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 of Ecological Hazard Studies

December 2020

EPA's Office of Pollution Prevention and Toxics (OPPT) developed data quality criteria for ecological hazard studies, presented in the *Application of Systematic Review in TSCA Risk Evaluations* document (EPA Document #740-P1-8001).

This document presents data quality evaluation results for ecological hazard studies evaluated for the Asbestos Risk Evaluation.

Table of Contents

Study Citation:	Trivedi, A. K.,Ahmad, I.,Musthapa, M. S.,Ansari, F. A.. 2007. Environmental contamination of chrysotile asbestos and its toxic effects on antioxidative system of Lemna gibba. Archives of Environmental Contamination and Toxicology 52:355-362
Data Type:	Chronic (>21 days); Aquatic; Plants
Hero ID:	621276

Domain	Metric		Rating†	MWF⋆	Score	Comments††
Domain 1: Test Substance						
	Metric 1:	Test Substance Identity	High	× 2	2	The test substance was identified definitively.
	Metric 2:	Test Substance Source	Low	× 1	3	Although the test material source not defined there is no indication this impacted the results of the study.
	Metric 3:	Test Substance Purity	Low	× 1	3	Although the purity was not reported, there is no indication that this had an effect on the results.
Domain 2: Test Design						
	Metric 4:	Negative Controls	Medium	× 2	4	Although aquatic plants used as controls were cultured in nutrient mediumwithout chrysotile fiber, they were from the third generation of plants obtained from a natural habitat in an aquatic body that was contaminated with asbestos. There are uncertainties (e.g., due to epigenetics) around how the initial exposure to asbestos at the parent generation would affect the plants from the third generation.
	Metric 5:	Negative Control Response	Medium	× 1	2	There were minor uncertainties or limitations regarding the biological responses of the negative control group(s).
	Metric 6:	Randomized Allocation	Low	× 1	3	Researchers did not report how organisms were allocated to study group.
Domain 3: Exposure Characterization						
	Metric 7:	Experimental System/Test Media Preparation	Unacceptable	× 2	8	The test organisms were cultured in a media containing asbestos, while also being exposed at a rate that is reported in terms of exposure per frond. The authors did not provide sufficient detail about the test organisms or exposure regime (ex. how many fronds per plant? Does excess test media applied to fronds enter the test suspension?) to allow the reviewer to confirm the scientific validity of this study.

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Data Type: Chronic (>21 days); Aquatic; Plants
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Domain	Metric		Rating†	MWF⋆	Score	Comments††
	Metric 8:	Consistency of Exposure Administration	Unacceptable	× 1	4	There were serious flaws in how the aquatic plants were exposed to asbestos. The authors described the test media as containing asbestos, while describing the exposure of asbestos to the fronds. This led the reviewer to question the source of the effects observed in this study and whether it was due to asbestos in the media or the asbestos applied to the frond. In addition, the lack of detail about the procedure used to apply asbestos to the fronds meant that the exposure cannot be adequately understood from the information provided in this study.
	Metric 9:	Measurement of Test Substance Concentration	N/A		N/A	Exposure concentrations to fronds in the plants were not measured due to the insoluble nature of asbestos fibers.
	Metric 10:	Exposure Duration and Frequency	High	× 1	1	Experiments were carried out for a test duration of 28 days. EPA determined this to be acceptable.
	Metric 11:	Number of Exposure Groups/Spacing of Exposure Levels	Low	× 1	3	There were no Justifications provided for the selection of the test concentrations.
	Metric 12:	Testing at or Below Solubility Limit	N/A		N/A	Test media was left in suspension because asbestos is an insoluble particle. .
Domain 4: Test Organism						
	Metric 13:	Test Organism Characteristics	Medium	× 2	4	There are minor reservations or uncertainties about the source of test organisms.
	Metric 14:	Acclimitization and Pretreatment Conditions	Unacceptable	× 1	4	Plants were cultured in a media containing asbestos which may interfere with the ability of the authors to adequately quantify the effects of the test material.
	Metric 15:	Number of Organisms and Replicates per Group	High	× 1	1	The numbers of test organisms and replicates were reported and sufficient to characterize toxicological effects.
	Metric 16:	Adequacy of Test Conditions	Unacceptable	× 1	4	Plants were cultured in a media containing asbestos in addition to having suspensions containing asbestos applied to their fronds.
Domain 5: Outcome Assessment						
	Metric 17:	Outcome Assessment Methodology	Low	× 2	6	The results were sufficiently reported, but uncertainties regarding the exposure led the reviewer to question the applicability of the results.

