United States
Environmental Protection Agency

Office of Chemical Safety and
Pollution Prevention

Final Risk Evaluation for Asbestos Part 1: Chrysotile Asbestos

Systematic Review Supplemental File:

Data Quality Evaluation for Consumer Exposure

December 2020

Table of Contents

3080975	Monitoring	Yeung, P.,Patience, K.,Apthorpe, L.,Willcocks, D.. 1999. An Australian study to evaluate worker exposure to chrysotile in the automotive service industry. Applied Occupational and Environmental Hygiene 14	**14**
3083368	Monitoring	Cheng, V. K.,O'Kelly, F. J.. 1986. Asbestos exposure in the motor vehicle repair and servicing industry in Hong Kong. Journal of the Society of Occupational Medicine 36	**16**
3084342	Monitoring	Langer, A. M.,Maggiore, C. M.,Nicholson, W. J.,Rohl, A. N.,Rubin, I. B.,Selikoff, I. J.. 1979. The contamination of Lake Superior with amphibole gangue minerals. Annals of the New York Academy of Sciences 330	**17**
3099264	Monitoring	T. C. Cooper, J. W. Sheehy, D. M. O'Brien, J. D. Mcglothlin, W. F. Todd. 1988. In-depth survey report: Evaluation of brake drum service controls at Cincinnati Gas and Electric Garages, Cincinnati, Evanston, and Monroe, Ohio and Covington, Kentucky.	**18**
3099353	Monitoring	Cooper, T. C.,Sheehy, J. W.,O'Brien, D. M.,McGlothlin, J. D.,Todd, W. F.. 1987. In-Depth Survey Report: Evaluation of Brake Drum Service Controls at United States Postal Service Vehicle Maintenance Facility, Louisville, Kentucky, Report No. CT-152-11B.	**20**
3099476	Monitoring	Godbey, F. W.,Cooper, T. C.,Sheehy, J. W.,O'Brien, D. M.,Van Wagenen, H. D.,McGlothlin, J. D.,Todd, W. F.. 1987. In-Depth Survey Report: Evaluation of Brake Drum Service Controls at United States Postal Service, Vehicle Maintenance Facility, Nashville, Tennessee, Report No. CT-152-20B.	**21**
3099480	Monitoring	Sheehy, J. W.,Todd, W. F.,Cooper, T. C.,Van Wagenen, H. D.. 1987. In-Depth Survey Report: Evaluation of Brake Drum Service Controls at Cincinnati Bell Maintenance Facility, Fairfax, Ohio, Report No. CT-152-21B.	**22**
3100008	Monitoring	Kauppinen, T.,Korhonen, K.. 1987. Exposure to Asbestos During Brake Maintenance of Automotive Vehicles by Different Methods. American Industrial Hygiene Association Journal 48	**23**
3278824	Monitoring	Musthapa, M. S.,Ahmad, I.,Trivedi, A. K.,Rahman, Q.. 2003. Asbestos contamination in biota and abiota in the vicinity of asbestos-cement factory. Bulletin of Environmental Contamination and Toxicology 70	**25**
3520458	Monitoring	C. L. Blake, G. S. Dotson, R. D. Harbison. 2006. Assessment of airborne asbestos exposure during the servicing and handling of automobile asbestos-containing gaskets. Regulatory Toxicology and Pharmacology 45	**26**
3520524	Monitoring	Cely-García, M. F.,Curriero, F. C.,Sánchez-Silva, M.,Breysse, P. N.,Giraldo, M.,Méndez, L.,Torres-Duque, C.,Durán, M.,González-García, M.,Parada, P.,Ramos-Bonilla, J. P.. 2016. Estimation of personal exposure to asbestos of brake repair workers. Journal of Exposure Science and Environmental Epidemiology 27	**30**

3531131	Monitoring	L. R. Liukonen, F. W. Weir. 2005. Asbestos exposure from gaskets during disassembly of a medium duty diesel engine. Regulatory Toxicology and Pharmacology 41	**33**
3531296	Monitoring	Paustenbach, D. J.,Madl, A. K.,Donovan, E.,Clark, K.,Fehling, K.,Lee, T. C.. 2006. Chrysotile asbestos exposure associated with removal of automobile exhaust systems (ca. 1945-1975) by mechanics: results of a simulation study. Journal of Exposure Science and Environmental Epidemiology 16	**36**
3531556	Monitoring	Weir, F. W.,Tolar, G.,Meraz, L. B.. 2001. Characterization of vehicular brake service personnel exposure to airborne asbestos and particulate. Applied Occupational and Environmental Hygiene 16	**37**
3580912	Monitoring	Pitt, R.. 1988. ASBESTOS AS AN URBAN AREA POLLUTANT. Journal of Water Pollution Control Federation 60	**38**
3610801	Monitoring	Hickish, D. E.,Knight, K. L.. 1970. Exposure to asbestos during brake maintenance. Annals of Occupational Hygiene 13	**40**
3615571	Monitoring	Rohl, A. N.,Langer, A. M.,Klimentidis, R.,Wolff, M. S.,Seilikoff, I. J.. 1977. Asbestos content of dust encountered in brake maintenance and repair. Proceedings of the Royal Society of Medicine 70	**42**
3645882	Monitoring	Niosh,. 1976. Preliminary industrial hygiene survey at Auto Brake Clinic, Cincinnati, Ohio. 3	**44**
3646036	Monitoring	Lorimer, W. V.,Rohl, A. N.,Miller, A.,Nicholson, W. J.,Selikoff, I. J.. 1976. Asbestos exposure of brake repair workers in United States. Mount Sinai Journal of Medicine 43	**46**
3648228	Monitoring	Sheehy, J. W.,Godbey, F. W.,Cooper, T. C.,Lenihan, K. L.,Van Wagenen, H. D.,McGlothlin, J. D.. 1987. In-Depth Survey Report: Control Technology for Brake Drum Service Operations at Ohio Department of Transportation, Maintenance Facility, Lebanon, Ohio, CT-152-18b.	**48**
3649985	Monitoring	Oliver, T.,Murr, L. E.. 1977. An electron microscope study of asbestiform fiber concentrations in Rio Grande valley water supplies. 69	**49**
3655537	Monitoring	Sheehy, J. W.,Cooper, T. C.,O'Brien, D. M.,McGlothlin, J. D.,Froehlich, P. A.. 1989. Control of asbestos exposure during brake drum service.	**50**
3970543	Monitoring	Crandall, M. S.,Fleeger, A. K.. 1989. Health hazard evaluation report no. HETA 88-372-1953, Barbados Ministry of Health, Bridgetown, Barbados.	**51**
4152071	Monitoring	Equitable Environmental Health, Inc. 1977. Dust exposures during the cutting and machining of asbestos/cement pipe, additional studies.	**52**
4152150	Monitoring	Roberts, D. R.. 1980. Industrial hygiene report: Asbestos at Allied Brake Shop, Cincinnati, OH.	**53**

338	Completed Exposure Assessment	Mauskopf, J. A.. 1987. Projections of cancer risks attributable to future exposure to asbestos. Risk Analysis 7	**71**
522	Completed Exposure Assessment	Esmen, N. A.,Erdal, S.. 1990. Human occupational and nonoccupational exposure to fibers. Environmental Health Perspectives 88	**72**
60451	Completed Exposure Assessment	Millette, J. R.,Craun, G. F.,Stober, J. A.,Kraemer, D. F.,Tousignant, H. G.,Hildago, E.,Duboise, R. L.,Benedict, J.. 1983. Epidemiology study of the use of asbestos-cement pipe for the distribution of drinking water in Escambia County, Florida. Environmental Health Perspectives 53	**73**
60452	Completed Exposure Assessment	Millette, J. R.,Clark, P. J.,Stober, J.,Rosenthal, M.. 1983. Asbestos in water supplies of the United States. Environmental Health Perspectives 53	**74**
60455	Completed Exposure Assessment	Millette, J. R.,Clark, P. J.,Pansing, M. F.,Twyman, J. D.. 1980. Concentration and size of asbestos in water supplies. Environmental Health Perspectives 34	**75**
786508	Completed Exposure Assessment	Suta, B. E.,Levine, R. J.. 1979. Non-occupational asbestos emissions and exposures. 1	**76**
2546734	Completed Exposure Assessment	Finkelstein, M. M.. 2013. The analysis of asbestos count data with "nondetects": the example of asbestos fiber concentrations in the lungs of brake workers. American Journal of Industrial Medicine 56	**77**
2548725	Completed Exposure Assessment	Richter, R. O.,Finley, B. L.,Paustenbach, D. J.,Williams, P. R. D.,Sheehan, P. J.. 2009. An evaluation of short-term exposures of brake mechanics to asbestos during automotive and truck brake cleaning and machining activities. Journal of Exposure Science and Environmental Epidemiology 19	**78**
2581697	Completed Exposure Assessment	Donovan, E. P.,Donovan, B. L.,Sahmel, J.,Scott, P. K.,Paustenbach, D. J.. 2011. Evaluation of bystander exposures to asbestos in occupational settings: a review of the literature and application of a simple eddy diffusion model. Critical Reviews in Toxicology 41	**79**
3078581	Completed Exposure Assessment	Finley, B. L.,Pierce, J. S.,Paustenbach, D. J.,Scott, L. L.,Lievense, L.,Scott, P. K.,Galbraith, D. A.. 2012. Malignant pleural mesothelioma in US automotive mechanics: reported vs expected number of cases from 1975 to 2007. Regulatory Toxicology and Pharmacology 64	**80**
3079606	Completed Exposure Assessment	Madl, A. K.,Clark, K.,Paustenbach, D. J.. 2007. Exposure to airborne asbestos during removal and installation of gaskets and packings: a review of published and unpublished studies. Journal of Toxicology and Environmental Health, Part B: Critical Reviews 10	**81**
3080278	Completed Exposure Assessment	Paustenbach, D. J.,Finley, B. L.,Lu, E. T.,Brorby, G. P.,Sheehan, P. J.. 2004. Environmental and occupational health hazards associated with the presence of asbestos in brake linings and pads (1900 to present): a "state-of-the-art" review. Journal of Toxicology and Environmental Health, Part B: Critical Reviews 7	**82**

3084507	Completed Exposure Assessment	. 1977. IARC monographs on the evaluation of the carcinogenic risk of chemicals to man: asbestos. 14	**83**
3085741	Completed Exposure Assessment	Finley, B. L.,Richter, R. O.,Mowat, F. S.,Mlynarek, S.,Paustenbach, D. J.,Warmerdam, J. M.,Sheehan, P. J.. 2007. Cumulative asbestos exposure for US automobile mechanics involved in brake repair (circa 1950s-2000). Journal of Exposure Science and Environmental Epidemiology 17	**84**
3095297	Completed Exposure Assessment	Naylor, L. M.. 1989. Asbestos in sludge - a significant risk. BioCycle 30	**85**
3096697	Completed Exposure Assessment	Ganor, E.,Fischbein, A.,Brenner, S.,Froom, P.. 1992. Extreme airborne asbestos concentrations in a public building. British Journal of Industrial Medicine 49	**86**
3098571	Completed Exposure Assessment	Atsdr,. 2001. Toxicological profile for asbestos (update).	**87**
3531297	Completed Exposure Assessment	Paustenbach, D. J.,Richter, R. O.,Finley, B. L.,Sheehan, P. J.. 2003. An evaluation of the historical exposures of mechanics to asbestos in brake dust. Applied Occupational and Environmental Hygiene 18	**88**
3583091	Completed Exposure Assessment	Webber, J. S.,Covey, J. R.. 1991. Asbestos in water. Critical Reviews in Environmental Control 21	**89**
3615595	Completed Exposure Assessment	del Piano, M.,Palagiano, C.,Rimatori, V.. 1989. Asbestos hazards in the city of Rome, Italy. Social Science & Medicine 29	**90**
3648286	Completed Exposure Assessment	Anonymous,. 1975. Current Intelligence Bulletin 5 Asbestos. Asbestos Exposure during Servicing of Motor Vehicle Brake and Clutch Assemblies (with reference package). 5	**91**
3970153	Completed Exposure Assessment	U.S, E. P. A.. 1999. Methodology for conducting risk assessments at asbestos superfund sites Part 2: Technical background document.	**93**
3970271	Completed Exposure Assessment	ToxNet Hazardous Substances Data, Bank. 2017. HSDB: Asbestos.	**94**
3970851	Completed Exposure Assessment	Iarc,. 2012. ARC Monographs on the evaluation of carcinogenic risks to humans: Asbestos (Chrysotile, amosite, crocidolite, tremolite, actinolite, and anthophyllite).	**95**
3974877	Completed Exposure Assessment	Niosh,. 1976. Revised recommended asbestos standard.	**96**
3978350	Completed Exposure Assessment	Nicnas,. 1999. Chrysotile asbestos: priority exisiting chemical no. 9.	**97**
3982252	Completed Exposure Assessment	Oehha,. 2003. Public health goals for chemicals in drinking water asbestos.	**98**
3982335	Completed Exposure Assessment	Atsdr,. 2001. Toxicological profile for asbestos.	**99**
4151966	Completed Exposure Assessment	P. E. I. Associates. 1985. Asbestos dust control in brake maintenance. Draft.	**100**

Refer to Appendix E of '*Application of Systematic Review in TSCA Risk Evaluations*' at https://www.epa.gov for more information of evaluation procedures and parameters.

Study Citation:	Rohl, A. N.,Langer, A. M.,Wolff, M. S.,Weisman, I.. 1976. Asbestos exposure during brake lining maintenance and repair. Environmental Research.
Data Type	Monitoring
Hero ID	176

Domain		Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	High	1	Not many details provided, but used an OSHA method to collect inhalation samples.
	Metric 2:	Analytical Methodology	Medium	2	Method cited, but not osha or astm. No LOQ.
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	
	Metric 5:	Currency	Low	3	
	Metric 6:	Spatial and Temporal Variability	Low	3	<5 per scenario
	Metric 7:	Exposure Scenario	Medium	2	
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Medium	2	
	Metric 9:	Quality Assurance	Low	3	
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	High	1	
Overall Quality Determination[*]			Medium	2.0	
Extracted			Yes		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Steinsvag, K.,Bratveit, M.,Moen, B. E.. 2007. Exposure to carcinogens for defined job categories in Norway's offshore petroleum industry, 1970 to 2005. Occupational and Environmental Medicine.
Data Type	Monitoring
Hero ID	524541

Domain		Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Low	3	only stationary samples
	Metric 2:	Analytical Methodology	Medium	2	Describes the use of electron microscope but did not provide any other details of the methodology.
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Norway
	Metric 5:	Currency	Medium	2	5-15 years old
	Metric 6:	Spatial and Temporal Variability	Low	3	small sample size (2 samples)
	Metric 7:	Exposure Scenario	Low	3	oil industry brake band exposure
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Low	3	Multiple chemicals being summarized gives less analysis to asbestos
	Metric 9:	Quality Assurance	Low	3	Not well described
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Low	3	Needs more discussion specific to asbestos and only 2 samples
Overall Quality Determination[*]			Low	2.6	
Extracted			No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Hosny, G.,Akel, M.. 2006. Assessment of asbestos in drinking water in Alexandria, Egypt. Journal of the Egyptian Public Health Association.
Data Type	Monitoring
Hero ID	625815

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Low	3	limited info
	Metric 2:	Analytical Methodology	Medium	2	limited info SEM
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Alexandria, Egypt
	Metric 5:	Currency	Low	3	
	Metric 6:	Spatial and Temporal Variability	Low	3	number actually sampled not reported, but do know it was more than 1
	Metric 7:	Exposure Scenario	Low	3	drinking water, egypt
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Low	3	no concentration table
	Metric 9:	Quality Assurance	Low	3	no discussion
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Medium	2	some discussion of various locations, different methods
Overall Quality Determination[*]			Low	2.6	
Extracted			No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Dodson, R. F.,O'Sullivan, M.,Corn, C. J.. 1996. Relationships between ferruginous bodies and uncoated asbestos fibers in lung tissue. Archives of Environmental Health.
Data Type	Monitoring
Hero ID	758913

Domain		Metric	Rating†	Score	Comments‡
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Medium	2	Small sample size; grouped by lung conc, not previous work history
	Metric 2:	Analytical Methodology	Medium	2	Generally accepted method
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	America
	Metric 5:	Currency	Unacceptable	4	No discussion of timing of sample collection
	Metric 6:	Spatial and Temporal Variability	Medium	2	Sample size noted but small group per exposure set
	Metric 7:	Exposure Scenario	Unacceptable	4	relevant: pipeworker and brake repair. The relevant data is lung tissue data over time for workers. This does not relate to exposure from consumers
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Medium	2	Relatively complete analysis
	Metric 9:	Quality Assurance	Medium	2	lab blanks and background recorded
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Low	3	Needs more discussion of variability and uncertainty regarding linking outcomes and exposures, i.e. recorded work history
Overall Quality Determination*			Unacceptable	4.0	Metric mean score**: 2.4.
Extracted			No		

** Consistent with our *Application of Systematic Review in TSCARisk Evaluations* document, if a metric for a data source receives a score of Unacceptable (score = 4), EPA will determine the study to be unacceptable. In this case, two of the metrics were rated as unacceptable. As such, the study is considered unacceptable and the score is presented solely to increase transparency.

