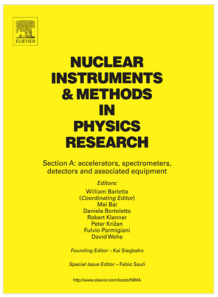
Accepted Manuscript



^{235}U enrichment determination on UF_6 cylinders with CZT detectors

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PII: S0168-9002(17)31224-X
DOI: https://doi.org/10.1016/j.nima.2017.11.026
Reference: NIMA 60269

To appear in: *Nuclear Inst. and Methods in Physics Research, A*

Received date : 18 August 2017
Revised date : 28 September 2017
Accepted date : 7 November 2017

Please cite this article as: R. Berndt, P. Mortreau,^{235}U enrichment determination on UF_6 cylinders with CZT detectors, *Nuclear Inst. and Methods in Physics Research, A* (2017), https://doi.org/10.1016/j.nima.2017.11.026

^{235}U enrichment determination on UF_6 cylinders with CZT detectors

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Keywords:

Gamma spectrometry, Nuclear Safeguards, cadmium Zinc Telluride, Semi-conductors detectors, ^{235}U enrichment, UF_6, Non-destructive assay methods

Abstract

Measurements of uranium enrichment in UF_6 transit cylinders are an important nuclear safeguards verification task, which is performed using a non-destructive assay method, the traditional enrichment meter, which involves measuring the count rate of the 186 keV gamma ray. This provides a direct measure of the ^{235}U enrichment. Measurements are typically performed using either high-resolution detectors (Germanium) with e-cooling and battery operation, or portable devices equipped with low resolution detectors (NaI). Despite good results being achieved when measuring Low Enriched Uranium in 30B type cylinders and natural uranium in 48Y type containers using both detector systems, there are situations, which preclude the use of one or both of these systems.

The focus of this work is to address some of the recognized limitations in relation to the current use of the above detector systems by considering the feasibility of an inspection instrument for ^{235}U enrichment measurements on UF_6 cylinders using the compact and light Cadmium Zinc Telluride (CZT) detectors.

In the present work, test measurements were carried out, under field conditions and on full-size objects, with different CZT detectors, in particular for situations where existing systems cannot be used e.g. for stacks of 48Y type containers with depleted uranium.

The main result of this study shows that the CZT detectors, actually a cluster of four μCZT1500 micro spectrometers provide as good results as the germanium detector in the ORTEC Micro-trans SPEC HPGe Portable spectrometer, and most importantly in particular for natural and depleted uranium in 48Y cylinders.

1. Introduction

Measurements of uranium enrichment in UF_6 cylinders are a significant Nuclear Safeguards task. They are routinely carried out by a non-destructive assay method using the traditional enrichment meter principle, which is based on the proportionality between the net peak area of the 185.7 keV line of ^{235}U, and the enrichment in case of infinitively thick samples [1].

Both high-resolution and low resolution detectors are currently used routinely by nuclear inspectors for this purpose. Inspection instruments include the ORTEC Micro-trans SPEC HPGe Portable spectrometer [2] equipped with a germanium detector of 50 mm diameter and 40 mm length, and the hand-held monitor system HM-5 equipped with a NaI detector of 1 inch diameter * 1 inch thickness [3].

[1] *Retired*