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Domain	Metric		Rating†	MWF⋆	Score	Comments††
	Metric 18:	Consistency of Outcome Assessment	Medium	× 1	2	There were incomplete reporting of minor details of outcome assessment protocol execution, but these uncertainties or limitations are unlikely to have substantial impact on results.
Domain 6: Confounding / Variable Control						
	Metric 19:	Confounding Variables in Test Design and Procedures	Medium	× 2	4	The study reported minor differences among the study groups with respect to environmental conditions or other non-treatment-related factors, but these are unlikely to have a substantial impact on results.
	Metric 20:	Outcomes Unrelated to Exposure	High	× 1	1	There were no differences among groups that could influence the outcome assessment.
Domain 7: Data Presentation and Analysis						
	Metric 21:	Statistical Methods	High	× 1	1	Statistical methods were clearly described and appropriate for dataset(s).
	Metric 22:	Reporting of Data	Unacceptable	× 2	8	Results were reported in terms of asbestos applied to each frond, but there were critical details lacking about the characteristics of the test organisms, particularly regarding the number of fronds /plant.
	Metric 23:	Explanation of Unexpected Outcomes	High	× 1	1	There were no unexpected outcomes, or unexpected outcomes were satisfactorily explained.
Overall Quality Determination‡			Unacceptable		4.0	
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, five of the metrics were rated as unacceptable. As such, the study is considered unacceptable and the score is presented solely to increase transparency.

⋆ MWF = Metric Weighting Factor

† 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.

$$\text{Overall rating} = \begin{cases} 4 & \text{if any metric is Unacceptable} \\ \left\lfloor \sum_i (\text{Metric Score}_i \times \text{MWF}_i) \,/\, \sum_j \text{MWF}_j \right\rceil_{0.1} & \text{(round to the nearest tenth) otherwise} \end{cases},$$

where High: ≥ 1 to < 1.7; Medium: ≥ 1.7 to < 2.3; Low: ≥ 2.3 to ≤ 3. If the reviewer determines that the overall rating needs adjustment, the original rating is crossed out and an arrow points to the new rating.

†† Metrics that are rated 'High' met the criteria for high confidence as expected for this type of study, and may not require additional comments.

Study Citation:	Trivedi, A. K.,Ahmad, I.,Musthapa, M. S.,Ansari, F. A.,Rahman, Q.. 2004. Environmental contamination of chrysotile asbestos and its toxic effects on growth and physiological and biochemical parameters of Lemna gibba. Archives of Environmental Contamination and Toxicology 47:281-289
Data Type:	Chronic (>21 days); Aquatic; Plants
Hero ID:	3080106

Domain	Metric		Rating†	MWF⋆	Score	Comments††
Domain 1: Test Substance						
	Metric 1:	Test Substance Identity	High	× 2	2	The test substance was identified definitively.
	Metric 2:	Test Substance Source	Low	× 1	3	Although the test material source not defined there is no indication this impacted the results of the study.
	Metric 3:	Test Substance Purity	Low	× 1	3	Although the purity was not reported, there is no indication that this had an effect on the results.
Domain 2: Test Design						
	Metric 4:	Negative Controls	Medium	× 2	4	Although aquatic plants used as controls were cultured in nutrient mediumwithout chrysotile fiber, they were from the third generation of plants obtained from a natural habitat in an aquatic body that was contaminated with asbestos. There are uncertainties (e.g., due to epigenetics) around how the initial exposure to asbestos at the parent generation would affect the plants from the third generation.
	Metric 5:	Negative Control Response	Medium	× 1	2	There were minor uncertainties or limitations regarding the biological responses of the negative control group(s).
	Metric 6:	Randomized Allocation	Low	× 1	3	Researchers did not report how organisms were allocated to study group.
Domain 3: Exposure Characterization						
	Metric 7:	Experimental System/Test Media Preparation	Unacceptable	× 2	8	The test organisms were cultured in a media containing asbestos, while also being exposed at a rate that is reported in terms of exposure per frond. The authors did not provide sufficient detail about the test organisms or exposure regime (ex. how many fronds per plant? Does excess test media applied to fronds enter the test suspension?) to allow the reviewer to confirm the scientific validity of this study.

