TECHNICAL EXCHANGE

NIOSH METHODS FOR FIELD PORTABLE ANALYSIS OF AIRBORNE METALS

FROM DEVELOPMENT TO TECHNOLOGY TRANSFER

BY NICHOLAS J. LAWRYK

The AIHA Aerosol Technology and ACGIH Air Sampling Instruments Committees jointly sponsored a forum that described progress in an ongoing program at NIOSH on the development and evaluation of analytical methods for airborne metals using field portable instruments. The program consists of four distinct projects encompassing instrument selection, method evaluation, method development, workplace applications and communication interventions encouraging method use. Since its inception in 2000, the program has focused on workplaces such as metal mines and construction sites. However, the events of September 2001 raised concerns over "dirty bombs" and other disasters, that could release airborne metals in sufficient concentrations to jeopardize the health of rescue workers and survivors. In all of these cases, methods using field portable instruments could be valuable for on-site exposure assessments and selection of appropriate engineering controls and personal protection equipment.

The health impact of airborne metal exposures in the workplace depends on the nature and duration of the task. Traditionally, air samples are collected on filters, which are sent offsite for analysis by fixed-site laboratory methods. Analytical results can take weeks or even months to arrive. Methods using field-portable instruments allow the screening or analysis of samples on location with same-day speed.

The methods can be used with laboratory-based analytical methods where the screening method indicates exposures close to or exceeding the occupational exposure limit, thereby reducing the number of samples sent to laboratories and making exposure assessment strategies more cost-efficient.

POTENTIAL NIOSH ANALYTICAL METHODS

Nicholas Lawryk, NIOSH Health Effects Laboratory Division, Morgantown, W.V., opened with a discussion of his project's search for portable technologies that may be developed into NIOSH analytical methods for the analysis of multiple airborne metals, with an emphasis on evaluating technologies capable of analyzing area and personal breathing zone samples collected on filter media.

Four principal technologies were identified by a thorough literature search and discussions with inventors and researchers: laser induced breakdown spectrometry, spark induced breakdown spectrometry, microwave induced plasma spectrometry and X-ray fluorescence with battery powered X-ray tubes. SIBS and MIP are well suited for direct air sampling at fixed sites, while LIBS works well for surface analyses of soils and paints. MIP and LIBS are more expensive to build than the other technologies but have lowe limits of detection. LIBS, SIBS and MI are rather bulky units, destroy sample to some degree and have a matrix-dependent calibration. Although XRF does not measure metals in air directl it can measure metals on filter sampl collected from the worker's breathing zone. The other technologies can complement XRF by measuring areas or specific processes for concentratio spikes. XRF is also the only portable instrument currently in full productio not sample destructive, easy to calibrate and comparatively inexpensive. Laboratory and field evaluations of accuracy, precision, durability, reliabi ty and ease of use will therefore be conducted on XRF.

MONITORING AIRBORNE METALS IN CONSTRUCTION

Kevin Ashley, NIOSH Division of Applied Research and Technology, Cincinnati, presented an overview o field-portable methods for lead and hexavalent chromium to assess occupational exposures of construction workers. Three NIOSH methods currently involve portable technologies for measuring airborne lead (7700, Lead in Air by Chemical Spot Test; 7701, Lead by Ultrasound/Anodic Stripping Voltammetry; and 7702, Lead by Field Portable XRF). A fourth portable method (7703) will soon be released for hexavalent chromium by visible spectrophotometry. The meth ods have been field-tested, and some have become ASTM procedures. The portable method for hexavalent chromium has been patented by NIOSH and adopted by the U.S. Air Force. Field methods using portable technologies for lead analysis are rel tively simple to run. The hexavalent chromium method is more complex by comparison but should be easily run by the field IH. Reliable results c be expected if standard quality assurance and quality control procedures are followed.