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.

‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.

* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Khan, A. H.,Ansari, F. A.,Misra, D.,Bhargava, S. K.. 2006. Study of asbestos fibre levels in and around a brake-lining industry. Journal of Scientific and Industrial Research.
Data Type	Monitoring
Hero ID	786483

Domain		Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Medium	2	Indian standards used; good description of equipment used
	Metric 2:	Analytical Methodology	Medium	2	acetone and PCM technique
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	India
	Metric 5:	Currency	Low	3	Sampling took place in 2002
	Metric 6:	Spatial and Temporal Variability	Medium	2	description of various sampling areas
	Metric 7:	Exposure Scenario	Low	3	More occupational than consumer, but potentially relevant exposure via ambient sampling
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Low	3	Two tables of raw data but very little discussion
	Metric 9:	Quality Assurance	N/A	N/A	No discussion of QAQC methods: no blanks, etc.
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Unacceptable	4	No discussion of the topic
Overall Quality Determination[*]			Unacceptable	4.0	Metric mean score[**]: 2.5.
Extracted			No		

** Consistent with our *Application of Systematic Review in TSCARisk Evaluations* document, if a metric for a data source receives a score of Unacceptable (score = 4), EPA will determine the study to be unacceptable. In this case, one of the metrics were rated as unacceptable. As such, the study is considered unacceptable and the score is presented solely to increase transparency.

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.

‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.

* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Kakooei, H.,Hormozy, M.,Marioryad, H.. 2011. Evaluation of asbestos exposure during brake repair and replacement. Industrial Health.
Data Type	Monitoring
Hero ID	1082293

Domain		Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Medium	2	Collection of all airborne asbestos samples consistent with NIOSH method 7400. Not calibrated
	Metric 2:	Analytical Methodology	Medium	2	Collection of all airborne asbestos samples consistent with NIOSH method 7400 (PCM). Method sensitivity reported.
	Metric 3:	Biomarker Selection	N/A	N/A	Biomarker is not used
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Study conducted in 30 brake & replacement auto shops (cars & trucks) in Iran
	Metric 5:	Currency	Medium	2	>5-15 yrs old; samples collected between July 2008 & December 2008
	Metric 6:	Spatial and Temporal Variability	High	1	large sample size (60 personal air samples collected in the auto shops from 32 cars and 28 trucks)
	Metric 7:	Exposure Scenario	Low	3	Minimal description of the process carried out during brake repair in the auto shops.
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Medium	2	Geometric means and ranges of airborne asbestos fiber concentrations provided in Table 1 and concentrations by season (Summer and Autumn) listed in Table 2. No supplemental or raw data are available.
	Metric 9:	Quality Assurance	Low	3	Controls, recoveries not reported
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Medium	2	
Overall Quality Determination[*]			Medium	2.0	
Extracted			Yes		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Cely-García, M. F.,Sánchez, M.,Breysse, P. N.,Ramos-Bonilla, J. P.. 2012. Personal exposures to asbestos fibers during brake maintenance of passenger vehicles. Annals of Occupational Hygiene.
Data Type	Monitoring
Hero ID	2560364

Domain		Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	High	1	
	Metric 2:	Analytical Methodology	High	1	
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	
	Metric 5:	Currency	Medium	2	>5-15 years old
	Metric 6:	Spatial and Temporal Variability	High	1	
	Metric 7:	Exposure Scenario	High	1	
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	High	1	
	Metric 9:	Quality Assurance	Medium	2	
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	High	1	
Overall Quality Determination[*]			High	1.2	
Extracted			Yes		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Madl, A. K.,Gaffney, S. H.,Balzer, J. L.,Paustenbach, D. J.. 2009. Airborne asbestos concentrations associated with heavy equipment brake removal. Annals of Occupational Hygiene.
Data Type	Monitoring
Hero ID	2591959

Domain		Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	High	1	
	Metric 2:	Analytical Methodology	High	1	
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	
	Metric 5:	Currency	Medium	2	>5 - 15 years ago
	Metric 6:	Spatial and Temporal Variability	High	1	
	Metric 7:	Exposure Scenario	Medium	2	somewhat relevant exposure scenario for construction equipment
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	High	1	
	Metric 9:	Quality Assurance	Medium	2	Limited previous studies on construction equipment for comparison
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Medium	2	some discussion based on limited previous studies
Overall Quality Determination[*]			High	1.4	
Extracted			Yes		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Blake, C. L.,Johnson, G. T.,Harbison, R. D.. 2009. Airborne asbestos exposure during light aircraft brake replacement. Regulatory Toxicology and Pharmacology.
Data Type	Monitoring
Hero ID	2594497

Domain	Metric		Rating†	Score	Comments‡
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	High	1	
	Metric 2:	Analytical Methodology	High	1	
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	
	Metric 5:	Currency	Low	3	
	Metric 6:	Spatial and Temporal Variability	Medium	2	
	Metric 7:	Exposure Scenario	Low	3	surrogate - airplane brakes
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Medium	2	
	Metric 9:	Quality Assurance	Low	3	
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	High	1	
Overall Quality Determination*			Medium	1.9	
Extracted			No		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Cely-García, M. F.,Torres-Duque, C. A.,Durán, M.,Parada, P.,Sarmiento, O. L.,Breysse, P. N.,Ramos-Bonilla, J. P.. 2015. Personal exposure to asbestos and respiratory health of heavy vehicle brake mechanics. Journal of Exposure Science and Environmental Epidemiology.
Data Type	Monitoring
Hero ID	3078032

Domain	Metric		Rating†	Score	Comments‡
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	High	1	Good description of methods, equipment used, etc
	Metric 2:	Analytical Methodology	High	1	Listed well known methods
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Colombia
	Metric 5:	Currency	High	1	Data collection in early 2012
	Metric 6:	Spatial and Temporal Variability	Medium	2	More than 10 workers total for personal monitoring would be better
	Metric 7:	Exposure Scenario	High	1	Very relevant exposure scenario
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	High	1	Extensive discussion
	Metric 9:	Quality Assurance	Medium	2	QC and background for personal samples were taken, but no control group for voluntary respiratory health study
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	High	1	Extensive discussion
Overall Quality Determination*			High	1.2	
Extracted			Yes		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Blake, C. L.,Van Orden, D. R.,Banasik, M.,Harbison, R. D.. 2003. Airborne asbestos concentration from brake changing does not exceed permissible exposure limit. Regulatory Toxicology and Pharmacology.
Data Type	Monitoring
Hero ID	3080338

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	High	1	Protocol defined sampling methods to be used in tests.
	Metric 2:	Analytical Methodology	High	1	Air samples analyzed by two methods NIOSH Methods 7400 (PCM) and 7402 (TEM). Reporting detection limits for airborne dust
	Metric 3:	Biomarker Selection	N/A	N/A	Biomarker is not used
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Former auto repair facility in New Kensington, PA
	Metric 5:	Currency	Medium	2	>5-15 yrs old; pub date 2003
	Metric 6:	Spatial and Temporal Variability	Medium	2	Indoor air samples collected at seven locations within building as well as personal air samples collected within the mechanic's breathing zone
	Metric 7:	Exposure Scenario	Low	3	Table 2 outlines procedures and microenvironment (date, temperature, humidity)
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Medium	2	Personal air fiber test data provided in Table 4. Results are reported as average airbone fiber concentration during the duration of each test and as an 8-h TWA.
	Metric 9:	Quality Assurance	Medium	2	Test 1 was a baseline test involving removal and replacement of brake shoes with no additional manipulation of the brake shoes.
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Medium	2	No standard deviations reported some manipulations of brake repair not captured. Supplemental data not available.
Overall Quality Determination[*]			Medium	1.8	
Extracted			Yes		

Continued on next page

– continued from previous page

Study Citation:	Blake, C. L.,Van Orden, D. R.,Banasik, M.,Harbison, R. D.. 2003. Airborne asbestos concentration from brake changing does not exceed permissible exposure limit. Regulatory Toxicology and Pharmacology.
Data Type	Monitoring
Hero ID	3080338

Domain	Metric	Rating†	Score	Comments‡

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Yeung, P.,Patience, K.,Apthorpe, L.,Willcocks, D.. 1999. An Australian study to evaluate worker exposure to chrysotile in the automotive service industry. Applied Occupational and Environmental Hygiene.
Data Type	Monitoring
Hero ID	3080975

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Medium	2	Sampling methodology discussed briefly. Nine typical establishments in the Sydney metropolitan area, including five service garages (four for passenger and light commercial vehicles, one for buses and coaches), three brake bonding workshops, and one gasket processing workshop participated in this study. The three brake bonding workshops and one gasket processing workshop were the only workshops in the industry that still processed asbestos-containing products and were located in the Sydney metropolitan area. The study methodology involved air monitoring to estimate exposure to chrysotile at work when chrysotile-containing friction materials were worked on, in relation to the type of control measures used, and sizing of airborne fibers by transmission electron microscopy (TEM). Task-specific personal and area air samples were collected at a flowrate of 2 liters per minute on 25-mm-diameter 0.8 um pore size Millipore mixed cellulose ester membrane filters housed in anti-static cowls, in accordance with the Australian standard membrane filter method. Area samples were taken at fixed locations in the vicinity of the work tasks, and between one and two meters above floor level. Single sample durations were selected not to exceed two hours, such that only a maximum of 240 liters of air would be collected.
	Metric 2:	Analytical Methodology	Medium	2	Analytical methodology discussed. This approach has resulted in a practical detection limit of around 0.05 f/mL (or 10 fibers/ 100 graticule areas) by Phase Contrast Microscopy (PCM). In addition to PCM analysis, 16 samples in half filters were selected for TEM analysis on a Phillips CM12 at 8800 X magnification. These 16 samples included all personal samples and some area samples with relatively high PCM fiber readings. TEM analysis was performed to identify asbestos fibers too small to be detected by PCM. Fibrous minerals were identified by selected area electron diffraction (SAED) and energy-dispersive X-ray analysis (EDAX), and sized by length and diameter. The grid openings used in TEM were sized by optical microscopy so that the TEM results could be reported in fibers per equivalent Walton Beckett graticule area and directly compared to the PCM results. Due to the higher resolution power of TEM, respirable fibers of all dimensions were recorded (resolution limit was about 0.02 l m in diameter).
	Metric 3:	Biomarker Selection	N/A	N/A	Biomarker is not used.

Continued on next page

– continued from previous page

Study Citation:	Yeung, P.,Patience, K.,Apthorpe, L.,Willcocks, D.. 1999. An Australian study to evaluate worker exposure to chrysotile in the automotive service industry. Applied Occupational and Environmental Hygiene.
Data Type	Monitoring
Hero ID	3080975

Domain	Metric		Rating†	Score	Comments‡
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Australia, Sydney
	Metric 5:	Currency	Low	3	>15 years (1996)
	Metric 6:	Spatial and Temporal Variability	Medium	2	Small to moderate sample size (1-6) No replicates.
	Metric 7:	Exposure Scenario	Medium	2	Brake and clutch service operations, brake bonding operations, and gasket processing discussed.
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Medium	2	No supplemental or raw data. Table II reports fiber concentrations (f/mL) GM and range for PCM for personal air samples for each establishment. Table III reports GM-fiber concentrations (f/mL) for PCM and TEM (chrysotile).
	Metric 9:	Quality Assurance	Medium	2	
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Medium	2	PCM is the international regulatory method for the determination of airborne asbestos fiber concentrations. However, as shown in this study, PCM is not able to detect the very many small fibers (< 0.2 l m in diameter) generated by high energy shearing processes (e.g., cutting, grinding, and sanding) of asbestos-containing materials. For this type of processes, PCM may underestimate exposure and thus the health risk; and TEM should be used as an adjunct to PCM in any regular air monitoring program.
Overall Quality Determination*			Medium	2.0	
Extracted			Yes		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Cheng, V. K.,O'Kelly, F. J.. 1986. Asbestos exposure in the motor vehicle repair and servicing industry in Hong Kong. Journal of the Society of Occupational Medicine.
Data Type	Monitoring
Hero ID	3083368

Domain		Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	High	1	12 garages chosen at random from Factory Inspectorate; description includes placement of individual and task. Occupational used as surrogate for Consumer.
	Metric 2:	Analytical Methodology	Medium	2	PCM as recommended by Asbestos Research Council. NIOSH is the standard now. PCM is a NIOSH test, so analytical methodology is appropriate.
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Hong Kong
	Metric 5:	Currency	Low	3	>15 years old
	Metric 6:	Spatial and Temporal Variability	High	1	personal samples and static samples within 5 m of activity; good sample size per approach
	Metric 7:	Exposure Scenario	High	1	very relevant: vehicle repair
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	High	1	No raw data but has range and mean : High; absence raw data is not a concern.
	Metric 9:	Quality Assurance	Medium	2	Minimal discussion :: No discussion of controls, e.g., flow rate calibration
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Medium	2	good comparison to other study outcomes :: min/max/mean provided. SD/quantiles not provided
Overall Quality Determination[*]			High	1.6	
Extracted			Yes		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Langer, A. M.,Maggiore, C. M.,Nicholson, W. J.,Rohl, A. N.,Rubin, I. B.,Selikoff, I. J.. 1979. The contamination of Lake Superior with amphibole gangue minerals. Annals of the New York Academy of Sciences.
Data Type	Monitoring
Hero ID	3084342

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Low	3	Sampling methodology published elsewhere
	Metric 2:	Analytical Methodology	Medium	2	Described but older method
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Lake Superior
	Metric 5:	Currency	Low	3	>15 yrs old
	Metric 6:	Spatial and Temporal Variability	Low	3	Small sample size for samples drawn from Lake Superior
	Metric 7:	Exposure Scenario	Medium	2	Somewhat relevant: drinking water drawn from contaminated surface water
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Medium	2	Lack of statistical analysis
	Metric 9:	Quality Assurance	Medium	2	Minimal discussion
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Medium	2	Minimal discussion
Overall Quality Determination[*]			Medium	2.2	
Extracted			No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	T. C. Cooper, J. W. Sheehy, D. M. O'Brien, J. D. Mcglothlin, W. F. Todd. 1988. In-depth survey report: Evaluation of brake drum service controls at Cincinnati Gas and Electric Garages, Cincinnati, Evanston, and Monroe, Ohio and Covington, Kentucky.
Data Type	Monitoring
Hero ID	3099264

Domain		Metric	Rating†	Score	Comments‡
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Medium	2	Personal air samples for asbestos were collected in duplicate on 25 mm, 0.8 um pore size cellulose ester membrane filters at 2.5 to 3.0 lpm using a DuPont P-4000 pump for the duration of one brake job, or 2 hours, whichever was longer. (Brake Jobs 1 and 2 were collected on one set of filters.) The minimum volume collected (300 liters) allowed a limit of detection of approximately 0.005 fibers/cc by Phase Contrast Microscopy (PCH) analysis. Area air samples for asbestos were also collected on 25 mm, 0.8 um pore size cellulose ester filters. Two area samples were collected at the fender and the axle (source samples) at approximately 7.0 lpm using rotary vane high volume pumps for the duration of one brake job or 2 hours, whichever was longer. The source samples were used to measure fibers escaping into the working environment during the brake service and repair activity.
	Metric 2:	Analytical Methodology	Medium	2	All filter air samples were analyzed by PCM according to NIOSH Method 7400. In addition to PCM analysis, approximately 82 percent of these samples were analyzed by light-field Transmission Electron Microscopy (TEM). To facilitate analysis by PCM and TEM on the same samples, the direct transfer method of sample preparation described by Burdett and Rood was used.
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Cincinnati, Evanston, and Monroe, Ohio and Covington, Kentucky
	Metric 5:	Currency	Low	3	> 15 years old
	Metric 6:	Spatial and Temporal Variability	Medium	2	Adequate discussion and sample size
	Metric 7:	Exposure Scenario	Medium	2	Exposure during brake work using different dust control techniques
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Medium	2	Acceptable discussion of the results

