The Complexities of Asbestos Data Management and How Asbestos Data Verification and Validation Can Be Used to Improve Data Quality of Asbestos Results

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Introduction

- Asbestos Analytical Methods
  - Asbestos analytical data compared to standard chemical analysis data
- Asbestos Data Management
  - Complexities
  - Database requirements
- Asbestos Data Verification
  - Purpose, goals, and benefits
- Asbestos Data Validation
  - Purpose, goals, and benefits

Asbestos Analytical Methods

- Methods differ from chemical analysis
  - Transmission electron microscopy (TEM)
    - Asbestos concentration
    - Asbestos structure attributes
  - Polarized light microscopy (PLM)
    - Optical properties of asbestos structures
- Analysis information manually recorded on hard copy benchsheet
- Information on the benchsheet is input into an electronic data deliverable (EDD)

TEM Benchsheet Example

- Detailed structure information (structure type and physical attributes)
- Mineral class identification

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions		Identification	Mineral Class				Mineral Desc	EDXA	Sketch/Comments
			Primary	Total	Length	Width		LA	OA	CH	NAM			
A1	F7	ND												
	F9	F	1	1	6.0	0.25	ADX	1				AC	XX	
A2	G5	ND												
	G7	F	2	2	3.0	0.35	ADX	1				WRTA	XK	
		F	3	3	13.0	0.50	ADX	1				WRTA	NaK	
	G9	B	4	4	21.5	1.7	ADX	1				WRTA	NaK	
A3	D6	MD10	5											
		MF		5	3.1	0.45	ADX	1				AC	XX	
		F	6	6	3.0	0.7	ADX	1				WRTA	NaK	
		MD10	7											

PLM Benchsheet Example

- Stereoscopic examination
- Optical properties

Sample	Stereomicroscopy Examination			Stereo Asbestos Est. %	Asbestos Type	% of Asbestos	Other Fibrous		Non-Fibrous	
	Color	Texture	Homogeneity				Type	%	Type	%
123	Tan	Non-fibrous	Homogenous	<1	Chrysotile	<1	Cellulose	2	Mica	<1

OPTICAL PROPERTIES							
Morph	Fiber Color	Sign Elong. (+/-)	Pleoch (Y/N)	Angle Extinct.	Ref. Index α	Ref. Index γ	Biref.
Fiberbundle	Tan	Positive	No	Inclined	1.625	1.632	Low

Electronic Data Deliverable (EDD)

- Standardized data reporting tool
- Microsoft® Excel spreadsheet
- Developed on a project-specific basis or the National Asbestos Data Entry Spreadsheet (NADES) can be utilized
- Example of data entry into an EDD for TEM analysis

Grid	Grid Opening	Structure Type	No. of Structures		Dimensions (a)		Identification	Mineral Class (b)				Mineral Desc (c)	EDXA Obs (d)
			Primary	Total	Length	Width		LA	OA	CH	NAM		
A1	F7	ND											
A1	F9	F	1	1	6	0.25	ADX	1				AC	XX
A2	G5	ND											
A2	G7	F	2	2	3	0.35	ADX	1				WRTA	XK
A2	G7	F	3	3	13	0.5	ADX	1				WRTA	NaK
A2	G9	B	4	4	21.5	1.7	ADX	1				WRTA	NaK
A3	D6	MD10	5										
A3	D6	MF		5	3.1	0.45	ADX	1				AC	XX
A3	D6	F	6	6	3	0.7	ADX	1				WRTA	NaK
A3	D6	MD10	7										

EDD Quality Control Functions

- Built-in quality control (QC) functions improve the accuracy of data entry and help maintain data integrity
  - Drop down menus
  - Color coded data input cells
  - Automatic computations
- Example tabs in TEM EDD which include data entry, formulas and computations, and data quality checks and reformatted to load into a database

Asbestos Data Management

- A relational database is utilized to manage asbestos data
- EDDs can be loaded directly into the database
- Multiple tables are needed to store the detailed information recorded on the benchsheet and entered in the EDD
  - Analysis details
  - Asbestos concentration
  - Detailed structure information
- QC checks can be performed in the database to ensure results are presented as expected according to analytical requirements

