MIOSHA

Michigan Occupational Safety and Health Administration (MIOSHA)
Department of Labor and Economic Opportunity (LEO)

AGENCY INSTRUCTION

DOCUMENT IDENTIFIER:	DATE:
MIOSHA-COM-17-3R1	December 6, 2022

SUBJECT: Coburn Equation Use

I. Purpose. The purpose of this instruction is to describe the use of the Coburn Equation to derive an employee's airborne carbon monoxide exposure.

II. Scope. This instruction applies to compliance inspections conducted by the Construction Safety and Health Division (CSHD), the General Industry Safety and Health Division (GISHD), and Technical Services Division (TSD).

III. References.

A. Construction Safety and Health Standard Part 601. /R325.60151 et seq., Air Contaminants for Construction.

B. General Industry Safety and Health Standard Part 301. /R325.51101 et seq., Air Contaminants for General Industry.

C. MIOSHA Laboratory and Equipment Services Section (LESS) Coburn Equation Calculator.

IV. Distribution. MIOSHA Staff; Federal OSHA; S-drive Accessible; MIOSHA Messenger; and Internet Accessible.

V. Cancellations. All previous versions of this agency instruction.

VI. Next Review Date. This instruction will be reviewed in five (5) years from date of issuance.

VII. History. History of previous versions includes:

MIOSHA-COM-17-3, October 24, 2017
MIOSHA-MEMO-COM-14-1, April 29, 2014

VIII. Contact. Lawrence Hidalgo, Division Director, CSHD; Ron Ray, Division Director, TSD; and Adrian Rocskay, Division Director, GISHD.

IX. Originator: Barton G. Pickelman, Director.

X. Significant Changes. In Appendix C, updated section and chapter referenced in the OSHA Technical Manual.

XI. Background. This instruction describes the use of the Coburn Equation to convert an employee's post-exposure blood carboxyhemoglobin (COHb) level to their airborne carbon monoxide (CO) exposure at the time of exposure. COHb values are obtained by clinics and hospitals for diagnostic purposes when an employee presents with symptoms indicative of CO exposure. Industrial hygienists (IHs) convert COHb to CO because the MIOSHA regulations have no limits for employee COHb level, but they do have limits for airborne CO exposure. Part 301, Air Contaminants for General Industry, has an 8-hour, time-weighted average (TWA) for CO of 35 parts per million (ppm) and a ceiling

Permissible Exposure Limit (PEL) of 200 ppm (measured as 5-minute TWA). Part 601, Air Contaminants for Construction, has a Maximum Allowable Concentration (MAC) of 50 ppm. The CO air concentration derived from the Coburn Equation can serve as the basis for citations for CO overexposures under Part 301 and Part 601.

XII. Guidelines.

A. Case File Documentation. Obtain the information outlined in Appendix A to assess the CO exposure situation at the establishment and the employer's compliance with applicable regulations. The circumstances of the inspection will dictate the extent to which information in Appendix A needs to be obtained. For inspections with CO overexposures, Appendix A provides a list of good supporting documentation for a citation under Part 301 or Part 601. Discuss the inspection findings with your supervisor as an employee can have an elevated COHb result unrelated to work.

B. Preliminary Value. Determine a preliminary CO exposure from the COHb value using the MIOSHA Coburn Equation Calculator. Appendix B lists the data needed for the MIOSHA Coburn Equation Calculator. The calculator lacks the scientific reliability to be utilized for citation purposes, but it is helpful for identifying samples that should undergo further, costlier analysis due to the high likelihood that the samples would show an exposure above a regulatory limit. Note that the CO exposure in ppm from the calculator (cell I10 on the Excel spreadsheet) is the average CO concentration for the exposure period (cell I14), and the average exposure (cell I10) will have to be converted to an 8-hour TWA before comparison to the PEL.

C. Final Value. If the MIOSHA Coburn Equation Calculator indicates the CO exposure is greater than 35 ppm (general industry) or 50 ppm (construction), obtain approval from division management to initiate a SLTC analysis. Once approval has been obtained, the IH should send the completed form to the MIOSHA LESS. LESS will forward the information to the SLTC for analysis with their Coburn-Forster-Kane (CFK) model. The CFK model has been extensively tested for reliability. Due to the high cost per sample, please discuss with your division management the number of samples to be sent per inspection. Ensure that the samples cover all potential representative overexposures (that is job titles, departments, and industrial processes) so all significant sources of CO can be addressed in the citation. For a basic exposure scenario (i.e., single source of CO, one work area, no extenuating circumstances), the typical limit on the number of samples would be three. See Appendix C for sample submittal instructions. The cost of the sample includes expert witness testimony from SLTC if the results are challenged in court.