Continued on next page

– continued from previous page

Study Citation:	T. C. Cooper, J. W. Sheehy, D. M. O'Brien, J. D. Mcglothlin, W. F. Todd. 1988. In-depth survey report: Evaluation of brake drum service controls at Cincinnati Gas and Electric Garages, Cincinnati, Evanston, and Monroe, Ohio and Covington, Kentucky.
Data Type	Monitoring
Hero ID	3099264

Domain	Metric	Rating†	Score	Comments‡
	Metric 9: Quality Assurance	Medium	2	Field blanks were prepared for each sampling date and submitted for PCM and TEM analysis. The minimum volume collected (840 liters) allowed a limit of detection of 0.002 fibers/cc by PCM. Two additional area samples were collected in the general garage area (background) at approximately 7.0 lpm for up to 4 hours encompassing pre- and post-brake job activities. These samples were used as "background" samples to determine effects of general shop cleanliness and overall containment effectiveness of the controls. The minimum volume collected (1,000 liters) allowed a limit of detection of 0.002 fibers/cc. Two other area samples were collected out-of-doors at 2.5 to 3.0 lpm using battery powered pumps for 3 to 8 hours. These outdoor (ambient) samples were collected at 7.0 lpm using a high volume pump. Ambient samples were used to determine environmental levels of asbestos. The minimum volume collected (400 liters) allowed a limit of detection of 0.004 fibers/cc. (One pair of area samples, one pair of background samples, and one pair of ambient samples were collected for Brake Jobs 1 and 2. All other brake jobs have one set of filters for each brake job.)
Domain 4: Variability and Uncertainty				
	Metric 10: Variability and Uncertainty	Medium	2	TEM Personal sample results (Tables 5 and B-1) showed a major difference between vehicles having brake drums greater than 12" in diameter and those having smaller brake drums. One possible explanation is that the brake surface area is greater resulting in a greater amount of brake dust that needs to be controlled. Also, the wheel well area is larger making the area to be sprayed less accessible.
Overall Quality Determination*		Medium	2.0	
Extracted		Yes		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Cooper, T. C.,Sheehy, J. W.,O'Brien, D. M.,McGlothlin, J. D.,Todd, W. F.. 1987. In-Depth Survey Report: Evaluation of Brake Drum Service Controls at United States Postal Service Vehicle Maintenance Facility, Louisville, Kentucky, Report No. CT-152-11B.
Data Type	Monitoring
Hero ID	3099353

Domain		Metric	Rating†	Score	Comments‡
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	High	1	personal & area air samples collected; Hand-Held Aerosol Monitor (HAM) used to measure & record dust levels
	Metric 2:	Analytical Methodology	High	1	PCM (NIOSH Method 7400) & TEM LODs reported for PCM
	Metric 3:	Biomarker Selection	N/A	N/A	Biomarker is not used
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Louisville, KY
	Metric 5:	Currency	Low	3	>15 yrs (1987)
	Metric 6:	Spatial and Temporal Variability	High	1	large sample size (12-22 personal, 7-11 fender, 8-11 axle, 5 each background, 4-8 ambient) Duplicate samples collected
	Metric 7:	Exposure Scenario	High	1	microenvironment (ventilation, temperature, humidity, and wind conditions)
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	High	1	Raw data included in Appendix A, Table A-1 Summaries provided in Tables 1 and 2 for PCM and TEM, resp.
	Metric 9:	Quality Assurance	High	1	Field blanks were prepared for each sampling date and submitted for PCM & TEM analysis
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Medium	2	
Overall Quality Determination*			High	1.3	
Extracted			Yes		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Godbey, F. W.,Cooper, T. C.,Sheehy, J. W.,O'Brien, D. M.,Van Wagenen, H. D.,McGlothlin, J. D.,Todd, W. F.. 1987. In-Depth Survey Report: Evaluation of Brake Drum Service Controls at United States Postal Service, Vehicle Maintenance Facility, Nashville, Tennessee, Report No. CT-152-20B.
Data Type	Monitoring
Hero ID	3099476

Domain		Metric	Rating†	Score	Comments‡
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	High	1	personal & area air samples collected; Hand-Held Aerosol Monitor (HAM) used to measure & record dust levels
	Metric 2:	Analytical Methodology	High	1	PCM (NIOSH Method 7400) & TEM LODs reported for PCM
	Metric 3:	Biomarker Selection	N/A	N/A	Biomarker is not used
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Nashville, TN
	Metric 5:	Currency	Low	3	>15 yrs (1986)
	Metric 6:	Spatial and Temporal Variability	High	1	large sample size (10-20 personal, 10 each fender and axle, 8-16 background, 4-8 ambient) Duplicate samples collected
	Metric 7:	Exposure Scenario	High	1	microenvironment (ventilation, temperature, humidity, and wind conditions)
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	High	1	Raw data included in Appendix A, Table A-1 Summaries provided in Tables 1 and 2 for PCM and TEM, resp.
	Metric 9:	Quality Assurance	Low	3	Field blanks were prepared for each sampling date and submitted for PCM & TEM analysis
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Medium	2	
Overall Quality Determination*			High	1.6	
Extracted			Yes		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Sheehy, J. W.,Todd, W. F.,Cooper, T. C.,Van Wagenen, H. D.. 1987. In-Depth Survey Report: Evaluation of Brake Drum Service Controls at Cincinnati Bell Maintenance Facility, Fairfax, Ohio, Report No. CT-152-21B.
Data Type	Monitoring
Hero ID	3099480

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	High	1	personal & area air samples collected; Hand-Held Aerosol Monitor (HAM) used to measure & record dust levels; calibrated
	Metric 2:	Analytical Methodology	High	1	PCM & TEM LODs reported for TEM
	Metric 3:	Biomarker Selection	N/A	N/A	Biomarker is not used
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Fairfax, OH
	Metric 5:	Currency	Low	3	>15 yrs (1986-1987)
	Metric 6:	Spatial and Temporal Variability	High	1	large sample size (13 each personal, 5 each fender and axle, 7-12 background, 7-12 ambient) Duplicate samples collected
	Metric 7:	Exposure Scenario	High	1	microenvironment (ventilation, temperature, humidity)
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	High	1	Raw data included in Appendix A, Table 1 Summaries provided in Tables 2 & 3 for PCM and TEM, resp.
	Metric 9:	Quality Assurance	Medium	2	Field blanks were prepared for each sampling date and submitted for PCM & TEM analysis.
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Medium	2	
Overall Quality Determination[*]			High	1.4	
Extracted			Yes		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Kauppinen, T.,Korhonen, K.. 1987. Exposure to Asbestos During Brake Maintenance of Automotive Vehicles by Different Methods. American Industrial Hygiene Association Journal.
Data Type	Monitoring
Hero ID	3100008

Domain		Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Medium	2	Sampling method discussed briefly. Measurements carried out by authors in 7 out of the 24 work-places. Other results collected from the measurement reports that include a description of sampling and anaytical methods used, data on sampling sites and time, and results with pertinent comments.
	Metric 2:	Analytical Methodology	Low	3	Phase-contrast-optical microscope standardized Method (Finnish Standard SFS 3868). Method has been tested in international quality control analyses.
	Metric 3:	Biomarker Selection	N/A	N/A	Biomarker is not used
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	24 work places in Finland
	Metric 5:	Currency	Low	3	>15 yrs (1977-1983)
	Metric 6:	Spatial and Temporal Variability	Medium	2	Number of samples varies from 1-30 based on operation in brake maintenance of trucks & buses or passenger cars. No replicates. Various number of work-places (1-13) and range of sampling time.
	Metric 7:	Exposure Scenario	Medium	2	Source of exposure presented by operation and type of vehicle.
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Medium	2	Supplemental or raw data are not reported. Concentrations by operation in brake maintenance (range, median, mean, number of samples, range of sampling time) reported in Table 1 trucks & buses and Table 2 for passenger cars.
	Metric 9:	Quality Assurance	Medium	2	The method has been tested in international quality control analyses. The calculated concentrations do not include the background concentration of asbestos, b/c only very few data were available.
Domain 4: Variability and Uncertainty					

Continued on next page

– continued from previous page

Study Citation:	Kauppinen, T.,Korhonen, K.. 1987. Exposure to Asbestos During Brake Maintenance of Automotive Vehicles by Different Methods. American Industrial Hygiene Association Journal.
Data Type	Monitoring
Hero ID	3100008

Domain	Metric	Rating†	Score	Comments‡
	Metric 10: Variability and Uncertainty	Medium	2	Variations in respirable dust concentrations measured by Leitz tyndallometer during different cleaning procedures are shown in Figure 2. The unestimated background concentration of asbestos in the brake maintenance work places, however, gives rise to the possibility of underestimation of the TWA concentrations.
Overall Quality Determination*		Medium	2.1	
Extracted		Yes		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Musthapa, M. S.,Ahmad, I.,Trivedi, A. K.,Rahman, Q.. 2003. Asbestos contamination in biota and abiota in the vicinity of asbestos-cement factory. Bulletin of Environmental Contamination and Toxicology.
Data Type	Monitoring
Hero ID	3278824

Domain		Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Low	3	Minimal description of sampling meth0dology
	Metric 2:	Analytical Methodology	Low	3	PCM by Indian Standard (1986)
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	India
	Metric 5:	Currency	Low	3	> 15 yrs old
	Metric 6:	Spatial and Temporal Variability	Medium	2	different locations within pond sampled for pond water
	Metric 7:	Exposure Scenario	Low	3	surface water contamination from asbestos cement factory
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Low	3	Tables of values, minimal discussion
	Metric 9:	Quality Assurance	Low	3	Minimal discussion
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Low	3	Minimal discussion of variability and uncertainty
Overall Quality Determination[*]			Low	2.7	
Extracted			No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	C. L. Blake, G. S. Dotson, R. D. Harbison. 2006. Assessment of airborne asbestos exposure during the servicing and handling of automobile asbestos-containing gaskets. Regulatory Toxicology and Pharmacology.
Data Type	Monitoring
Hero ID	3520458

Domain	Metric	Rating†	Score	Comments‡
Domain 1: Reliability				
Metric 1:	Sampling Methodology	Medium	2	Sampling methodology was discussed. Personal air samples were collected to estimate airborne fiber exposure levels that mechanic and hypothetical bystanders would encounter during the servicing and handling of asbestos-containing gaskets. The equipment utilized for collecting personal samples consisted of battery powered portable air pumps, Ametek Model alpha 1, that drew air at metered flowrates, nominally 2.0"2.4 liters per minute (lpm), through 25-mm diameter cassettes mounted mixed cellulose ester (MCE) membrane filters. The cassettes were placed within the mechanic"s breathing zone. The membrane filters placed atop the mechanics right shoulder were of 0.8 micron (um) pore size, while those placed atop his left shoulder were of 0.45 um pore size.

Continued on next page

– continued from previous page

Study Citation:	C. L. Blake, G. S. Dotson, R. D. Harbison. 2006. Assessment of airborne asbestos exposure during the servicing and handling of automobile asbestos-containing gaskets. Regulatory Toxicology and Pharmacology.
Data Type	Monitoring
Hero ID	3520458

Domain		Metric	Rating†	Score	Comments‡
	Metric 2:	Analytical Methodology	Medium	2	Samples were analyzed using phase contrast microscopy (PCM) and transmission electron microscopy (TEM). PCM analysis followed the National Institute of Occupational Safety and Health (NIOSH) Method 7400. This analytical method is unable to distinguish between fibers of asbestos and non-asbestos origins, and provides an index of airborne fibers commonly used to estimate asbestos concentrations (NIOSH, 1994a). The optical limitations of the phase contract microscope restrict its resolution capabilities to fibers wider than 0.25 micrometer (m) and longer than 5m in length. Additionally, fibers not exhibiting a three to one length to width ratio are excluded from the counting process. Use of this method satisfies requirements of the OSHA standards for asbestos specific air sampling. PCM analysis of air samples counts all resolvable fibrous structures including non-asbestos fibers that meet the dimensional criteria. There exists the potential for such analysis to yield airborne fiber concentration data which exceed the actual airborne asbestos concentrations. In settings such as automobile repair shops, cellulose fibers, long thin metal fragments from power brushing activities and synthetic, and other fibers often appear in air samples taken during work of the type subject of this research. For this reason, additional analysis of air samples was done using TEM, following NIOSH Method 7402. This analytical method measures fibers longer than 5 um and wider than 0.25 um, and allows development of an asbestos-to-total fiber ratio. This ratio is then multiplied by the airborne fiber concentration generated using the PCM analysis, yielding an asbestos fiber count known as phase contrast microscopy equivalent (PCME). This asbestos fiber count may be used for comparison against occupational exposure limits (OEL) such as the OSHA PEL or NIOSH recommended exposure limits (REL). Detection limits are not reported.
	Metric 3:	Biomarker Selection	N/A	N/A	Biomarker is not used.
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	United States, Detroit, MI
	Metric 5:	Currency	Medium	2	> 5 to 15 years (2006 publication date)
	Metric 6:	Spatial and Temporal Variability	Low	3	Small sample size (3 personal air samples), no replicates

Continued on next page

– continued from previous page

Study Citation:	C. L. Blake, G. S. Dotson, R. D. Harbison. 2006. Assessment of airborne asbestos exposure during the servicing and handling of automobile asbestos-containing gaskets. Regulatory Toxicology and Pharmacology.
Data Type	Monitoring
Hero ID	3520458

Domain	Metric		Rating†	Score	Comments‡
	Metric 7:	Exposure Scenario	Medium	2	Asbestos exposure during the removal of asbestos-containing gaskets on vehicles. Engine disassembly; gaskets removed - 1974 Chevrolet Malibu and Ford cubic inch V-8 390 Engine. During the gasket removal test sessions, the mechanic first removed engine heads and manifolds components that covered or otherwise held the target gaskets. Many of these gaskets came off intact leaving gasket residue on the metal mating surface. Bulk samples of the removed gaskets were obtained for subsequent analysis. The mechanic next scraped away gasket residue using a wide blade putty knife, sometimes assisted with a rubber hammer. Loose parts, such as engine heads and manifolds, were next immersed into a water bath cleaner, a product of Safety Kleen, and washed using an Arm and Hammer brand Aqua Works Cold Cleaning Solution, before being burnished using a rotary 1-in. knot type wire end brush, NAPA service tools Part Number (P/N) 2312. The end brush was powered by a hand held drill motor, Ingersoll Rand model 7803R, operated from 90 PSI line pressure. To aid in the gasket and other residue removal process, the mechanic sprayed the parts with a non-chlorine containing solvent dispersed from an aerosol spray can, Aerosol Systems, Inc., P/N TM 3506. This solvent contained; xylenes, aliphatic petroleum distillates, and acetone, with a compressed carbon dioxide propellant. When cleaning the surfaces of fixed, non-transportable parts such as engine blocks, the mechanic utilized scraping, powered wire brushing, and solvent spray, however no aqueous wash occurred with the fixed parts. This process continued until all gasket remnants were removed from the loose parts and engine blocks, and subject parts were sufficiently clean to allow reassembly.
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Medium	2	Personal air samples results containing asbestos fibers were reported in Table 7 as PCM 8-HR TWA (f/cc) and PCME 8-HR TWA (f/cc) . No supplemental or raw data were provided. Note: The minimum PCME 8-hr TWA value (0.0018 f/cc) reported in Table 6 does not match the minimum personal PCME 8-hr TWA value (0.0008 f/cc) reported in Table 7.
	Metric 9:	Quality Assurance	Low	3	QA/QC procedures not directly discussed, but can be implied
Domain 4: Variability and Uncertainty					

Continued on next page

– continued from previous page

Study Citation:	C. L. Blake, G. S. Dotson, R. D. Harbison. 2006. Assessment of airborne asbestos exposure during the servicing and handling of automobile asbestos-containing gaskets. Regulatory Toxicology and Pharmacology.
Data Type	Monitoring
Hero ID	3520458

