Evaluation of New X-Ray Fluorescence Instrumentation at Hazmat and Abandoned Mine Land Sites

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Background

The Bureau of Land Management (BLM) has a large number of Hazmat and abandoned mine land (AML) sites that have metals in soils, sediment, tailings, and waste rock dumps. To evaluate removal or remedial actions, these sites need to be characterized to determine if elements exceed risk-based concentrations and to determine the area and volume of material needing remediation. In addition, a means of testing the soil or mine waste is needed in the field during excavation and removal to determine if risk-based cleanup concentrations are met. Portable x-ray fluorescence (XRF) technology offers a relatively low-cost means of accomplishing these objectives. The National Science and Technology Center (NSTC) has been using XRF technology for a number of years and instructs field personnel in the use of the technology in NTC class 1703-14, Site Characterization at AML Sites.

Discussion

XRF instruments determine the element present by irradiating the soil sample with x-rays. A fluorescence spectrum is generated and detected that is unique for each element. In addition, the x-rays ionize the atom, dislodging electrons from the interior shells. Each electron dislodged is an ionization, and the number of ionizations is proportional to concentration. The XRF reports as many as 20 elements simultaneously and, depending on the instrument and source configuration, as many as 40 elements in the periodic table—from magnesium to uranium—can be reported. Measurements can be taken directly on the soil (in situ) or samples can be collected, dried, and sieved for greater accuracy (intrusive). Detection limits range from about 10 to 50 mg/kg depending on the element and should be tailored to data quality objectives for the project.

NITON XRF in situ measurement

Innov-X XRF in situ measurement

The NSTC has used this technology at many Hazmat and AML sites, including wire burns, waste dumps, shooting ranges, and virtually all types of AML sites. The Environmental Protection Agency has established Method 6200, which specifies accepted quality assurance-quality control and sampling procedures for using XRF technology. These procedures typically include the use of blanks, certified standards, precision samples, and laboratory confirmation split samples. Laboratory split samples are compared to XRF results by using linear regression, and the regression coefficient and slope bias are compared to acceptable ranges published in Method 6200. Regression coefficients of >0.7 are considered screening data and >0.9 are considered definitive data. It is typical to achieve >0.9 on intrusive sampling for many target elements such as arsenic, lead, copper, and zinc. It is essential that Method 6200 be used for removal or remedial action to provide legally defensible data.

During 1995–2006, the NSTC and various field offices purchased and used the NITON 700 XRF,

which uses a radioactive source or sources to produce the x-rays. The Cadmium-109 source should be replaced every 2–3 years and replacement is costly. Thermo Fisher Scientific Inc., provider of the NITON Analyzers product line, has informed users that it will no longer support this model after 2009. A newer XRF instrument by Innov-X that uses an x-ray tube instead of a radioactive source is now available and configured with a Global Positioning System and keyboard through a Pocket PC. Additionally, the Innov-X does not require costly source replacement or radioactive source licensing, and it detects all eight Resource Conservation and Recovery Act metals. Because of the obsolescence of the NITON, the NSTC performed a demonstration with the Innov-X XRF unit at the Clear Creek mercury site.

Side-by-side measurements using certified standards for ten elements showed the Innov-X provides better accuracy and lower detection limits, especially for mercury, whereas the NITON underestimated mercury by twofold to threefold, depending on concentration range.

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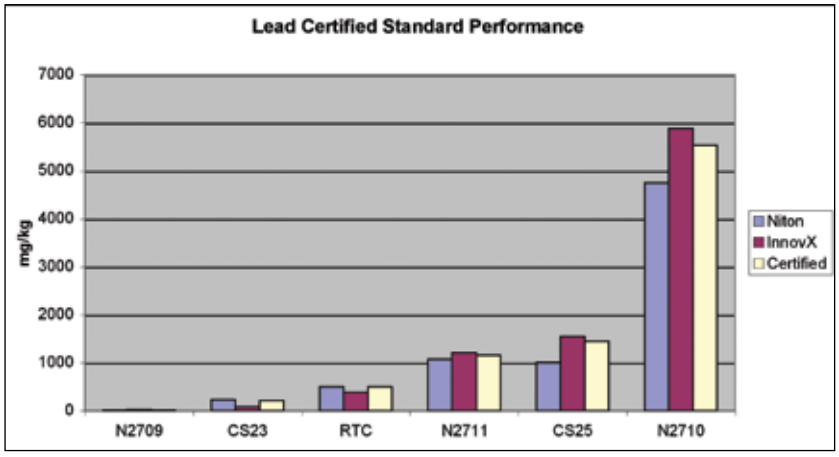

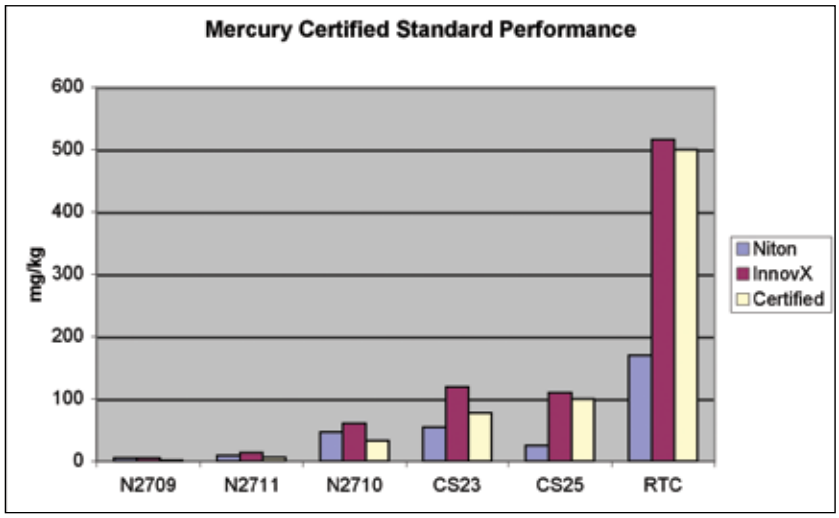

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