These methods can also be modified for use on other environmental matrices, such as paint and dust wipes. Statistical procedures for estimating performance criteria and characteristics of the methods have also been developed. The performance of screening methods for other analytes besides those studied to date can be assessed using appropriate statistical models. In general, on-site screening methods can be used for making defensible decisions regarding human exposures.

Measuring Airborne Metals at Mining Sites

Pamela Drake, NIOSH Spokane Research Laboratory, Spokane, Wash., discussed a number of projects where field-portable equipment would have been useful to measure airborne metals on location, such as assessments of silver refineries and mercury release in the extraction and processing of gold ores. Refineries and underground mines can be excessively warm and humid, and some airborne chemicals may interfere with field-portable methods. It is important to know if these factors affect the ability of portable instruments to read filters that were collected in such diverse environments.

To date, samples were taken at three mills that processed ore from lead mines and one smelter that recycled batteries. In these surveys, field-portable methods compared favorably to traditional laboratory analyses. The methods were simple, easy to use and could be done near the workplace, greatly reducing the time delay in determining processes or tasks contributing to overexposure. Future studies will use these methods to analyze samples collected immediately before and after implementing control strategies to determine their effectiveness.

A Message-Based Campaign

Steve Booth-Butterfield, consultant to the NIOSH Health Effects Laboratory Division, Morgantown, W.Va., discussed communication intervention to encourage the use of new NIOSH methods for portable instruments by field IHs. To do this, the message must take the recipient through the stages of reception (getting the message), processing (remembering the message in a favorable way) and response (changing beliefs, attitudes and intentions to achieve behavior change).

In a baseline survey, AIHA members revealed that one of the main reasons for not using NIOSH methods was lack of awareness and information. A project was therefore developed to design a multichannel, multiexposure campaign. Messages were first pretested at AIHce in 2001 to identify the proper format and medium for the intervention. Members reported liking text-driven messages, as excessive graphics interfered with message processing. Messages were then placed in the *AIHA Journal*, on a Web site and in the mail. Initially, 14 percent of about 260 members surveyed reported using the methods. Following this intervention, this percentage increased to about 20 percent. A much greater increase is needed for full success of the intervention. A closer examination found that 50 percent of the experimental group who received the focused message by mail acknowledged receipt of the message. Maximum effect is seen with 80 percent reception.

Barriers preventing positive response to messages appear to be related to accuracy, expense and need. The intervention therefore needs to be refined by increasing repetition, and the messages must directly address these barriers. Another round of surveys will follow this intervention to evaluate its success and allow further communication and information adjustments to be made. Ultimately, a model for communication intervention will be developed that can be applied in the IH field where behavior changes may be needed.

Open Microphone

Audience members voiced their questions and comments to the panelists at the end of the forum. Suggestions included investigating the ASV method for beryllium analysis on filters and evaluating a commercially available portable ASV device that uses automated sample preparation. It was also noted that the correlation of concentrations reported by XRF and laboratory analyses was good when particle sizes were small, but tends to deteriorate as particle size becomes larger.

There was concern that analyses not done at an AIHA-accredited laboratory would not withstand legal challenge. Three solutions were offered:

1. The methods can be used for preliminary screening analyses, with samples of sufficiently high concentration sent for confirmatory analysis to an accredited laboratory;
2. A new certification program can be developed for those who use these methods on a regular basis, ensuring that they are qualified to use the methods and interpret the results in a legally defensible manner; and
3. Mobile laboratories using portable methods can receive AIHA accreditation. Lead and IH laboratories can become accredited under the AIHA Environmental Lead Laboratory Accreditation Program and AIHA Industrial Hygiene Laboratory Accreditation Program, respectively.

Although accuracy may be lower with portable methods, they allow time-efficient analyses where many samples are collected to identify locations or operations where exposures may pose a health risk to the worker. Field portable methods can provide an easy, simple way to obtain quick estimates of task-based exposures, so workers can more readily realize what tasks may be increasing exposures and the appropriate controls can be implemented in a timely manner.

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