Domain	Metric	Rating†	Score	Comments‡
	Metric 10: Variability and Uncertainty	Medium	2	Limitations associated with NIOSH Methods 7400 and 7402 are discussed. Criticism of the use of phase contrast microscopy and transmission electron microscopy focuses on the exclusion of short (<5 um long) and long, but thin (<0.25 um wide) asbestos fibers (Atkinson et al., 2004; Lemen, 2004). Those who oppose the use of NIOSH Methods 7400 and 7402 state that the elimination of short and thin structures from the data set underestimates the risk that exposed workers encounter. Recent committee findings released by the Agency for Toxic Substances and Disease Registry (ATSDR) report limited or no human cancer risk from fibers fitting the previous descriptions (ATSDR, 2003). Research has demonstrated that the pathogenesis of asbestos-related diseases is directly influenced by the physical dimensions of asbestos fibers (Stanton et al., 1981). The length and width of fibers determine their ability to be deposited within the lungs, and subsequently affect the onset of malignant and non-malignant diseases (Lippmann, 1990; ATSDR, 2003). Fibers longer than 10 um are not easily phagocytized, and tend to remain in the lower respiratory tract or penetrate the pleural membrane (Hume and Rimstidt, 1992). Shorter fibers, including the fiber populations (<5 um in length and <0.25 um in width) excluded from consideration by NIOSH Methods 7400 and 7402, are arguably of less significance in terms of the development of asbestos-related cancers. In addition, the debate regarding dimension based fiber exclusion distracts attention from the real benefit these methods offer. NIOSH Methods 7400/7402 data can be directly compared against established health risk databases. No such databases exist for the asbestos structure data for short (<5 um long) and long but thin (<0.25 um wide) asbestos fibers. Despite the limitations associated with these NIOSH Methods 7400 and 7402, the advantages of their use exceed their disadvantages.
Overall Quality Determination*		Medium	2.1	
Extracted		Yes		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Cely-García, M. F.,Curriero, F. C.,Sánchez-Silva, M.,Breysse, P. N.,Giraldo, M.,Méndez, L.,Torres-Duque, C.,Durán, M.,González-García, M.,Parada, P.,Ramos-Bonilla, J. P.. 2016. Estimation of personal exposure to asbestos of brake repair workers. Journal of Exposure Science and Environmental Epidemiology.
Data Type	Monitoring
Hero ID	3520524

Domain	Metric		Rating†	Score	Comments‡
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	High	1	Personal and quality control samples were collected according to NIOSH methods 7400 and 7402 using MCE filters, with 0.45 "m pore size, on conducting extension cowls cassettes of 50 mm connected to AIRCheck XR5000 pumps. Thirty-minute short-term personal samples were collected during manipulation activities, and longer or shorter personal samples were collected during non-manipulation activities.
	Metric 2:	Analytical Methodology	High	1	Samples were analyzed on a Philips CM12 transmission electron microscopy (FEI Corp, Hillsboro OR, USA). A magnification of " 2500 was used for the general analysis, scanning for fibers longer than 5 "m. A magnification of " 19,000 was used for more precise measurements, to confirm the dimensions of fibers close to the method limits. Only fibers >5 "m long and >0.25 "m diameter were counted. Energy Dispersive X-ray (EDXA) NORAN System 7 (NS7) (Thermo Electron Scientific Instruments, Madison, WI, USA) was used for elemental composition analysis, and the accelerating voltage was 100 keV. All samples were coded, and the laboratory was blinded about the activities performed during the collection of each sample, and about the working conditions of the shops.
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Bogota, Colombia
	Metric 5:	Currency	Medium	2	Samples taken since 2010, 10 years old (>5 to 15 years)
	Metric 6:	Spatial and Temporal Variability	Medium	2	Analysis of the bulk asbestos content of 18 duplicate samples of brake products from 12 of the most common brands commercialized in Bogot" was performed by Forensic Analytical Laboratories (Hayward, CA, USA), following EPA 600/R-93-116 PLM method.

Continued on next page

– continued from previous page

Study Citation:	Cely-García, M. F.,Curriero, F. C.,Sánchez-Silva, M.,Breysse, P. N.,Giraldo, M.,Méndez, L.,Torres-Duque, C.,Durán, M.,González-García, M.,Parada, P.,Ramos-Bonilla, J. P.. 2016. Estimation of personal exposure to asbestos of brake repair workers. Journal of Exposure Science and Environmental Epidemiology.
Data Type	Monitoring
Hero ID	3520524

Domain	Metric	Rating†	Score	Comments‡
	Metric 7: Exposure Scenario	High	1	Relevant exposure scenarios; Activity diaries were filled with information regarding all the activities performed by workers during sampling campaigns, the number and type of products manipulated daily (i.e., brake pads, brake linings, and brake blocks), and if the brake product manipulated contained asbestos (i.e., based on the labels of the products and/or the knowledge of workers).
Domain 3: Accessibility/Clarity				
	Metric 8: Reporting of Results	Medium	2	Based on the results of the sampling campaigns, 103 8-h TWA PCM-Eq personal asbestos concentrations were calculated. Forty three were for 13 riveters that worked in 9 passenger vehicles BRS, and had a mean of 0.151 f/cm3, a median of 0.048 f/cm3, a SD of 0.191 f/cm3 and a range from 0.00 to 0.61 f/cm3. Sixty were for 15 riveters that worked in 9 heavy duty vehicles BRS, and had a mean of 0.042 f/cm3, a median of 0.021 f/cm3 and SD of 0.057 f/cm3, and a range from 0.00 to 0.31 f/cm3.
	Metric 9: Quality Assurance	High	1	Blank samples were collected each sampling day, and background samples were collected during one night in each shop sampled. Asbestos analyses were performed by two American Industrial Hygiene Association (AIHA) accredited laboratories (Forensic Analytical Laboratories, Inc, Hayward, CA, USA, and RJ Lee Group, Monroeville, PA, USA).
Domain 4: Variability and Uncertainty				
	Metric 10: Variability and Uncertainty	Medium	2	40 out of the 318 30-min short-term personal samples collected during manipulation activities were not classified in any task-related EF. In addition, 25 out of the 280 personal samples collected during non-manipulation activities were not classified because a worker had inadvertently performed a brake product manipulation, and these samples were longer than 30 min (i.e., and because of the duration, they were not included in the 318 30-min short-term personal samples). Furthermore, another 32 of the 280 personal samples collected during non-manipulation activities were not classified because they were collected in a shop with a workload that vastly exceeded the average workload of the shops sampled, which could limit the generalizability of the results.

Continued on next page

– continued from previous page

Study Citation:	Cely-García, M. F.,Curriero, F. C.,Sánchez-Silva, M.,Breysse, P. N.,Giraldo, M.,Méndez, L.,Torres-Duque, C.,Durán, M.,González-García, M.,Parada, P.,Ramos-Bonilla, J. P.. 2016. Estimation of personal exposure to asbestos of brake repair workers. Journal of Exposure Science and Environmental Epidemiology.
Data Type	Monitoring
Hero ID	3520524

Domain	Metric	Rating†	Score	Comments‡
Overall Quality Determination*		High	1.4	
Extracted		Yes		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	L. R. Liukonen, F. W. Weir. 2005. Asbestos exposure from gaskets during disassembly of a medium duty diesel engine. Regulatory Toxicology and Pharmacology.
Data Type	Monitoring
Hero ID	3531131

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Medium	2	Sampling methodology discussed. All samples were collected using SKC PCXR3 or PCXR7 sampling pumps and open-faced 25mm mixed cellulose ester filters. The pumps were calibrated to a nominal 2L/min (lpm) before and after each day of testing with a primary standard (Mini-Buck). Sampling procedures were in accordance with National Institute of Occupational Safety and Health (NIOSH) Sampling and Analytical Method 7400, Asbestos and Other Fibers by PCM (NIOSH, 1994). Throughout the disassembly process, portions of all engine gaskets were placed in sealed polyethylene sample bags, labeled, and stored for subsequent analysis. Personal and area air samples were collected to evaluate the quantity of asbestos fibers in the breathing zone of the mechanic as well as the area near the disassembly procedure. The personal sampler was located on the lapel of the mechanic"s shirt. For several of the gasket-surface cleaning tasks, a third sample was collected where one of the observers wore a second monitor and stood as near as was practical to the mechanic throughout the task"approximately 2"5 ft. To the extent possible, the observer with the monitor stood facing the mechanic and directly across from the work being performed to sample the air for any materials generated by the process.
	Metric 2:	Analytical Methodology	Medium	2	Analyses were conducted using PCM as required by NIOSH 7400 and the Occupational Safety and Health Administration (OSHA) Reference Method. Analysis was by RJ Lee Group, a laboratory accredited by the American Industrial Hygiene Association (AIHA) and National Voluntary Laboratory Accreditation program (NVLAP). As PCM does not distinguish between asbestos and non-asbestos fibers, samples that recorded detectable concentrations of airborne fibers were further analyzed by TEM using NIOSH 7402, Asbestos by TEM (NIOSH, 1994) to determine a ratio of asbestos to nonasbestos fibers. This ratio was then used to reduce, if appropriate, the fiber count.
	Metric 3:	Biomarker Selection	N/A	N/A	No biomarker used.
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	United States; authors from TX. The engine rebuilding was conducted at a privately operated, independent repair facility.

Continued on next page

– continued from previous page

Study Citation:	L. R. Liukonen, F. W. Weir. 2005. Asbestos exposure from gaskets during disassembly of a medium duty diesel engine. Regulatory Toxicology and Pharmacology.
Data Type	Monitoring
Hero ID	3531131

Domain	Metric		Rating†	Score	Comments‡
	Metric 5:	Currency	Medium	2	>5 to 15 years (2005 publication date). Early part of August.
	Metric 6:	Spatial and Temporal Variability	Medium	2	Large sample size (14 personal air samples collected over 3 days during 10 engine disassembly task). No replicates.
	Metric 7:	Exposure Scenario	Medium	2	Disassembly of the engine was divided into tasks. The mechanic was instructed to proceed as he would for any similar procedure, but to identify and describe each task as he initiated work. No attempt was made by any party to suggest procedures or to otherwise influence the customary processes of the mechanic. The mechanic removed the gaskets with a scraper. Any remaining residue was cleaned from the surface using either a rotary wire brush or a 3M brand Scotch Brite pad on a hand held air-operated grinder. Gasket scraps were allowed to fall to the floor until normal work area cleanup was done by the mechanic, usually at the end of each work interval, such as at the end of the day. Each task was timed. Table 1 presents information relating to the disassembly tasks. For the most part, personal samples were changed at the beginning of each task, except as noted.
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Medium	2	No supplementary or raw data provided. PCM personal air sample results reported in Table 3 for 10 disassembly tasks. These results are presented as fibers greater than 5 um in length per cubic centimeter of air (f/cm3) as determined by phase contrast microscopy.
	Metric 9:	Quality Assurance	Medium	2	QA/QC techniques and results not directly discussed but can be implied through the study's use of standard field and laboratory protocols.
Domain 4: Variability and Uncertainty					

Continued on next page

– continued from previous page

Study Citation:	L. R. Liukonen, F. W. Weir. 2005. Asbestos exposure from gaskets during disassembly of a medium duty diesel engine. Regulatory Toxicology and Pharmacology.
Data Type	Monitoring
Hero ID	3531131

Domain	Metric	Rating†	Score	Comments‡
	Metric 10: Variability and Uncertainty	Low	3	A limiting factor in determining exposure to asbestos fibers during investigations such as the diesel engine overhaul is the accumulation of particulate on the filters. This limitation becomes more pronounced as sample times and volumes increase. The industrial hygienist must balance the need to collect sufficient volume of the workplace air to permit sufficient sensitivity but not so much as to overload the filter so that the fibers cannot be reliably counted. Thus, because of the presence of other, [non-fibrous], particulate in the atmosphere of the workshop, the detection limits in such a study are somewhat less than optimal. less than optimal.
Overall Quality Determination*		Medium	2.0	
Extracted		Yes		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Paustenbach, D. J.,Madl, A. K.,Donovan, E.,Clark, K.,Fehling, K.,Lee, T. C.. 2006. Chrysotile asbestos exposure associated with removal of automobile exhaust systems (ca. 1945-1975) by mechanics: results of a simulation study. Journal of Exposure Science and Environmental Epidemiology.
Data Type	Monitoring
Hero ID	3531296

Domain		Metric	Rating†	Score	Comments‡
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Medium	2	Limitation of only 2 mechanics being sampled
	Metric 2:	Analytical Methodology	High	1	
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Study was conducted inn Santa Rosa, CA.
	Metric 5:	Currency	Medium	2	>5 - 15 years old
	Metric 6:	Spatial and Temporal Variability	High	1	
	Metric 7:	Exposure Scenario	High	1	
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Medium	2	No raw data
	Metric 9:	Quality Assurance	Low	3	very little discussion of QA/QC measures
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Medium	2	needs better discussion of uncertainty
Overall Quality Determination*			Medium	1.7	
Extracted			Yes		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Weir, F. W.,Tolar, G.,Meraz, L. B.. 2001. Characterization of vehicular brake service personnel exposure to airborne asbestos and particulate. Applied Occupational and Environmental Hygiene.
Data Type	Monitoring
Hero ID	3531556

Domain		Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	High	1	Phase 1 monitoring protocol for a "closed" drum brake system. Instrument calibrated
	Metric 2:	Analytical Methodology	High	1	Phase 1 air samples analyzed using PCM (NIOSH Method 239).
	Metric 3:	Biomarker Selection	N/A	N/A	Biomarker is not used
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Public service organization auto/truck repair facility (Texas? All three authors from Texas)
	Metric 5:	Currency	Low	3	>15 yrs (2001 pub date)
	Metric 6:	Spatial and Temporal Variability	Medium	2	Phase 1: Three vehicles monitored. A total of 36 samples collected during this series; five stationary samples and one personal sample collected for each rear wheel of every vehicle.
	Metric 7:	Exposure Scenario	Medium	2	Description of facility, gas heaters in operation so limited air circulation in work area
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Low	3	Phase 1 results reported as average ranges. No supplemental or raw data provided.
	Metric 9:	Quality Assurance	Low	3	No controls, baseline, recoveries reported
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Low	3	Average concentrations reported. No maximum values so variability is unknown.
Overall Quality Determination[*]			Medium	2.1	
Extracted			Yes		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Pitt, R.. 1988. ASBESTOS AS AN URBAN AREA POLLUTANT. Journal of Water Pollution Control Federation.
Data Type	Monitoring
Hero ID	3580912

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Medium	2	Sampling procedures & equipment described, calibration not mentioned.
	Metric 2:	Analytical Methodology	High	1	Two phased approach: screening qualitative procedure and quantitative transmission electron microscopic and selected-area electron diffraction (TEM/SAED). Procedures based on published EPA methodology.
	Metric 3:	Biomarker Selection	N/A	N/A	Biomarker is not used
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Castro Valley, CA
	Metric 5:	Currency	Low	3	>15 yrs (1979 and 1980)
	Metric 6:	Spatial and Temporal Variability	Medium	2	Moderate sample size, 22 samples collected showed quantitative results for asbestos, 5 of which were creek water samples
	Metric 7:	Exposure Scenario	Medium	2	Some asbestos pipe may be involved, the primary source of asbestos in San Francisco drinking water is the erosion of serpentine rock formations.
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Medium	2	Supplemental or raw data are not reported. Table 1 reports results of TEM/SAED quantitative asbestos analyses on Creek water samples
	Metric 9:	Quality Assurance	Medium	2	Two phase approach to analysis, optical qualitative screening and quantitative TEM/SAED. No recoveries or controls
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Medium	2	Individual creek asbestos concentrations (Table 5) vary widely. Only a few medium sized runoff events contributed most of the asbestos. These concentration estimates can therefore be expected to vary appreciably for other periods and locations of monitoring.
Overall Quality Determination[*]			Medium	1.9	
Extracted			No		

Continued on next page

– continued from previous page

Study Citation:	Pitt, R.. 1988. ASBESTOS AS AN URBAN AREA POLLUTANT. Journal of Water Pollution Control Federation.
Data Type	Monitoring
Hero ID	3580912

Domain	Metric	Rating†	Score	Comments‡

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Hickish, D. E.,Knight, K. L.. 1970. Exposure to asbestos during brake maintenance. Annals of Occupational Hygiene.
Data Type	Monitoring
Hero ID	3610801

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Medium	2	Limit information on sampling methodology discussed; however, article stated air sampling was carried out using membrane filters and sampling and subsequent assessment was in accordance with the technique described in the "Hygiene Standard for Chrysotile Asbestos Dust" (1968); not calibrated
	Metric 2:	Analytical Methodology	Medium	2	Limit information on analytical methodology discussed; however, article stated air sampling and subsequent assessment was in accordance with the technique described in the "Hygiene Standard for Chrysotile Asbestos Dust" (1968)
	Metric 3:	Biomarker Selection	N/A	N/A	Biomarker is not used
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Study conducted at Service Bay of a Ford Main Dealer in Greater London area in England
	Metric 5:	Currency	Low	3	>15 yrs old; 1970 pub date
	Metric 6:	Spatial and Temporal Variability	Low	3	small sample size (6 personal during car brake service, 4 personal druing truck brake service, and 3 general area air samples collected during truck brake service in morning and afternoon)
	Metric 7:	Exposure Scenario	Low	3	Minimal description of the process carried out during brake servicing on cars and trucks in the auto shop. Brake servicing carried out on 11 vehicles.
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Low	3	Concentration (fibers/cm3) results were presented in Tables 2 (6 personal air samples during car brake service), 3 (general atmosphere samples during truck brake service in morning and afternoon, 4 (personal air samples during truck brake & clutch service during various operations; No supplemental or raw data are available.
	Metric 9:	Quality Assurance	Low	3	Controls, recoveries not reported
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Low	3	Does not compare to other studies. No standard deviation or ranges reported.

