figure."

UNDERSTANDING XENON BACKGROUND LEVELS

Through joint campaigns in Japan, Kuwait, Indonesia and other countries, and with the support of the European Union (EU), advanced automated detection systems have been established to measure noble gases in more places, thus providing evidence of the background levels of radioxenon in the atmosphere.

In Jakarta, Indonesia, a system to measure noble gases has been set up at the BATAN Center for Technology, Metrology and Safety. This customized transportable xenon lab is known as the TXL. The unit can be up and running within days after delivery. According to Susilo Widodo, Director of

NORTH KOREA'S 2013 ANNOUNCED NUCLEAR TEST



When the CTBTO's radionuclide station in Takasaki, Japan, detected two radioactive isotopes of the noble gas xenon almost two months after North Korea announced that it had conducted a nuclear test on 12 February 2013, CTBTO experts worked closely with national authorities to eliminate the hypothesis of other radioxenon sources in the region. The ratio of the isotopes was found to be consistent with a nuclear fission event occurring more than 50 days before the detection. CTBTO experts also used a technique called Atmospheric Transport Modelling (ATM) to backtrack the travel paths of the radioxenon; ATM calculations indicated that the North Korean test site was a possible source for the emission.

Inside Indonesia's Serpong medical isotope production facility.

CTBTO Executive Secretary-elect Lassina Zerbo (left) and Jean-Michel Vanderhofstadt, Manager Director, Institute for Radioelements, signing a pledge to cooperate to mitigate the effects of radioxenon emissions in Vienna, Austria, on 20 June 2013.

the Center for Technology of Radiation Safety and Metrology at BATAN, the system now operates continuously every day and data are sent routinely to the International Data Centre in Vienna for evaluation. As Ted Bowyer, Program Manager Nuclear Explosion Monitoring, Pacific Northwest National Laboratory, USA, explained, the TXL has been used in collaboration with local partners and also with the CTBTO to make measurements in locations across the world.

MITIGATING THE EFFECTS OF NOBLE GAS EMISSIONS

In an important development in June 2013, the Belgium-based Institute for Radioelements (IRE) signed a pledge to cooperate with the CTBTO to mitigate the effects of noble gas emissions. The IRE is a major worldwide producer of radioelements used for diagnoses and therapeutics in nuclear medicine.

Through its voluntary contributions, the EU supports the development of the mitigation systems that will be used by the IRE. At the *CTBT: Science and Technology 2013 Conference*, the EU also sponsored the "EU Star Award for best presentation on a verification topic," which was awarded to Johan Camps from the Belgian Nuclear Research Centre (SCK•CEN) for his work to test radioxenon mitigation methods at the IRE.

SUSTAINABLE GLOBAL COLLABORATION

Ultimately, cooperation helps achieve bigger goals. "Our prime responsibility is verifying the CTBT. It's all about collaboration because we have to put everything in the context of helping the International Monitoring System to assist the verification of the Treaty. When people see there's collaboration, I think it can only help for trust-building," says the CTBTO's Executive Secretary Lassina Zerbo. "The noble gas background measurement is an important factor. It is one of the important measures that gives the nuclear nature of a test."

»We are pleased to cooperate on mitigating xenon emissions with the CTBTO, while keeping our focus on health care for the around 6 million patients who receive our products each year.«

JEAN-MICHEL VANDERHOFSTADT,
MANAGING DIRECTOR, INSTITUTE FOR RADIOELEMENTS