Dr Christina Baxter, of EmergencyResponseTIPS.com and Hazard3.com, offers helpful advice for first responders

Keeping you safe!

This column is intended to provide operational guidance to the hazmat/CBRNE community regarding the selection and performance of equipment and tactics. In this issue we focus on the use of x-ray fluorescence (XRF) detectors in hazmat/CBRNE response. XRF is a non-destructive analytical technique to determine the elemental composition of a solid or liquid in field operations.

An XRF instrument operates by employing an x-ray beam to excite a sample. As the sample relaxes back to its normal state, it releases a unique secondary fluorescent x-ray. The instrument then detects this fluorescent x-ray to identify the element, and uses the intensity of the energy to quantify the amount of the element present.

It is a relatively new technique applied to field operations.

Safety considerations

XRF instruments utilise high intensity radiation in the form of x-rays to excite the sample for analysis. To minimise exposure to this radiation, the x-ray source should never be initiated without a sample in place, the sample should cover the entire sample window, and the X-rays should never be directed toward a person. Care should be taken when analysing samples that are small, thin, or of low density as areas of the primary beam may become available and could cause exposure to persons, including the operator (mSv/hr – Sv/hr). During normal system operations, operators will be exposed to secondary scattered radiation from the primary beam, but typically they do not receive a measurable dose. Nonetheless, always follow the manufacturer's instructions and your agency's normal approaches, to minimise opportunities for inadvertent exposure. Consideration should be given to monitoring operator exposure using radiation dosimeters.

Operational considerations

Most field XRF instruments are ineffective for very light elements, with their detection efficiency increasing as the atomic number increases. Essentially, XRF systems will ignore the sample contribution from hydrogen, helium, lithium, beryllium, boron, carbon, nitrogen, oxygen, fluorine, neon, and sodium. Be sure to check your instrument's ability to detect other very light elements such as magnesium, aluminum, silicon, phosphorus, and sulfur.

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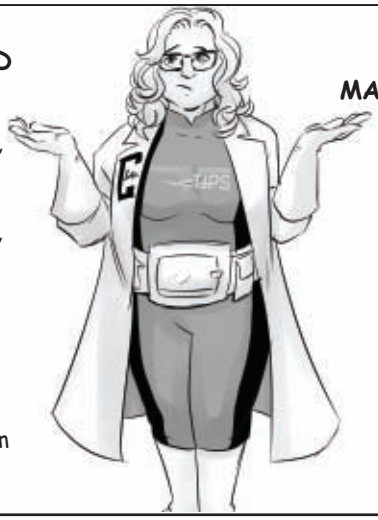
hydrogen, helium, lithium, beryllium, boron, carbon, nitrogen, oxygen, fluorine, neon, and sodium



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magnesium, aluminum, silicon, phosphorus, and sulfur

There are two common reasons for the inability to measure low atomic number atoms, firstly fluorescence is often reabsorbed, and secondly that it cannot penetrate the air gap to reach the detector.

Interferences between elements can sometimes make some elements 'invisible' to detection especially if one of them is present in a much higher concentration than the other one.

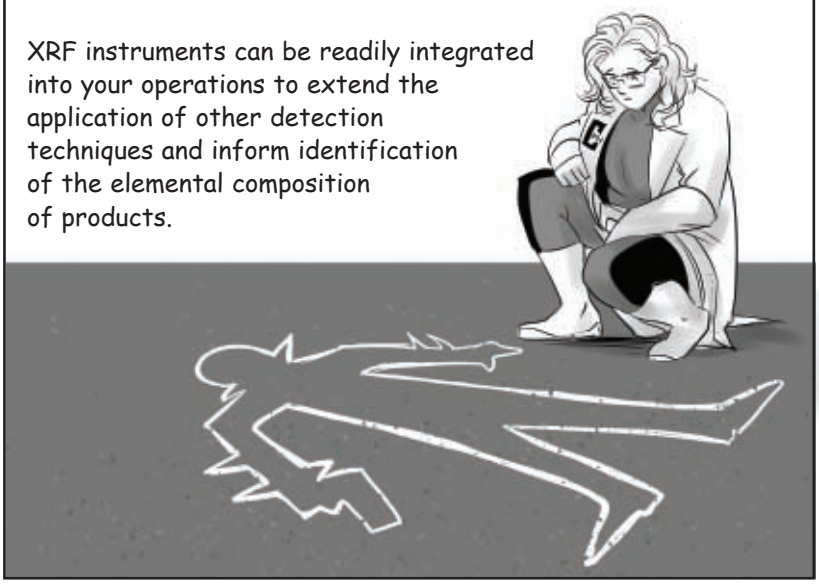
Tactical applications

Unknown powder calls: Operationally, many teams rely on Raman or infrared spectroscopy to identify unknown powders, but unfortunately, these field techniques cannot detect all materials, for example simple ionic compounds like lithium chloride (LiCl).

XRF instruments, however, can identify the elemental composition of the salt, as long as the atomic number exceeds 16. While Raman and infrared techniques will not have a signal for table salt, or NaCl, the XRF will identify chlorine. Knowing that the sample is solid and not Raman or infrared active and is clearly not chlorine gas, then the options are now reduced to materials such as NaCl or LiCl. Based upon availability, the lab staff would deduce with high likelihood that the sample was NaCl. This also extends to elemental container analysis to inform container suitability and reactivity with its contents or spillage, residues from radiological dispersal devices, and post blast residues.

Forensics: There are significant opportunities to use XRF to obtain quick and useful forensic-based information at the scene of an incident. These may include the elemental analysis of gunshot residue, glass and ceramic analysis, solids residues, paints, plastics and containers.

XRF instruments can be readily integrated into your operations to extend the application of other detection techniques and inform identification of the elemental composition of products.



Stay safe out there!

CBax away!

Images are courtesy of Phil Buckenham
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