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## A Study of Candidate Nondestructive Assay Methods for Unattended UF<sub>6</sub> Cylinder Verification: Measurement Campaign Results

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Verification of uranium hexafluoride (UF<sub>6</sub>) cylinders is one of the key components of enrichment plant safeguards, and in recent years, the International Atomic Energy Agency (IAEA) has explored the possibility of developing an Unattended Cylinder Verification Station (UCVS) to provide 100% verification of cylinders within an enrichment facility while reducing the need for routine measurements and sampling during on-site inspections. In 2011, the U.S. Department of Energy (DOE) and the European Atomic Energy Community (Euratom) signed an Action Sheet for the exchange of recent findings and a joint measurement campaign to advance the capabilities of both parties in the area of nondestructive assay (NDA) methods for UF<sub>6</sub> cylinder verification. The measurement campaign occurred in May 2013 at URENCO's gas centrifuge enrichment plant in the Netherlands and included participants from Pacific Northwest National Laboratory (PNNL), Los Alamos National Laboratory (LANL), the Joint Research Centre (JRC) in Ispra, the EC's Nuclear Safeguards Directorate, and an observer from the IAEA. Over five days at the site, the participants measured a total of 45 cylinders. Included in the population were typical 30B and 48Y cylinders containing feed, product, and tails and, in order to stress test the NDA systems, a smaller subset of atypical cylinders containing reprocessed (i.e., uranium derived from reactor recycle), non-homogenized, or very old UF<sub>6</sub>. The joint measurement campaign allowed for the direct comparison of mature handheld gamma-ray detectors that are in regular use by Euratom inspectors with two emerging NDA technologies for UF<sub>6</sub> cylinder verification, namely the Hybrid Enrichment Verification Array (HEVA) and the Passive Neutron Enrichment Meter (PNEM). This paper provides an overview of the Action Sheet, background on the two emerging NDA techniques, a summary of the measurement campaign results, and the implications for a potential UCVS.

### Country or International Organization

USA

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