Continued on next page

– continued from previous page

Study Citation:	Hickish, D. E.,Knight, K. L.. 1970. Exposure to asbestos during brake maintenance. Annals of Occupational Hygiene.
Data Type	Monitoring
Hero ID	3610801

Domain	Metric	Rating†	Score	Comments‡
Overall Quality Determination*		Low	2.6	
Extracted		Yes		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Rohl, A. N.,Langer, A. M.,Klimentidis, R.,Wolff, M. S.,Seilikoff, I. J.. 1977. Asbestos content of dust encountered in brake maintenance and repair. Proceedings of the Royal Society of Medicine.
Data Type	Monitoring
Hero ID	3615571

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	High	1	Air sampling for the determination of fiber concentrations in accordance with OSHA techniques
	Metric 2:	Analytical Methodology	Medium	2	Analytical methods for the determination of fiber concentrations in accordance with OSHA techniques Reporting limits, detection limits (LOQ/LOD) not reported
	Metric 3:	Biomarker Selection	N/A	N/A	Biomarker is not used
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	NYC
	Metric 5:	Currency	Low	3	>15 yrs (1977 study pub date)
	Metric 6:	Spatial and Temporal Variability	Medium	2	large sample size (13 for automotive brake repair & 23 for truck brake repair) no replicates?
	Metric 7:	Exposure Scenario	High	1	Source of exposure: blowing dust from brake drums; renewing used linings by grinding Various distances from source
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Medium	2	No supplemental or raw data
	Metric 9:	Quality Assurance	Medium	2	Samples of brake dust first examined by optical microscopy, X-ray diffraction, transmission electron microscopy and energy dispersive X-ray spectroscopy to determine presence of chrysotile.
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Medium	2	For dust samples, article indicates that samples were obtained from areas representing variable circumstances (e.g., driving conditions, friction material composition, type of automobile and climate For personal air samples, samples collected from various distances from source.
Overall Quality Determination[*]			Medium	1.8	
Extracted			Yes		

Continued on next page

– continued from previous page

Study Citation:	Rohl, A. N.,Langer, A. M.,Klimentidis, R.,Wolff, M. S.,Seilikoff, I. J.. 1977. Asbestos content of dust encountered in brake maintenance and repair. Proceedings of the Royal Society of Medicine.
Data Type	Monitoring
Hero ID	3615571

Domain	Metric	Rating†	Score	Comments‡

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Niosh,. 1976. Preliminary industrial hygiene survey at Auto Brake Clinic, Cincinnati, Ohio.
Data Type	Monitoring
Hero ID	3645882

Domain		Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Low	3	Limit information on sampling methodology. Seven general area and five personal air samples collected on millipore filters. Three bulk brake drum dust samples collected; sampling methodology not specified. Not calibrated
	Metric 2:	Analytical Methodology	Low	3	Limited analytical methodology information provided. Both general area and personal samples analyzed by phase contrast counting methods. Bulk brake drum dust were presently being analyzed by electron microscopy.
	Metric 3:	Biomarker Selection	N/A	N/A	Biomarker is not used
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Study conducted at Auto Brake Clinic in Cincinnati, OH
	Metric 5:	Currency	Low	3	>15 yrs old; samples collected August 1976
	Metric 6:	Spatial and Temporal Variability	Low	3	small sample size (4 personal and 7 general area air samples collected; during the survey the brakes of four vehicles were serviced)
	Metric 7:	Exposure Scenario	Low	3	Minimal description of the process carried out during brake servicing in the auto shop.
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Medium	2	Fiber concentration (fibers >5 "m/cc of air) results were presented in Table I for four personal and 7 general area. No supplemental or raw data are available.
	Metric 9:	Quality Assurance	Low	3	Controls, recoveries not reported
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Low	3	Range of sample concentrations not reported.
Overall Quality Determination[*]			Low	2.7	
Extracted			Yes		

Continued on next page

– continued from previous page

Study Citation:	Niosh,. 1976. Preliminary industrial hygiene survey at Auto Brake Clinic, Cincinnati, Ohio.
Data Type	Monitoring
Hero ID	3645882

Domain	Metric	Rating†	Score	Comments‡

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Lorimer, W. V.,Rohl, A. N.,Miller, A.,Nicholson, W. J.,Selikoff, I. J.. 1976. Asbestos exposure of brake repair workers in United States. Mount Sinai Journal of Medicine.
Data Type	Monitoring
Hero ID	3646036

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Low	3	"Standard OSHA" but no description of type of personal air monitor used
	Metric 2:	Analytical Methodology	Medium	2	"standard optical technique" and OSHA standard for fiber counting but sounds outdated
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	
	Metric 5:	Currency	Low	3	personal air monitoring for 2-10 min; actual dates of sampling not discussed; 1976 print date
	Metric 6:	Spatial and Temporal Variability	Low	3	Only one shop tested in NYC; background samples taken at various distances and times but not specified; moderate sample size per exposure scenario
	Metric 7:	Exposure Scenario	High	1	Very relevant exposure scenario
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Low	3	duration of sampling for personal samples not reported individually, only background has specific duration of sampling;
	Metric 9:	Quality Assurance	Low	3	Little discussion of QA/QC; dust samples were examined by two techniques for comparison
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Low	3	little discussion; conclusions indicate that results can't be generalized to all brake workers; states both TWA and peak levels showed significant asbestos exposure but TWA was not calculated for this study
Overall Quality Determination[*]			Low	2.4	
Extracted			Yes		

Continued on next page

– continued from previous page

Study Citation:	Lorimer, W. V.,Rohl, A. N.,Miller, A.,Nicholson, W. J.,Selikoff, I. J.. 1976. Asbestos exposure of brake repair workers in United States. Mount Sinai Journal of Medicine.
Data Type	Monitoring
Hero ID	3646036

Domain	Metric	Rating†	Score	Comments‡

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Sheehy, J. W.,Godbey, F. W.,Cooper, T. C.,Lenihan, K. L.,Van Wagenen, H. D.,McGlothlin, J. D.. 1987. In-Depth Survey Report: Control Technology for Brake Drum Service Operations at Ohio Department of Transportation, Maintenance Facility, Lebanon, Ohio, CT-152-18b.
Data Type	Monitoring
Hero ID	3648228

Domain		Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	High	1	personal & area air samples collected; Hand-Held Aerosol Monitor (HAM) used to measure & record dust levels; calibrated
	Metric 2:	Analytical Methodology	High	1	PCM (NIOSH Method 7400) & TEM LODs reported for PCM
	Metric 3:	Biomarker Selection	N/A	N/A	Biomarker is not used
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Lebanon, OH
	Metric 5:	Currency	Low	3	>15 yrs (1986)
	Metric 6:	Spatial and Temporal Variability	High	1	large sample size (18 each personal, 9 each fender and axle, 10-11 background, 10-12 ambient) Duplicate samples collected
	Metric 7:	Exposure Scenario	High	1	microenvironment (ventilation, temperature, humidity, and wind conditions)
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	High	1	Raw data included in Appendix A, Table 1 Summaries provided in Tables 1 and 2a for PCM and TEM, resp. Table 2b TEM concentrations excluding one large salt truck
	Metric 9:	Quality Assurance	Medium	2	Field blanks were prepared for each sampling date and submitted for PCM & TEM analysis.
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Medium	2	Detection was only slightly above background. No statistical difference between ambient and background conc.
Overall Quality Determination[*]			High	1.4	
Extracted			Yes		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Oliver, T.,Murr, L. E.. 1977. An electron microscope study of asbestiform fiber concentrations in Rio Grande valley water supplies.
Data Type	Monitoring
Hero ID	3649985

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Medium	2	Some info on sample collection, but not detailed.
	Metric 2:	Analytical Methodology	Medium	2	
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	
	Metric 5:	Currency	Low	3	1977, >15 years
	Metric 6:	Spatial and Temporal Variability	Low	3	
	Metric 7:	Exposure Scenario	Low	3	Background and asbestos pipe. Surface water and groundwater. Source water samples, but difficult to determine if surface water or well.
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Low	3	Older study, not as clear as to number of samples. no raw data.
	Metric 9:	Quality Assurance	Low	3	limited info.
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Low	3	limited discussion. possible one sample per water body.
Overall Quality Determination[*]			Low	2.6	
Extracted			No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Sheehy, J. W.,Cooper, T. C.,O'Brien, D. M.,McGlothlin, J. D.,Froehlich, P. A.. 1989. Control of asbestos exposure during brake drum service.
Data Type	Monitoring
Hero ID	3655537

Domain		Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	High	1	personal & area air samples collected; Hand-Held Aerosol Monitor (HAM) used to measure & record dust levels; calibrated
	Metric 2:	Analytical Methodology	High	1	PCM & TEM LODs reported for PCM
	Metric 3:	Biomarker Selection	N/A	N/A	Biomarker is not used
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	U.S., sites not specified, taken from in-depth surveys
	Metric 5:	Currency	Low	3	>15 yrs (1989 study pub date)
	Metric 6:	Spatial and Temporal Variability	Medium	2	small to large sample size, based on Control Method Note: Water hose and solvent control method is considered a "do-it-yourself" mechanic (2 samples each for PCM and TEM)
	Metric 7:	Exposure Scenario	High	1	microenvironment (ventilation, temperature, humidity)
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Medium	2	No raw/supplemental data Summaries provided in Tables 5-1 and 5-2 for PCM and Tables 5-3 and 5-4 for TEM
	Metric 9:	Quality Assurance	Medium	2	Samples analyzed by PCM & TCM. "Uncontrolled" samples (i.e., no dust controls were used; brake drums were banged on the floor to remove dust) were also analyzed.
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Medium	2	
Overall Quality Determination[*]			Medium	1.7	
Extracted			Yes		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Crandall, M. S.,Fleeger, A. K.. 1989. Health hazard evaluation report no. HETA 88-372-1953, Barbados Ministry of Health, Bridgetown, Barbados.
Data Type	Monitoring
Hero ID	3970543

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Low	3	Bulk samples, surface sweep, and air samples were collected. No asbestos containing materials found at vehicle repair shop. Brief descriptions of surface sweep and air sampling provided.
	Metric 2:	Analytical Methodology	High	1	Air samples analyzed by two methods NIOSH Methods 7400 (PCM) and 7402 (TEM). Reporting detection limits
	Metric 3:	Biomarker Selection	N/A	N/A	Biomarker is not used
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Barbados, vehicle repair shop
	Metric 5:	Currency	Low	3	>15 yrs (1988)
	Metric 6:	Spatial and Temporal Variability	Low	3	Small sample size, 3 air samples collected, one was an outdoor air sample
	Metric 7:	Exposure Scenario	Medium	2	Source of exposure: description of vehicle repair shop; little activity on day of survey
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Medium	2	Supplemental or raw data are not reported. Air samples all 3 samples were <LOD.
	Metric 9:	Quality Assurance	Low	3	One outdoor air sample served as control
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Medium	2	There was no brake lining work scheduled for the day, so they placed samplers at each end of the shop where there was general maintenance work going on.
Overall Quality Determination[*]			Medium	2.2	
Extracted			No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Equitable Environmental Health, Inc. 1977. Dust exposures during the cutting and machining of asbestos/cement pipe, additional studies.
Data Type	Monitoring
Hero ID	4152071

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Medium	2	short term and longer term personal and helper sampling for several well-described ac pipe activities
	Metric 2:	Analytical Methodology	Medium	2	Asbestos fiber counts were done by an experienced and accredited technician, following OSHA and NIOSH methods; PCM
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Torrance, CA
	Metric 5:	Currency	Low	3	October 1977; > 15 yrs old
	Metric 6:	Spatial and Temporal Variability	Medium	2	Personal and helper air sampling; multiple activity scenarios covered; smaller sample sizes
	Metric 7:	Exposure Scenario	High	1	asbestos cement pipe exposure
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Medium	2	Multiple tables
	Metric 9:	Quality Assurance	Medium	2	three replicate short term exposures for personal and helper exposure; background samples collected at end of each day; samplers changed at regular intervals;
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Medium	2	acceptable description of variability among activity exposures and some discussion of uncertainty regarding concentrations
Overall Quality Determination[*]			Medium	1.9	
Extracted			No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Roberts, D. R.. 1980. Industrial hygiene report: Asbestos at Allied Brake Shop, Cincinnati, OH.
Data Type	Monitoring
Hero ID	4152150

Domain		Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Medium	2	Brake shop exposure: personal exposures for two mechanics; general area samples; 15 minute samples
	Metric 2:	Analytical Methodology	Medium	2	transmission electron microscope (TEM) utilizing selected area electron diffraction (SAED) and an energy dispersive X-ray analyzer;
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Cincinnati Ohio
	Metric 5:	Currency	Low	3	1979; > 15 yrs old
	Metric 6:	Spatial and Temporal Variability	Medium	2	personal as well as area samples taken for spatial variability; lacks temporal based only on one day's sampling.
	Metric 7:	Exposure Scenario	High	1	very relevant exposure during brake repair
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Medium	2	Minimal discussion
	Metric 9:	Quality Assurance	Low	3	minimal discussion
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Medium	2	Minimal discussion
Overall Quality Determination[*]			Medium	2.0	
Extracted			Yes		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Roberts, D. R.. 1980. Industrial hygiene survey report of the New York City sanitation, traffic, and police brake servicing facilities, Queens, New York.
Data Type	Monitoring
Hero ID	4152152

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Low	3	Personal breathing zone, general area, high-volume general area, and bulk brake dust samples were collected. Minimal description of sampling methodology.
	Metric 2:	Analytical Methodology	Medium	2	Occupational Safety and Health Administration and the NIOSH P&CAM #239. PCM and TEM
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representativeness					
	Metric 4:	Geographic Area	High	1	Queens, NY
	Metric 5:	Currency	Low	3	> 15 yrs old
	Metric 6:	Spatial and Temporal Variability	Medium	2	Sampling across three different repair stations: sanitation, traffic, and police vehicle repair stations; small sample sizes per scenario
	Metric 7:	Exposure Scenario	High	1	very relevant brake maintenance exposure
Domain 3: Accessibility/Clarity					
	Metric 8:	Reporting of Results	Medium	2	Acceptable discussion of results; lacking calculations to compare across different time/volume sampling
	Metric 9:	Quality Assurance	Medium	2	The filters were changed periodically during the work shift to prevent overloading of the sampling media; varying total times for sampling
Domain 4: Variability and Uncertainty					
	Metric 10:	Variability and Uncertainty	Low	3	Peak .samples were collected using identical media and flow rate as when workers were cleaning dust from brake assemblies; small sample sizes for each scenario; discusses actual activities during sampling
Overall Quality Determination[*]			Medium	2.1	
Extracted			Yes		

Continued on next page

– continued from previous page

Study Citation:	Roberts, D. R.. 1980. Industrial hygiene survey report of the New York City sanitation, traffic, and police brake servicing facilities, Queens, New York.
Data Type	Monitoring
Hero ID	4152152

Domain	Metric	Rating†	Score	Comments‡

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Sahmel, J.,Barlow, C. A.,Gaffney, S.,Avens, H. J.,Madl, A.,Henshaw, J.,Unice, K. en,Galbraith, D.,Derose, G.,Lee, R. J.,Van Orden, D.,Sanchez, M.,Zock, M.,Paustenbach, D. J.. 2016. Airborne asbestos take-home exposures during handling of chrysotile-contaminated clothing following simulated full shift workplace exposures. Journal of Exposure Science and Environmental Epidemiology.
Data Type	Experimental
Hero ID	3093966

Domain	Metric		Rating†	Score	Comments‡
Domain 1: Reliability					
	Metric 1:	Sampling Methodology and Conditions	Medium	2	Study design approved by institutional review board, negative pressure chamber, sampling conditions provided (temp & humidity), no calibration
	Metric 2:	Analytical Methodology	High	1	NIOSH 7400 (PCM) & NIOSH 7402 (TEM)
	Metric 3:	Biomarker Selection	N/A	N/A	Biomarker is not used
Domain 2: Representative					
	Metric 4:	Testing Scenario	High	1	Figure 2 Chamber design for clothes-handling and shake-out (SO) events (simulated household environment); minimum of two field blanks collected during each study event; HEPA ventilation AFD operated at rate of 3.5 ACH which is consistent with EPA reported rate. Three types of clothing used.
	Metric 5:	Sample Size and Variability	Medium	2	Sample size moderate. See Figure 6, air samples collected during various sampling periods for active clothing shake out (SO) and post SO (N=6) for each time interval and Bystander (N=24). Medium grade assigned since it has between 5-10 samples.
	Metric 6:	Temporality	High	1	<5 yrs old; pub date 2016
Domain 3: Accessibility/Clarity					
	Metric 7:	Reporting of Results	Medium	2	Figure 6 provides a bar graph of mean airborne concentration (f/cc) data for PCM and PCME for various sampling periods for SO and Post SO and bystanders. Article indicates that supplementary information accompanies the paper on the Journal of Exposure Science and Epidemiology website (http://www.nature.com/jes)
	Metric 8:	Quality Assurance	N/A	N/A	Minimum of two field blanks collected during each study event. Between study events a separate AFD was run to decontaminate the chamber & decrease time to background concentrations.
Domain 4: Variability and Uncertainty					