Analysis Requirements

- Analysis requirements can differ depending on project-specific needs and sample media type
- Example
  - Size of structures recorded
    - Record all asbestos structures > 10 micrometers [µm] in length
    - Record all asbestos structures > 0.5 µm in length
  - Types of observed structures
    - Record component structures individually for “clusters” or record as aggregate

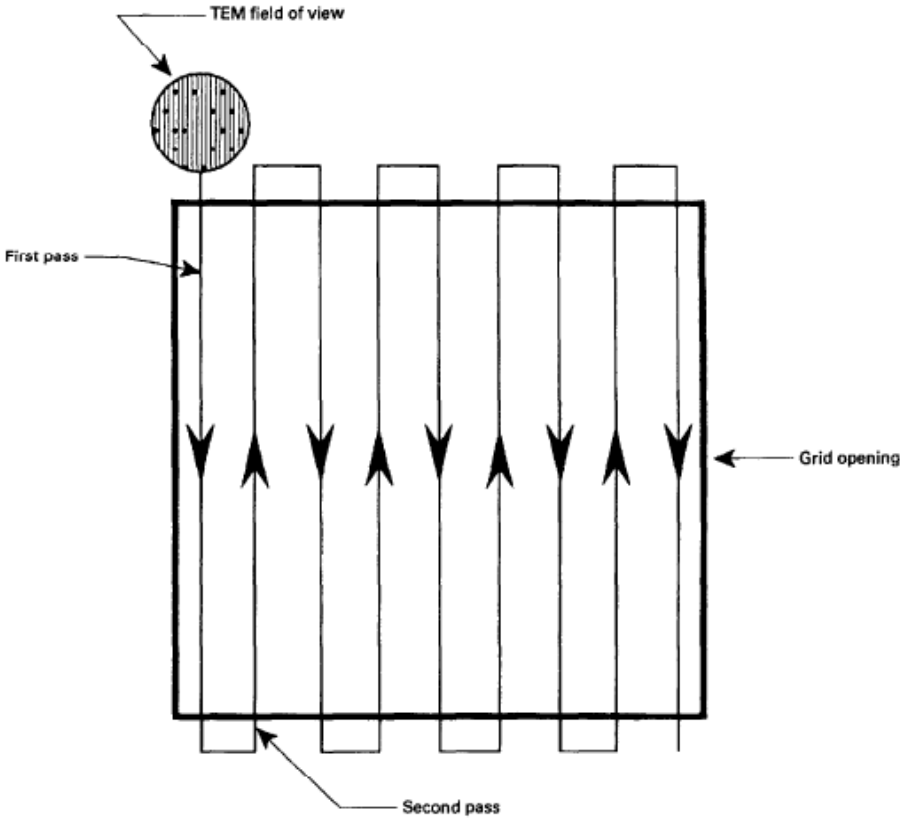
Example of asbestos fibers

Analytical Sensitivity

- For chemical analytical methods, method detection limit is established by instrument capabilities
- For asbestos analytical methods, it is possible to improve the achieved analytical sensitivity by increasing the level of effort expended on the analysis
  - Example
    - For TEM analysis, additional grid openings can be examined
    - For PLM analysis, if point-counting is used, more points can be counted

TEM Grid Opening

Example of a TEM grid
Source: www.2spi.com



Example of a TEM grid opening
Source: ISO 1995

Analytical Sensitivity Calculation

- Media types analyzed by TEM may include air, ash, duff, dust, soil, tissue, tree bark, and water
- Calculation for analytical sensitivity differs by media type
- For air, the analytical sensitivity is calculated as:

$$S = \frac{EFA}{(GO * Ago * V * 1000 * F)}$$

Where:

S	=	Sensitivity for air (per cubic centimeter [cc^{-1}])
EFA	=	Effective area of the filter (square millimeter [mm^2])
GO	=	Number of grid openings examined
Ago	=	Area of a grid opening (mm^2)
V	=	Volume of air passed through the filter (liter [L])
1000	=	Conversion factor (cc/L)
F	=	F-factor (for indirect prep; F=1 for direct prep)