D. Citations and Data Sheets. If the SLTC values exceed the PEL or MAC, issue a citation under Part 301 or Part 601, provided the other required elements for a citation are present. Remember to account for the Sampling and Analytical Error (SAE) before citing. The SAE is reported by SLTC and varies with each sample. Include the following comment on the Air Contaminant Data Sheet: “Employee

exposure is based on the result of Coburn-Forster-Kane model to convert the employee's carboxyhemoglobin level in the clinic/hospital to the value of airborne CO in the workplace at the time of employee exposure." Determine if the employer's handling of the CO exposure was in compliance with the MIOSHA regulations for hazard communication training, recordable injury and illness reporting, and availability of medical services, and propose citations if appropriate.

APPENDIX A

Case File Documentation and Sampling Procedures

- Review employer's MIOSHA 300 logs for any entries indicating CO exposure. Request any incident reports of CO exposure that were communicated to the employer.

- Review any additional injury and illness reports and obtain any records of emergency room visits, hospitalizations, medical clinic visits, and ambulance transport (run reports) even if hospitalizations did not occur. Obtain blood COHb results and any documentation of medical treatment. For MIOSHA staff, the procedure for obtaining medical records, like COHb results and medical records of employees with CO overexposure symptoms, is found in Agency Instruction MIOSHA-COM-08-2, Access to Employee Medical Records, as amended. Obtain the records from the employee if they are unavailable from the employer or the incident was not reported to the employer.

- Interview employees to identify presence of symptoms, such as, headache, dizziness, lightheadedness, fainting, nausea, weakness, and vomiting. Information to be obtained should include duration, frequency, severity, time of day, day of week, and dates of symptoms, and whether the symptoms go away on days the employee is off work. Note that symptoms may increase during the course of the work shift and peak when the employee first goes home.

- Conduct a walk-around inspection and obtain CO screening measurements to identify the potential sources of CO and document employee job tasks associated with CO exposure.

- Obtain personal CO measurements for employees working in areas near sources of CO, for employees who had blood COHb measurements taken, for employees identified in incident reports or injury logs, and for employees experiencing signs and symptoms of CO exposure.

- Measure exhaust emissions on any combustible engine-powered equipment, e.g., industrial trucks, generators, etc.

- Document whether first aid or prompt medical attention are readily available.

- Document whether employees have received information and training regarding the hazards of CO. Review the training materials for content and the training records for attendance by all affected employees. Interview employees to confirm training.

- Obtain required information in Appendix B for Coburn Equation.

- Obtain required information in Appendix C for CFK calculation.

APPENDIX B

MIOSHA Coburn Equation Calculator – Required Data

The data required for MIOSHA Coburn Equation Calculator are:

- Blood COHb result (in %)
- Employee activity level (sedentary, light work, or heavy work)
- If the employee is a smoker or non-smoker
- Time of exposure to CO (in minutes)
- Time between end of CO exposure and blood sample (in minutes)
- Type of recovery between end of CO exposure and collection of blood sample (air, oxygen, hyperbaric or mixture)
- If employee recovery was a mixture as defined above, please note the number of minutes in each type of treatment (i.e., number of minutes in air, number of minutes in oxygen and number of minutes in hyperbaric).

APPENDIX C

SLTC Sample Submittal Instructions

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To obtain the SLTC Application, log on to the OSHA Extranet

- In the right-hand column, under *OSHA LINKS,*
- click on *CSHO Resources, Salt Lake Technical Center,*
- Under *The Laboratory,*
- click on *Carboxyhemoglobin back calculations to environmental CO levels*
- **In the upper right of the screen, click on *printer friendly version.***

Print the PDF worksheet that is in the SLTC Application. Follow the instructions on the form and collect the requested information. The SLTC Application is completed by hand. Some of the instructions on the application pertain to only federal compliance officers, so speak to the MIOSHA laboratory and your supervisor to determine exactly what procedure to follow. The SLTC Application includes instruction for completing the MIOSHA form 91-S.

A catalog of activity levels is also available in the upper right of the screen on the SLTC Application. This provides activity levels for questions #14 and #16 on the SLTC Application. The procedure for obtaining medical records, like COHb results and medical records of employees with CO overexposure symptoms, is found in Agency Instruction MIOSHA-COM-08-2, Access to Employee Medical Records, as amended.

The following link can be used to obtain the elevation range required for question #20 of the SLTC Application: elevation range. At the linked website, enter the ZIP Code, and the website will display a variety of data about the ZIP Code including the elevation range.

Submit the MIOSHA form 91-S, Air Sampling Report, and SLTC Application form to the MIOSHA Lab. It is preferred that the forms are emailed to the lab director. The SLTC Application will have to be scanned. The MIOSHA Lab will forward the SLTC Application to the SLTC.

For additional information, please see OSHA Technical Manual, Section III, Chapter 2, Indoor Air Quality Investigation.