Continued on next page

– continued from previous page

Study Citation:	Sahmel, J.,Barlow, C. A.,Gaffney, S.,Avens, H. J.,Madl, A.,Henshaw, J.,Unice, K. en,Galbraith, D.,Derose, G.,Lee, R. J.,Van Orden, D.,Sanchez, M.,Zock, M.,Paustenbach, D. J.. 2016. Airborne asbestos take-home exposures during handling of chrysotile-contaminated clothing following simulated full shift workplace exposures. Journal of Exposure Science and Environmental Epidemiology.
Data Type	Experimental
Hero ID	3093966

Domain	Metric	Rating[†]	Score	Comments[‡]
	Metric 9: Variability and Uncertainty	Medium	2	Lengthy discussion section; lists several factor that should be considered when evaluating the results (i.e., use of stationery mannequins as a surrogate for active workers, study did not consider effects of commuting or blowing/brushing off work clothes before entering the home)
Overall Quality Determination[*]		High	1.6	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Sahmel, J.,Barlow, C. A.,Simmons, B.,Gaffney, S. H.,Avens, H. J.,Madl, A. K.,Henshaw, J.,Lee, R. J.,Van Orden, D.,Sanchez, M.,Zock, M.,Paustenbach, D. J.. 2014. Evaluation of Take-Home Exposure and Risk Associated with the Handling of Clothing Contaminated with Chrysotile Asbestos. Risk Analysis.
Data Type	Experimental
Hero ID	3093967

Domain	Metric		Rating†	Score	Comments‡
Domain 1: Reliability					
	Metric 1:	Sampling Methodology and Conditions	High	1	Study design approved by institutional review board, sealed chamber, sampling conditions provided (temp & humidity), sampling pumps were calibrated with a frictionless piston primary flow meter before & after each sample collected.
	Metric 2:	Analytical Methodology	High	1	NIOSH 7400 (PCM) & NIOSH 7402 (TEM). LOD reported for NIOSH 7400. Sensitivity limits for NIOSH 7402 estimated.
	Metric 3:	Biomarker Selection	N/A	N/A	Biomarker is not used
Domain 2: Representative					
	Metric 4:	Testing Scenario	High	1	Figure 1 is a depiction of chamber & test arrangements. Six 30-minute clothes-handling and shake out events performed during study and described for simulated home environment. Supplemental Materials further describe Study Methods.
	Metric 5:	Sample Size and Variability	Medium	2	A total of 12 air-monitoring events were conducted (six loading events and six shake-out events) over a 5-day period. Sample size is moderate to low. Six personal airborne fiber samples were collected on the clothes handler during each SO event. Four area samples intended to reflect exposure to bystander collected. Sample size for most is 5-10 samples.
	Metric 6:	Temporality	High	1	<5 yrs old; pub date 2014
Domain 3: Accessibility/Clarity					
	Metric 7:	Reporting of Results	Medium	2	Airborne concentration (f/cc) reported in Figures 2-4 provides a bar graphs. Article indicates that additional supporting information may be found on the online version of this article at the publisher's website. Supplemental info obtained and supplemental tables provided mean concentrations for each loading event.
	Metric 8:	Quality Assurance	N/A	N/A	Airborne fiber concentrations outside the chamber were ND by PCME. All clearance samples taken inside the chamber prior to handling and SO events were also ND. Safety/Quality Control Procedures discussed in supplemental materials
Domain 4: Variability and Uncertainty					

Continued on next page

– continued from previous page

Study Citation:	Sahmel, J.,Barlow, C. A.,Simmons, B.,Gaffney, S. H.,Avens, H. J.,Madl, A. K.,Henshaw, J.,Lee, R. J.,Van Orden, D.,Sanchez, M.,Zock, M.,Paustenbach, D. J.. 2014. Evaluation of Take-Home Exposure and Risk Associated with the Handling of Clothing Contaminated with Chrysotile Asbestos. Risk Analysis.
Data Type	Experimental
Hero ID	3093967

Domain	Metric	Rating†	Score	Comments‡
	Metric 9: Variability and Uncertainty	Medium	2	Under the Discussion section, it is noted that some of the variations in the magnitude of handling and SO air concentrations in the study could have been caused by differences in how the clothes were treated between loading and SO events.
Overall Quality Determination*		High	1.4	
Extracted		No		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Weir, F. W.,Tolar, G.,Meraz, L. B.. 2001. Characterization of vehicular brake service personnel exposure to airborne asbestos and particulate. Applied Occupational and Environmental Hygiene.
Data Type	Experimental
Hero ID	3531556

Domain	Metric		Rating†	Score	Comments‡
Domain 1: Reliability					
	Metric 1:	Sampling Methodology and Conditions	High	1	Phase 2, during Run 1 utilize sampling pumps to estimate airborne concentrations in the breathing zone at various positions, Runs 2, 3, & 4 conducted within an exposure chamber with sampling pumps. All sampling pumps were calibrated.
	Metric 2:	Analytical Methodology	High	1	Phase 2 samples submitted to accredited lab for analysis. NIOSH Method #7400 (PCM) to evaluate all area and personal total and respirable airborne fiber samples. Bulk samples from the brake pad analyzed by Polarized Light Microscopy (PCM).
	Metric 3:	Biomarker Selection	N/A	N/A	Biomarker is not used
Domain 2: Representative					
	Metric 4:	Testing Scenario	Medium	2	Four sequences of tests run. Run 1 conducted outside of chamber; Runs 2, 3, and 4 conducted in a dynamic flow exposure chamber; environmental conditions include no detectable net air flow. Chamber temperature maintained at 26C during study.
	Metric 5:	Sample Size and Variability	Low	3	Sample size not really reported, but I don't want to make it unacceptable. Air samples both personal and area) were collected. Discussion on placement and position of sampling pumps. For asbestos content verification, a bulk sample was collected from each of the 6 pairs of shoes used in this study.
	Metric 6:	Temporality	Low	3	>15 yrs (2001 pub date)
Domain 3: Accessibility/Clarity					
	Metric 7:	Reporting of Results	Low	3	Phase 2 results reported in the text only, no tables. No supplemental or raw data provided.
	Metric 8:	Quality Assurance	N/A	N/A	For asbestos content verification, a bulk sample was collected from each of the 6 pairs of shoes used in this study.
Domain 4: Variability and Uncertainty					
	Metric 9:	Variability and Uncertainty	Low	3	The sample data was not summarized in a table to provided statistics on variance. Since it was an emission study it was not clear why more studies were not collected.

Continued on next page

– continued from previous page

Study Citation:	Weir, F. W.,Tolar, G.,Meraz, L. B.. 2001. Characterization of vehicular brake service personnel exposure to airborne asbestos and particulate. Applied Occupational and Environmental Hygiene.
Data Type	Experimental
Hero ID	3531556

Domain	Metric	Rating†	Score	Comments‡
Overall Quality Determination*		Low	2.3	
Extracted		Yes		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Inoko, M.,Ariiso, K.. 1982. DETERMINATION OF CHRYSOTILE FIBERS IN RESIDUAL DUST ON ROAD VEHICLE BRAKE DRUMS. Environmental Pollution Series B: Chemical and Physical.
Data Type	Experimental
Hero ID	3583030

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology and Conditions	Low	3	Three kinds of dust samples found in brake drums when worn brake linings are exchanged for new ones were provided by a bus company; no other info provided.
	Metric 2:	Analytical Methodology	Low	3	Ordinary membrane filter method is not suitable for measuring concentrations of asbestos in the residual dust on brake drums produced during car brake action. Other analytical methods were assessed: xray diffraction analysis, xray diffraction analysis after chemical pre-treatment; xray diffraction analysis after burning treatment
	Metric 3:	Biomarker Selection	N/A	N/A	Biomarker is not used
Domain 2: Representative					
	Metric 4:	Testing Scenario	Low	3	Activities have a lesser similarity but are still potentially applicable to the activity within scope (brake repair)
	Metric 5:	Sample Size and Variability	Low	3	< 5 samples: 3 kinds of dust samples; authors state sample number insufficient to explain the differences in chrysotile concentration
	Metric 6:	Temporality	Low	3	>15 yrs (1982)
Domain 3: Accessibility/Clarity					
	Metric 7:	Reporting of Results	Low	3	Concentration of chrysotile in three car brake dust samples shown in Table 1; listed as wt percent
	Metric 8:	Quality Assurance	N/A	N/A	Calibration curves for determination of chrysotile in dust samples were linear (Fig. 4)
Domain 4: Variability and Uncertainty					
	Metric 9:	Variability and Uncertainty	Medium	2	Differences in the chrysotile concentration between dust samples taken from the front and rear brake drums; the reasons for this could not be explained for the following reasons: 1) sample number (3) was insufficient; and 2) concentration difference might be due to the pattern of use.
Overall Quality Determination[*]			Low	2.9	

Continued on next page

– continued from previous page

Study Citation:	Inoko, M.,Ariiso, K.. 1982. DETERMINATION OF CHRYSOTILE FIBERS IN RESIDUAL DUST ON ROAD VEHICLE BRAKE DRUMS. Environmental Pollution Series B: Chemical and Physical.
Data Type	Experimental
Hero ID	3583030

Domain	Metric	Rating†	Score	Comments‡
Extracted		No		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Rowson, D. M.. 1978. CHRYSOTILE CONTENT OF WEAR DEBRIS OF BRAKE LININGS. Wear.
Data Type	Experimental
Hero ID	3585095

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology and Conditions	Medium	2	Debris collection technique was described and seemed reasonable. The method may have been used in H. D. Bush, D. M. Rowson and S. E. Warren, Wear, 20 (2) (1972) 211. , but is unclear
	Metric 2:	Analytical Methodology	Medium	2	Limited details on sampling methodology.
	Metric 3:	Biomarker Selection	N/A	N/A	
Domain 2: Representative					
	Metric 4:	Testing Scenario	Medium	2	Dust from brakes. Dust was from a simulation, not actual brake repair. Brake dust was collected from two temperature conditions.
	Metric 5:	Sample Size and Variability	Low	3	number of samples not specifically reported. Brake dust was collected from two temperature conditions.
	Metric 6:	Temporality	Low	3	
Domain 3: Accessibility/Clarity					
	Metric 7:	Reporting of Results	Low	3	Results not clearly described. Uncertain on the number of replicated performed, no CV.
	Metric 8:	Quality Assurance	N/A	N/A	
Domain 4: Variability and Uncertainty					
	Metric 9:	Variability and Uncertainty	Low	3	looked at various temperatures.
Overall Quality Determination[*]			Low	2.6	
Extracted			No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	U.S, E. P. A.. 2017. STORET: Asbestos.
Data Type	Databases Not Unique to a Chemical
Hero ID	3970045

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	High	1	
	Metric 2:	Analytical Methodology	High	1	
Domain 2: Representative					
	Metric 3:	Geographic Area	High	1	
	Metric 4:	Temporal	High	1	
	Metric 5:	Exposure Scenario	Low	3	
Domain 3: Accessibility/Clarity					
	Metric 6:	Availability of DB and Supporting Documents	High	1	
	Metric 7:	Reporting Results	High	1	
Domain 4: Variability and Uncertainty					
	Metric 8:	Variability and Uncertainty	N/A	N/A	
Overall Quality Determination[*]			High	1.3	
Extracted			No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	U.S, E. P. A.. 2017. Chemical and product categories: Abestos.
Data Type	Databases Not Unique to a Chemical
Hero ID	3970091

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Medium	2	Could not find documentation of how MSDS were selected. for inclusion
	Metric 2:	Analytical Methodology	N/A	N/A	
Domain 2: Representative					
	Metric 3:	Geographic Area	High	1	
	Metric 4:	Temporal	High	1	
	Metric 5:	Exposure Scenario	Low	3	
Domain 3: Accessibility/Clarity					
	Metric 6:	Availability of DB and Supporting Documents	High	1	
	Metric 7:	Reporting Results	High	1	
Domain 4: Variability and Uncertainty					
	Metric 8:	Variability and Uncertainty	N/A	N/A	
Overall Quality Determination[*]			High	1.5	
Extracted			No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	U.S, E. P. A.. 2017. Chemical and product categories: Amosite.
Data Type	Databases Not Unique to a Chemical
Hero ID	3970094

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Medium	2	Could not find documentation of how MSDS were selected. for inclusion
	Metric 2:	Analytical Methodology	N/A	N/A	no analytical method for msds.
Domain 2: Representative					
	Metric 3:	Geographic Area	High	1	
	Metric 4:	Temporal	High	1	
	Metric 5:	Exposure Scenario	High	1	
Domain 3: Accessibility/Clarity					
	Metric 6:	Availability of DB and Supporting Documents	Medium	2	Documentation available, but limited.
	Metric 7:	Reporting Results	High	1	
Domain 4: Variability and Uncertainty					
	Metric 8:	Variability and Uncertainty	N/A	N/A	
Overall Quality Determination[*]			High	1.3	
Extracted			No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	U.S, E. P. A.. 2017. Chemical and product categories: Tremolite.
Data Type	Databases Not Unique to a Chemical
Hero ID	3970095

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	High	1	Could not find documentation of how MSDS were selected. for inclusion
	Metric 2:	Analytical Methodology	N/A	N/A	
Domain 2: Representative					
	Metric 3:	Geographic Area	High	1	
	Metric 4:	Temporal	High	1	
	Metric 5:	Exposure Scenario	Low	3	No brakes listed.
Domain 3: Accessibility/Clarity					
	Metric 6:	Availability of DB and Supporting Documents	High	1	
	Metric 7:	Reporting Results	High	1	
Domain 4: Variability and Uncertainty					
	Metric 8:	Variability and Uncertainty	N/A	N/A	
Overall Quality Determination[*]			High	1.3	
Extracted			No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	U.S, E. P. A.. 2017. Chemical and product categories: Anthophyllite.
Data Type	Databases Not Unique to a Chemical
Hero ID	3970096

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Medium	2	Could not find documentation of how MSDS were selected. for inclusion
	Metric 2:	Analytical Methodology	N/A	N/A	
Domain 2: Representative					
	Metric 3:	Geographic Area	High	1	
	Metric 4:	Temporal	High	1	
	Metric 5:	Exposure Scenario	Low	3	
Domain 3: Accessibility/Clarity					
	Metric 6:	Availability of DB and Supporting Documents	Medium	2	Documented on web, but limited.
	Metric 7:	Reporting Results	High	1	
Domain 4: Variability and Uncertainty					
	Metric 8:	Variability and Uncertainty	N/A	N/A	
Overall Quality Determination[*]			Medium	1.7	
Extracted			No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	U.S, E. P. A.. 2017. Chemical and product categories: Chrysotile.
Data Type	Databases Not Unique to a Chemical
Hero ID	3970097

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Sampling Methodology	Medium	2	Could not find documentation of how MSDS were selected. for inclusion
	Metric 2:	Analytical Methodology	N/A	N/A	
Domain 2: Representative					
	Metric 3:	Geographic Area	High	1	
	Metric 4:	Temporal	High	1	
	Metric 5:	Exposure Scenario	High	1	
Domain 3: Accessibility/Clarity					
	Metric 6:	Availability of DB and Supporting Documents	High	1	
	Metric 7:	Reporting Results	High	1	
Domain 4: Variability and Uncertainty					
	Metric 8:	Variability and Uncertainty	N/A	N/A	
Overall Quality Determination[*]			High	1.2	
Extracted			No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Mauskopf, J. A.. 1987. Projections of cancer risks attributable to future exposure to asbestos. Risk Analysis.
Data Type	Completed Exposure Assessment
Hero ID	338