Changes in Analytical Sensitivity

- The following table illustrates how the analytical sensitivity can be improved when additional grid openings are examined

Input	Analysis 1	Analysis 2
EFA (mm^2)	385	385
Number of GO	10	100
Ago (mm^2)	0.01	0.01
V (L)	250	250
Conversion (cc/L)	1,000	1,000
F-factor	1	1
Sensitivity (cc^{-1})	0.015	0.0015

Notes:

Ago = area of a grid opening

cc^{-1} = per cubic centimeter

cc/L = cubic centimeter per liter

GO = grid opening

L = liter

mm^2 = square millimeter

V = volume

Asbestos Data Verification

- The goal of data verification is to identify and correct data reporting errors as well as ensure the analytical method has been followed properly.
- Unlike chemical analytical methods, there are no established data verification procedures for asbestos analytical methods.
  - Procedures can be developed on a project-specific basis
- Verification includes:
  - Ensuring that analysts are following the project- and method-specific analysis requirements, and
  - Ensuring that results have been transferred correctly from the hard copy benchsheet to the EDD

Steps for Asbestos Data Verification

- The main steps of data verification include:
  - Consistency review of data on the hard copy benchsheet to ensure the analytical method has been followed properly
  - Data transfer from hard copy benchsheet to the EDD
  - Analysis calculations (e.g., analytical sensitivity, concentration, structure count)
  - Project-specific analytical requirements
    - Target analytical sensitivity
    - Maximum number of structures recorded
    - Maximum number of grid openings examined
  - Project-specific laboratory modifications

Verification Frequency

- Frequency
  - Depends upon the intended use of the data
    - No tolerance for errors: 100% of analyses
    - Some tolerance for errors: subset (e.g., 10%) of analyses
  - Tiered approach
    - High percentage at the beginning of a project
    - Decreasing frequency if error rates are low
    - Increasing frequency if error rates are high
    - Increasing frequency if changes are made to the program (e.g., EDD revision, new analytical approach, change of data manager)
- Issues identified can be rectified to eliminate negative impacts on overall data quality

Asbestos Data Validation

- The goal of data validation is to evaluate overall data quality and to assign data qualifiers.
- No established data validation procedures for asbestos analytical methods.
- U.S. Environmental Protection Agency (EPA)
  - *Draft National Functional Guidelines (NFGs) for Asbestos Data Review*
    - TEM
    - PLM

Asbestos Data Validation Assessment

- Draft National Functional Guidelines (NFGs) for Asbestos Data Review assessments:
  - Sample receipt conditions
  - Sample preparation techniques
  - Instrument checks and calibration results
  - Analytical sensitivity and structure recording
  - Laboratory quality control (QC) analysis results
  - Laboratory deviation/modification documentation

Data Qualifiers

- Data qualifiers and reason codes may be assigned to results in the data validation process
- Example
  - Qualifier: J – the result is estimated; the associated numerical value is an approximation.
  - Reason Code: MC – structure counts and recorded structure dimensions may be inaccurate due to improper or infrequent scope alignment and/or magnification calibrations.

Laboratory Quality Control

- Laboratory QC results provide valuable information on potential within- and between- laboratory differences
- TEM laboratory QC can include:
  - Laboratory blanks
  - Repreparations
  - Recount analyses (recount by the same analyst, recount by a different analyst)
  - Inter-laboratory analyses
- PLM laboratory QC can include:
  - Intra-laboratory analyses
    - Laboratory duplicates
  - Inter-laboratory analyses

Conclusions

- Due to the complexity of asbestos data management, data verification and data validation are used together to improve overall quality of the asbestos results and gain an understanding for the level of confidence in the results.
- The asbestos data verification process undergoes continued development and refinement to better accommodate current and anticipated future data needs and requirements.
- Areas for growth
  - Establish national guidelines for asbestos data verification
  - Finalize the NFGs into a widely accepted procedure for asbestos data validation.

References

- EPA. 2011. *Draft National Functional Guidelines for Asbestos Validation.*
- International Organization for Standardization (ISO). 1995. *Ambient Air – Determination of asbestos fibres – Direct-transfer transmission electron microscopy method.* ISO 10312:1995(E).

Questions