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	Medium	2	Gave the sources for which 1983 data was used; needs more explanation on how the search was conducted
Domain 2: Representative				
	Metric 2: Exposure Scenario	High	1	Very relevant exposure scenario: exposure to friction products
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	High	1	Gave the whole list of references, included in table of data used
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	High	1	Good discussion of model data variability and assumption uncertainty
Overall Quality Determination[*]		High	1.2	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Esmen, N. A.,Erdal, S.. 1990. Human occupational and nonoccupational exposure to fibers. Environmental Health Perspectives.
Data Type	Completed Exposure Assessment
Hero ID	522

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	Low	3	Selected paper for demonstrations of variances in sample collection
Domain 2: Representative				
	Metric 2: Exposure Scenario	High	1	very relevant: brake repair
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	Medium	2	Some selected without documentation; otherwise, documented
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	High	1	Good discussion of variability in data collection and data gap uncertainty
Overall Quality Determination[*]		Medium	1.8	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Millette, J. R.,Craun, G. F.,Stober, J. A.,Kraemer, D. F.,Tousignant, H. G.,Hildago, E.,Duboise, R. L.,Benedict, J.. 1983. Epidemiology study of the use of asbestos-cement pipe for the distribution of drinking water in Escambia County, Florida. Environmental Health Perspectives.
Data Type	Completed Exposure Assessment
Hero ID	60451

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	Medium	2	No discussion of ample analysis type
Domain 2: Representative				
	Metric 2: Exposure Scenario	Low	3	Asbestos cement pipe, tap water
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	High	1	
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	High	1	
Overall Quality Determination[*]		Medium	1.8	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Millette, J. R.,Clark, P. J.,Stober, J.,Rosenthal, M.. 1983. Asbestos in water supplies of the United States. Environmental Health Perspectives.
Data Type	Completed Exposure Assessment
Hero ID	60452

Domain	Metric	Rating†	Score	Comments‡
Domain 1: Reliability				
	Metric 1: Methodology	Medium	2	Review of previous summary articles with only some additional data
Domain 2: Representative				
	Metric 2: Exposure Scenario	High	1	relevant: asbestos cement pipes and contaminated surface waters
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	Medium	2	Older references
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Medium	2	Needs a more robust discussion
Overall Quality Determination*		Medium	1.8	
Extracted		No		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Millette, J. R.,Clark, P. J.,Pansing, M. F.,Twyman, J. D.. 1980. Concentration and size of asbestos in water supplies. Environmental Health Perspectives.
Data Type	Completed Exposure Assessment
Hero ID	60455

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	High	1	Collection of asbestos analyses from all other the US
Domain 2: Representative				
	Metric 2: Exposure Scenario	High	1	Relevant: reservoirs, surface waters exposed to asbestos
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	High	1	Well documented
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Medium	2	Discusses variability in concentration and size data
Overall Quality Determination[*]		High	1.2	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Suta, B. E.,Levine, R. J.. 1979. Non-occupational asbestos emissions and exposures.
Data Type	Completed Exposure Assessment
Hero ID	786508

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
Metric 1:	Methodology	Medium	2	Chapter 5 Non-occupational asbestos emissions and exposures is based on material included in Asbestos: An Informational Resource, Ed. by Richard J. Levine, U.S. Dept. Health, Education, and Welfare DHEW Publication No. (NIH) 78-1681, May 1978, and supported under contract number NO1-CN-55176.
Domain 2: Representative				
Metric 2:	Exposure Scenario	Medium	2	Discussion on automotive friction materials under Section 4(iii).1
Domain 3: Accessibility/Clarity				
Metric 3:	Documentation of References	High	1	References listed
Domain 4: Variability and Uncertainty				
Metric 4:	Variability and Uncertainty	Medium	2	
Overall Quality Determination[*]		Medium	1.8	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Finkelstein, M. M.. 2013. The analysis of asbestos count data with "nondetects": the example of asbestos fiber concentrations in the lungs of brake workers. American Journal of Industrial Medicine.
Data Type	Completed Exposure Assessment
Hero ID	2546734

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	Medium	2	Specific data sets from previous publications detailed
Domain 2: Representative				
	Metric 2: Exposure Scenario	Medium	2	Very relevant: brake workers - asbestos dose
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	Medium	2	Few studies but detailed
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Medium	2	Some discussion of the uncertainty of methodology for accounting for fiber counts vs density
Overall Quality Determination[*]		Medium	2.0	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Richter, R. O.,Finley, B. L.,Paustenbach, D. J.,Williams, P. R. D.,Sheehan, P. J.. 2009. An evaluation of short-term exposures of brake mechanics to asbestos during automotive and truck brake cleaning and machining activities. Journal of Exposure Science and Environmental Epidemiology.
Data Type	Completed Exposure Assessment
Hero ID	2548725

Domain	Metric	Rating†	Score	Comments‡
Domain 1: Reliability				
	Metric 1: Methodology	Medium	2	Studies accepted from a large date range; good description of acceptance criteria
Domain 2: Representative				
	Metric 2: Exposure Scenario	High	1	Very relevant exposure scenario: mechanic's exposure; gives numerous raw data values and SD/range information
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	Medium	2	Gives a complete list of the included studies and the large database used to search for them; could use more discussion of search terms
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Medium	2	Discussion of variability among mechanical procedures for creating dust and discussed uncertainty regarding simulating pre-1970 conditions
Overall Quality Determination*		Medium	1.8	
Extracted		Yes		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Donovan, E. P.,Donovan, B. L.,Sahmel, J.,Scott, P. K.,Paustenbach, D. J.. 2011. Evaluation of bystander exposures to asbestos in occupational settings: a review of the literature and application of a simple eddy diffusion model. Critical Reviews in Toxicology.
Data Type	Completed Exposure Assessment
Hero ID	2581697

Domain	Metric	Rating†	Score	Comments‡
Domain 1: Reliability				
	Metric 1: Methodology	High	1	Detailed criteria for choosing studies and the methodology to search for them; includes 1970s studies and more recent simulation studies
Domain 2: Representative				
	Metric 2: Exposure Scenario	High	1	very relevant: friction products exposure
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	High	1	Thorough documentation of sources used
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	High	1	Great discussion of model differences and uncertainties
Overall Quality Determination*		High	1.0	
Extracted		No		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Finley, B. L.,Pierce, J. S.,Paustenbach, D. J.,Scott, L. L.,Lievense, L.,Scott, P. K.,Galbraith, D. A.. 2012. Malignant pleural mesothelioma in US automotive mechanics: reported vs expected number of cases from 1975 to 2007. Regulatory Toxicology and Pharmacology.
Data Type	Completed Exposure Assessment
Hero ID	3078581

Domain	Metric	Rating†	Score	Comments‡
Domain 1: Reliability				
	Metric 1: Methodology	High	1	Good description of criteria for chosen studies and search strategy
Domain 2: Representative				
	Metric 2: Exposure Scenario	High	1	very relevant: auto mechanics exposure; percent by weight friction products
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	High	1	well documented and available
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	High	1	discussion of factors that could overestimate or underestimate the observed number of cases
Overall Quality Determination*		High	1.0	
Extracted		No		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Madl, A. K.,Clark, K.,Paustenbach, D. J.. 2007. Exposure to airborne asbestos during removal and installation of gaskets and packings: a review of published and unpublished studies. Journal of Toxicology and Environmental Health, Part B: Critical Reviews.
Data Type	Completed Exposure Assessment
Hero ID	3079606

Domain	Metric	Rating†	Score	Comments‡
Domain 1: Reliability				
	Metric 1: Methodology	High	1	described exposure of interest; indicated include/exclude criteria
Domain 2: Representative				
	Metric 2: Exposure Scenario	High	1	relevant: exposure to gaskets and packing material used in pipes and autos
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	Medium	2	published and unpublished but well documented
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Medium	2	Good discussion of variability regarding the studies used, needs better discussion of uncertainty of outcome
Overall Quality Determination*		High	1.5	
Extracted		No		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Paustenbach, D. J.,Finley, B. L.,Lu, E. T.,Brorby, G. P.,Sheehan, P. J.. 2004. Environmental and occupational health hazards associated with the presence of asbestos in brake linings and pads (1900 to present): a "state-of-the-art" review. Journal of Toxicology and Environmental Health, Part B: Critical Reviews.
Data Type	Completed Exposure Assessment
Hero ID	3080278

Domain	Metric	Rating†	Score	Comments‡
Domain 1: Reliability				
	Metric 1: Methodology	High	1	
Domain 2: Representative				
	Metric 2: Exposure Scenario	High	1	
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	High	1	
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	High	1	
Overall Quality Determination*		High	1.0	
Extracted		No		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	. 1977. IARC monographs on the evaluation of the carcinogenic risk of chemicals to man: asbestos.
Data Type	Completed Exposure Assessment
Hero ID	3084507

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	Medium	2	Summary paper: late 1970s
Domain 2: Representative				
	Metric 2: Exposure Scenario	Medium	2	Some relevant friction values, percent by weight
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	High	1	Complete
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Low	3	Separate section of discussion on results that includes some discussion
Overall Quality Determination[*]		Medium	2.0	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Finley, B. L.,Richter, R. O.,Mowat, F. S.,Mlynarek, S.,Paustenbach, D. J.,Warmerdam, J. M.,Sheehan, P. J.. 2007. Cumulative asbestos exposure for US automobile mechanics involved in brake repair (circa 1950s-2000). Journal of Exposure Science and Environmental Epidemiology.
Data Type	Completed Exposure Assessment
Hero ID	3085741

Domain	Metric	Rating†	Score	Comments‡
Domain 1: Reliability				
	Metric 1: Methodology	Medium	2	greater extrapolation necessary for 8-h TWA for monte carlo analysis vs raw data
Domain 2: Representative				
	Metric 2: Exposure Scenario	High	1	Very relevant exposure scenario: lifetime exposure for career mechanics in the US
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	High	1	Extensive discussion of references and criteria for study acceptance
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Medium	2	Discussed variability among selected studies and uncertainty of representativeness and previous studies' shortcomings
Overall Quality Determination*		High	1.5	
Extracted		No		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Naylor, L. M.. 1989. Asbestos in sludge - a significant risk. BioCycle.
Data Type	Completed Exposure Assessment
Hero ID	3095297

Domain	Metric	Rating†	Score	Comments‡
Domain 1: Reliability				
	Metric 1: Methodology	Low	3	No information on methodology for surface water; secondary source
Domain 2: Representative				
	Metric 2: Exposure Scenario	Low	3	No info on exposure scenario for surface water; secondary source
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	High	1	References cited for Surface Water; secondary source
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Low	3	No info on variability/uncertainty for surface water; secondary source
Overall Quality Determination*		Low	2.5	
Extracted		No		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Ganor, E.,Fischbein, A.,Brenner, S.,Froom, P.. 1992. Extreme airborne asbestos concentrations in a public building. British Journal of Industrial Medicine.
Data Type	Completed Exposure Assessment
Hero ID	3096697

Domain	Metric		Rating†	Score	Comments‡
Domain 1: Reliability					
	Metric 1:	Methodology	Low	3	Sampling and analysis were carried out according to Method No. 2 (RTM-2) which was issued by the Asbestos International Association; secondary source
Domain 2: Representative					
	Metric 2:	Exposure Scenario	Unacceptable	4	No information provided on garage where brake linings containing asbestos are repaired.
Domain 3: Accessibility/Clarity					
	Metric 3:	Documentation of References	Low	3	Reference provided for Method (RTM-2)
Domain 4: Variability and Uncertainty					
	Metric 4:	Variability and Uncertainty	Low	3	Variability & uncertainty are not discussed
Overall Quality Determination*			Unacceptable	4.0	Metric mean score**: 3.2.
Extracted			No		

** Consistent with our *Application of Systematic Review in TSCARisk Evaluations* document, if a metric for a data source receives a score of Unacceptable (score = 4), EPA will determine the study to be unacceptable. In this case, one of the metrics were rated as unacceptable. As such, the study is considered unacceptable and the score is presented solely to increase transparency.

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.

‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.

* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Atsdr,. 2001. Toxicological profile for asbestos (update).
Data Type	Completed Exposure Assessment
Hero ID	3098571

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	Medium	2	Gov't report (ATSDR Tox Profile) but did not provide info on literature search methods.
Domain 2: Representative				
	Metric 2: Exposure Scenario	Low	3	Cannot determine if air concentrations are indoor or ambient.
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	High	1	References listed: *WHO. 1998. Chrysotile asbestos: Environmental health criteria. Geneva: Switzerland: World Health Organization.
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Low	3	Variability & uncertainty are not discussed
Overall Quality Determination[*]		Medium	2.2	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Paustenbach, D. J.,Richter, R. O.,Finley, B. L.,Sheehan, P. J.. 2003. An evaluation of the historical exposures of mechanics to asbestos in brake dust. Applied Occupational and Environmental Hygiene.
Data Type	Completed Exposure Assessment
Hero ID	3531297

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	High	1	Historical analysis of over 200 samples; convert 8-h TWA for comparison; US and abroad; at least 1 hr of sampling to be included
Domain 2: Representative				
	Metric 2: Exposure Scenario	High	1	Very relevant exposure scenario
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	High	1	30 years of data; 10 studies chosen-listed in a table
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	High	1	Automobile vs truck exposure differences; thorough discussion of characterizing variability
Overall Quality Determination[*]		High	1.0	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Webber, J. S.,Covey, J. R.. 1991. Asbestos in water. Critical Reviews in Environmental Control.
Data Type	Completed Exposure Assessment
Hero ID	3583091

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
Metric 1:	Methodology	Medium	2	For methodology there is no discussion of literature search methods. Under Section IV Aquatic Ecosystems, secondary sources: some of the studies state that samples were analyzed by TEM. Article also contains a Section V Detection and Analysis that discusses a variety of analytical methods have been assessed for their ability to detect asbestos in water and states TEM is the method of choice for detection and identification for waterborne asbestos.
Domain 2: Representative				
Metric 2:	Exposure Scenario	Low	3	No info on exposure scenario for surface water; however, various aquatic species are discussed; secondary source
Domain 3: Accessibility/Clarity				
Metric 3:	Documentation of References	High	1	References listed for Aquatic Ecosystems
Domain 4: Variability and Uncertainty				
Metric 4:	Variability and Uncertainty	Medium	2	Variability & uncertainty are not discussed
Overall Quality Determination[*]		Medium	2.0	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	del Piano, M.,Palagiano, C.,Rimatori, V.. 1989. Asbestos hazards in the city of Rome, Italy. Social Science & Medicine.
Data Type	Completed Exposure Assessment
Hero ID	3615595

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
Metric 1:	Methodology	Medium	2	Samples collected using membran filters (AIA and NIOSH Methods). Fibers counted by PCOM
Domain 2: Representative				
Metric 2:	Exposure Scenario	Medium	2	Some discussion but limited on exposure scenario for brake repair/servicing; secondary sources
Domain 3: Accessibility/Clarity				
Metric 3:	Documentation of References	High	1	References listed for brake repair/servicing
Domain 4: Variability and Uncertainty				
Metric 4:	Variability and Uncertainty	Low	3	Variability & uncertainty are not discussed
Overall Quality Determination[*]		Medium	2.0	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Anonymous,. 1975. Current Intelligence Bulletin 5 Asbestos. Asbestos Exposure during Servicing of Motor Vehicle Brake and Clutch Assemblies (with reference package).
Data Type	Completed Exposure Assessment
Hero ID	3648286

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	Low	3	Primary data were presented at a July 21, 1975 NIOSH meeting by investigators from the Mount Siani School of Medicine in New York City indicating that workers engaged in the maintenance and repair of automobile and truck brake linings are exposed to potentially hazardous levels of airborne asbestos dust. Specific brake servicing operations studied included blow-out of automobile drum brake assemblies, grinding of used truck brake linings, and bevelling of new truck brake linings. Average peak asbestos air concentrations for these three activities based on personal samples taken within ten feet of the operator were reported; however, there is no discussion on how samples were collected or analyzed.
Domain 2: Representative				
	Metric 2: Exposure Scenario	Medium	2	Workers engaged in the maintenance and repair of automobile and truck brake linings are exposed to potentially hazardous levels of airborne asbestos dust. Specific brake servicing operations studied included blow-out of automobile drum brake assemblies, grinding of used truck brake linings, and bevelling of new truck brake linings.
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	Low	3	Citation for primary data from the investigators at the Mount Sinai School of Medicine is implied based on this being presented at the July 21, 1975 NIOSH meeting. Other references are provided.
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Low	3	
Overall Quality Determination[*]		Low	2.8	
Extracted		No		

Continued on next page

– continued from previous page

Study Citation:	Anonymous,. 1975. Current Intelligence Bulletin 5 Asbestos. Asbestos Exposure during Servicing of Motor Vehicle Brake and Clutch Assemblies (with reference package).
Data Type	Completed Exposure Assessment
Hero ID	3648286

Domain	Metric	Rating†	Score	Comments‡

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	U.S, E. P. A.. 1999. Methodology for conducting risk assessments at asbestos superfund sites Part 2: Technical background document.
Data Type	Completed Exposure Assessment
Hero ID	3970153

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	High	1	
Domain 2: Representative				
	Metric 2: Exposure Scenario	Low	3	No brakes
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	High	1	
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	High	1	
Overall Quality Determination[*]		High	1.5	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	ToxNet Hazardous Substances Data, Bank. 2017. HSDB: Asbestos.
Data Type	Completed Exposure Assessment
Hero ID	3970271

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	High	1	For methodology there is no discussion of literature search methods; however, it is a ToxNet Hazardous Substances Data, Bank from NLM, NIH so should be accepted by the scientific community
Domain 2: Representative				
	Metric 2: Exposure Scenario	Medium	2	Exposure scenario for brake repair and domestic exposure associated with DIY construction briefly discussed; secondary source
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	High	1	References listed for brake repair and domestic exposure associated with DIY construction
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Low	3	Variability & uncertainty are not discussed
Overall Quality Determination[*]		Medium	1.8	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Iarc,. 2012. ARC Monographs on the evaluation of carcinogenic risks to humans: Asbestos (Chrysotile, amosite, crocidolite, tremolite, actinolite, and anthophyllite).
Data Type	Completed Exposure Assessment
Hero ID	3970851

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	Medium	2	For methodology there is some discussion of using systematic review of epidemiological literature, but not much discussion on literature search methods for other areas. It is an International Agency for Research and Cancer (IARC) monograph so should be accepted by the scientific community
Domain 2: Representative				
	Metric 2: Exposure Scenario	Medium	2	Exposure scenario for clutches, brake repair, and cement cutting briefly discussed; secondary source; Table 1.3 fiber concentrations in air in different workplaces in Germany and text narratives list under Section on Studies of Occupational Exposure
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	Low	3	References listed for clutches, brake repair, cement cutting
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Low	3	Variability & uncertainty are not discussed
Overall Quality Determination[*]		Low	2.5	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Niosh,. 1976. Revised recommended asbestos standard.
Data Type	Completed Exposure Assessment
Hero ID	3974877

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	Medium	2	For methodology there is not much discussion on literature search methods; however, it is a NIOSH Revised Recommended Asbestos Standard; should be accepted by the scientific community
Domain 2: Representative				
	Metric 2: Exposure Scenario	Low	3	Epidemiological study (Lorimer et al. 1976) for brake repair maintenance and xray abnormalities, no concentrations reported; secondary source
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	High	1	References listed for epidemiological study (Lorimer et al. 1976) for brake repair maintenance and xray abnormalities,
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Low	3	Variability & uncertainty are not discussed
Overall Quality Determination[*]		Medium	2.2	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Nicnas,. 1999. Chrysotile asbestos: priority exisiting chemical no. 9.
Data Type	Completed Exposure Assessment
Hero ID	3978350

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	Medium	2	See App. 2, personal monitoring conducted at all workshops membrane filter samplin (MFM) and PCM specified in Asbestos Code of Practice. Some samples analyzed by ATEM using the NIOSH/TEM/MFM1 and MFM2. Sampling was less than the specified 4 hours as work was task oriented (therefore results were not expressed as TWA).
Domain 2: Representative				
	Metric 2: Exposure Scenario	Medium	2	Workplace surveyed in Sydney, NSW: 5 service garages (4 cars & 1 bus), 3 brake bonding workshops, and one gasket processing workshop. Table 10 provides results of NICNAS Automotive Aftermarket Survey: Control measures used in workshops (exposure duration & frequency, comments on ventilation)
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	Medium	2	Reference list provided
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Medium	2	
Overall Quality Determination[*]		Medium	2.0	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Oehha,. 2003. Public health goals for chemicals in drinking water asbestos.
Data Type	Completed Exposure Assessment
Hero ID	3982252

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	Medium	2	For methodology there is not any discussion on literature search methods; however, it is an OEHHA CA EPA document on Public Health Goals for Asbestos in Drinking Water; should be accepted by the scientific community
Domain 2: Representative				
	Metric 2: Exposure Scenario	Low	3	Asbestos in drinking water is Off PECO; however, document also contains some discussion on surface water (river, lakes, streams), rainwater into a cistern and surface water from cistern with considerable asbestos contamination to raise concern about use of water for room humidification , corrosion of asbestos-cement pipes; secondary sources
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	High	1	References listed
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Low	3	Variability & uncertainty are not discussed
Overall Quality Determination[*]		Medium	2.2	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Atsdr,. 2001. Toxicological profile for asbestos.
Data Type	Completed Exposure Assessment
Hero ID	3982335

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	High	1	
Domain 2: Representative				
	Metric 2: Exposure Scenario	Low	3	No concentration data for brakes
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	High	1	
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	High	1	
Overall Quality Determination[*]		High	1.5	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	P. E. I. Associates. 1985. Asbestos dust control in brake maintenance. Draft.
Data Type	Completed Exposure Assessment
Hero ID	4151966

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	Low	3	Because this monitoring was done under a variety of sampling times and conditions. with variable amounts of brake drum dust, and variable asbestos concentrations in the dust. and by different test methods, the results should be viewed only as rough estimates of worker exposure.
Domain 2: Representative				
	Metric 2: Exposure Scenario	High	1	very relevant: dust control for brake maintenance workers
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	Low	3	A mix of old agency reports and publications, industry papers, and also some personal communications and workshops; but well documented
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Medium	2	Variability described and uncertainty addressed; ultimately a comparison of dust control methods relative to each other.
Overall Quality Determination[*]		Medium	2.2	
Extracted		Yes		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Niehs,. 1982. Control of toxic substances in the atmosphere: Asbestos (Preliminary draft).
Data Type	Completed Exposure Assessment
Hero ID	4152042

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	Medium	2	multiple methodologies from various studies
Domain 2: Representative				
	Metric 2: Exposure Scenario	High	1	various activity exposure concentrations
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	Medium	2	Older agency reports and publications but well documented
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Medium	2	
Overall Quality Determination[*]		Medium	1.8	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	P. E. I. Associates. 1987. Cost of engineering controls for brake maintenance/repair.
Data Type	Completed Exposure Assessment
Hero ID	4152047

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	Medium	2	number of do-it-yourself brake jobs; number of brake shops
Domain 2: Representative				
	Metric 2: Exposure Scenario	High	1	brake maintenance exposure
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	Medium	2	The primary sources of information for this study were direct contact with vendors of control equipment, the National Institute for Occupational Safety and Health (NIOSH), the Occupational Safety and Health Administration (OSHA), literature supplied by the vendors, and the open literature. Other sources included trade associations such as the Motor Vehicle Manufacturers Association and trade publications
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Low	3	minimal discussion
Overall Quality Determination[*]		Medium	2.0	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Bragg, G.. 1986. Exposure to asbestos: An analysis of the technical aspects of the Environmental Protection Agency proposal to ban and phase out asbestos.
Data Type	Completed Exposure Assessment
Hero ID	4152099

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	Medium	2	
Domain 2: Representative				
	Metric 2: Exposure Scenario	Medium	2	
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	Low	3	Lots of older agency documents, fewer published scientific literature
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Medium	2	Some discussion
Overall Quality Determination[*]		Medium	2.2	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Osha,. 1986. Final regulatory impact and regulatory flexibility analysis of the revised asbestos standard.
Data Type	Completed Exposure Assessment
Hero ID	4152104

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Methodology	Medium	2	
Domain 2: Representative					
	Metric 2:	Exposure Scenario	Medium	2	
Domain 3: Accessibility/Clarity					
	Metric 3:	Documentation of References	Medium	2	Older references
Domain 4: Variability and Uncertainty					
	Metric 4:	Variability and Uncertainty	Low	3	some discussion
Overall Quality Determination[*]			Medium	2.2	
Extracted			No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Cogley, D.,Krusell, N.,McInnes, R.,Anderson, P.,Bell, R.. 1982. Life cycle of asbestos in commercial and industrial use including estimates of releases to air, water, and land.
Data Type	Completed Exposure Assessment
Hero ID	4152169

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	Medium	2	
Domain 2: Representative				
	Metric 2: Exposure Scenario	Medium	2	
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	Low	3	Includes older documentation and personal communications
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Low	3	Some discussion
Overall Quality Determination[*]		Low	2.5	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	Wright, M. D.. 1984. Phase I report: Regulatory analysis of the proposed OSHA standard on asbestos.
Data Type	Completed Exposure Assessment
Hero ID	4152228

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Methodology	Medium	2	Multiple exposure activities
Domain 2: Representative				
	Metric 2: Exposure Scenario	High	1	Some very relevant exposure scenarios
Domain 3: Accessibility/Clarity				
	Metric 3: Documentation of References	Low	3	Older documentation
Domain 4: Variability and Uncertainty				
	Metric 4: Variability and Uncertainty	Low	3	Minimal discussion
Overall Quality Determination[*]		Medium	2.2	
Extracted		No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	U.S, E. P. A.. 1987. Household solvent products: A national usage survey.
Data Type	Survey
Hero ID	1005969

Domain	Metric		Rating[†]	Score	Comments[‡]
Domain 1: Reliability					
	Metric 1:	Data Collection Methodology	High	1	
	Metric 2:	Data Analysis Methodology	High	1	
Domain 2: Representative					
	Metric 3:	Geographic Area	High	1	Nationwide (U.S.A.) survey with outreach via random dialing and willingness to provide address and respond to survey.
	Metric 4:	Sampling / Sampling Size	High	1	
	Metric 5:	Response Rate	Medium	2	
Domain 3: Accessibility/Clarity					
	Metric 6:	Reporting of Results	High	1	
	Metric 7:	Quality Assurance	Medium	2	
Domain 4: Variability and Uncertainty					
	Metric 8:	Variability and Uncertainty	N/A	N/A	
Overall Quality Determination[*]			High	1.3	
Extracted			No		

[†] High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
[‡] The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
[*] If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.

Study Citation:	N. Plato, G. Tornling, C. Hogstedt, S. Krantz. 1995. An index of past asbestos exposure as applied to car and bus mechanics. Annals of Occupational Hygiene.
Data Type	Modeling
Hero ID	3081596

Domain	Metric	Rating[†]	Score	Comments[‡]
Domain 1: Reliability				
	Metric 1: Mathematicl Equations	Medium	2	The model was designed to calculate asbestos exposure from work with friction materials such as dust from clutches and break shoes. It has been described in detail in Swedish (Plato et al., 1991), and is more briefly summarized in the Appendix. By reviewing the international literature, a set of parameters that influence the asbestos exposure of car and bus mechanics was selected. The magnitude of the multipliers associated with those variables was estimated and chosen from a large series of past measurements covering representative values for different work activities, technical equipment, ventilation, technical standard and workshop sizes. The derivation is discussed in more detail in Table Al of the Appendix. The coefficients were used in an equation that takes task activity as well as background exposure (general shop exposure) into consideration. The model was created as a combination of an additive and a multiplicative model (Table A2 in the Appendix) and makes calculation of cumulative exposure possible. The equation in the model expresses the quantative exposure in an asbestos index. Asbestos index (AI) = general shop exposure + task activity exposure, for each mechanic, for each year, summed for all years of employment as a vehicle mechanic.

Continued on next page

– continued from previous page

Study Citation:	N. Plato, G. Tornling, C. Hogstedt, S. Krantz. 1995. An index of past asbestos exposure as applied to car and bus mechanics. Annals of Occupational Hygiene.
Data Type	Modeling
Hero ID	3081596

Domain	Metric	Rating†	Score	Comments‡
	Metric 2: Model Evaluation	Medium	2	The model was validated using representative Swedish measurements in car and bus repair shops for the period 1976-1988. The fiber measurement criteria using phase-contrast optical microscopy were: length > 5 um, diameter less than or equal 3 um and aspect ratio 2 3: 1. Ten reports, including 23 8-h measurements (personal sampling) at different car repair shops, were selected from the data bank of industrial measurements at the Swedish National Board of Occupational Health to validate the efficiency of the model. These investigation reports were selected because they contained sufficient information on work activity, production rate and other information needed to choose coefficients in the model. Many reports in the databank did not contain adequate information and could not be used. The coefficients and equations in the Appendix were applied for those 23 measurements. Asbestos indices (AI) were calculated and plotted against the measured fiber level in the transformed curve (Fig. 1). The calculated asbestos index was related to asbestos fiber level by the statistically significant regression line y = 0.029 + 0.011 x, shown in Fig. 3. The correlation coefficient was r=0.69 for all observations (N= 23). This demonstrates that a quantitative relationship exists between f/ml and the AI. It also shows that the exposure was generally low.
Domain 2: Representative				

Continued on next page

– continued from previous page

Study Citation:	N. Plato, G. Tornling, C. Hogstedt, S. Krantz. 1995. An index of past asbestos exposure as applied to car and bus mechanics. Annals of Occupational Hygiene.
Data Type	Modeling
Hero ID	3081596

Domain	Metric	Rating†	Score	Comments‡
	Metric 3: Exposure Scenario	Medium	2	The model was used to characterize the exposures of 103 car and bus mechanics. Each subject answered a questionnaire which asked about the repair shops where they had worked, job activities and employment time. The self-administered questionnaire was expanded with a standardized personal interview. Two industrial hygienists asked 38 additional questions for each workplace in a subject"s work history. The questions included the following topics: room conditions (11 questions); treatment/handling of brake shoes (eight questions); work activities involved with repair (13 questions); and activities of the bystanders (six questions). The people interviewed also had to estimate the duration of work to replace brake shoe linings, number of changes from year to year, grinding of brake lining, time and end year for use of compressed air, and use of respiratory protection. For each decade they also estimated the general condition of the work area and dustiness from different work operations using a five-level ranking scale with the existing condition as the reference point. The aim of the personal interview was to collect information that could have influenced early exposure, such as work activities that generate high exposure peaks and also the possibility of dispersing the fiber in dusts found in brake drums and clutch housings, A model was constructed to calculate cumulative asbestos exposure from friction materials including duration, intensity and exposure. The model is a combination of an additive and a multiplicative model, where an asbestos index was constructed that takes both near field and far field exposure into consideration. The model was based upon data from the international literature and quantitative asbestos measurements performed 1976-1988 in Swedish car repair workshops.
Domain 3: Accessibility/Clarity				
	Metric 4: Model and Model Documentation Availability	High	1	The model and documentation are provided in Appendix A. The cumulative index for asbestos exposure was calculated using a three-step model, combining additive and multiplicative components. Coefficients for eight variables representing job activity, technology level, workshop conditions and time (Table Al), were put into an exposure matrix. The model has been described earlier in detail in Swedish (Plato et al., 1991).
	Metric 5: Model Inputs and Defaults	Medium	2	The mechanics' fiber exposure at 398 repair workshops during a period of 48 years were calculated using the model. The mean cumulative exposure was estimated to be 2.6 f/ml * year.

Continued on next page

– continued from previous page

Study Citation:	N. Plato, G. Tornling, C. Hogstedt, S. Krantz. 1995. An index of past asbestos exposure as applied to car and bus mechanics. Annals of Occupational Hygiene.
Data Type	Modeling
Hero ID	3081596

Domain	Metric	Rating†	Score	Comments‡
Domain 4: Variability and Uncertainty				
	Metric 6: Variability and Uncertainty	Medium	2	A model was developed to estimate past exposure from asbestos friction materials for Swedish vehicle mechanics. The model was based on estimations of multipliers for different exposure variables derived from the worker"s task activities and background activities in the workshop. The constructed model was applied on interview data from 103 mechanics. The mean cumulative asbestos exposure for this population was 2.6 f ml * year. Despite the perception that car and bus mechanics constitute a homogeneous group, the variation in exposure was wide, 0.1-11.6 f ml * year. Annual asbestos exposure estimates showed a three times higher mean exposure in 1964 compared to 1984. A statistically significant 13 percent decrease in mean TL,, was observed for the exposed group compared to the non-asbestos exposed control group. However, no exposure-response relationship was observed between either cumulative asbestos exposure or employment time and any of the lung function variables TL co, TLC, FEV1, CV percent or VC.
Overall Quality Determination*		Medium	1.8	
Extracted		No		

† High = 1; Medium = 2; Low = 3; Unacceptable = 4; N/A has no value.
‡ The overall rating is calculated as necessary. EPA may not always provide a comment for a metric that has been categorized as High.
* If any individual metrics are deemed Unacceptable, then the overall rating is also unacceptable. Otherwise, the overall rating is based on the following scale: High: ≥ 1 to < 1.7; Medium: $=\geq 1.7$ to < 2.3; Low: $=\geq 2.3$ to ≤ 3.