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Domain		Metric	Rating†	MWF⋆	Score	Comments††
	Metric 8:	Consistency of Exposure Administration	Unacceptable	× 1	4	There were serious flaws in how the aquatic plants were exposed to asbestos. The authors described the test media as containing asbestos, while describing the exposure of asbestos to the fronds. This led the reviewer to question the source of the effects observed in this study and whether it was due to asbestos in the media or the asbestos applied to the frond. In addition, the lack of detail about the procedure used to apply asbestos to the fronds meant that the exposure cannot be adequately understood from the information provided in this study.
	Metric 9:	Measurement of Test Substance Concentration	N/A		N/A	Exposure concentrations to fronds in the plants were not measured due to the insoluble nature of asbestos fibers.
	Metric 10:	Exposure Duration and Frequency	High	× 1	1	Experiments were carried out for a test duration of 28 days. EPA determined this to be acceptable.
	Metric 11:	Number of Exposure Groups/Spacing of Exposure Levels	Low	× 1	3	There were no Justifications provided for the selection of the test concentrations.
	Metric 12:	Testing at or Below Solubility Limit	N/A		N/A	Test media was left in suspension because asbestos is an insoluble particle.
Domain 4: Test Organism						
	Metric 13:	Test Organism Characteristics	Medium	× 2	4	There are minor reservations or uncertainties about the source of test organisms.
	Metric 14:	Acclimitization and Pretreatment Conditions	Unacceptable	× 1	4	Plants were cultured in a media containing asbestos which may interfere with the ability of the authors to adequately quantify the effects of the test material.
	Metric 15:	Number of Organisms and Replicates per Group	High	× 1	1	The numbers of test organisms and replicates were reported and sufficient to characterize toxicological effects.
	Metric 16:	Adequacy of Test Conditions	Unacceptable	× 1	4	Plants were cultured in a media containing asbestos in addition to having suspensions containing asbestos applied to their fronds.
Domain 5: Outcome Assessment						

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Domain	Metric		Rating†	MWF⋆	Score	Comments††
	Metric 17:	Outcome Assessment Methodology	Low	× 2	6	The results were sufficiently reported, but uncertainties regarding the exposure led the reviewer to question the applicability of the results.
	Metric 18:	Consistency of Outcome Assessment	Medium	× 1	2	There were incomplete reporting of minor details of outcome assessment protocol execution, but these uncertainties or limitations are unlikely to have substantial impact on results.
Domain 6: Confounding / Variable Control						
	Metric 19:	Confounding Variables in Test Design and Procedures	Medium	× 2	4	The study reported minor differences among the study groups with respect to environmental conditions or other non-treatment-related factors, but these are unlikely to have a substantial impact on results.
	Metric 20:	Outcomes Unrelated to Exposure	High	× 1	1	There were no differences among groups that could influence the outcome assessment.
Domain 7: Data Presentation and Analysis						
	Metric 21:	Statistical Methods	High	× 1	1	Statistical methods were clearly described and appropriate for dataset(s).
	Metric 22:	Reporting of Data	Unacceptable	× 2	8	Results were reported in terms of asbestos applied to each frond, but there were critical details lacking about the characteristics of the test organisms, particularly regarding the number of fronds /plant.
	Metric 23:	Explanation of Unexpected Outcomes	High	× 1	1	There were no unexpected outcomes, or unexpected outcomes were satisfactorily explained.
Overall Quality Determination‡			Unacceptable		4.0	
Extracted			No			

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Domain	Metric	Rating†	MWF⋆	Score	Comments††

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⋆ MWF = Metric Weighting Factor

† 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.

$$\text{Overall rating} = \begin{cases} 4 & \text{if any metric is Unacceptable} \\ \left\lfloor \sum_i (\text{Metric Score}_i \times \text{MWF}_i) \,/\, \sum_j \text{MWF}_j \right\rceil_{0.1} & \text{(round to the nearest tenth) otherwise} \end{cases},$$

where High: ≥ 1 to < 1.7; Medium: ≥ 1.7 to < 2.3; Low: ≥ 2.3 to ≤ 3. If the reviewer determines that the overall rating needs adjustment, the original rating is crossed out and an arrow points to the new rating.

†† Metrics that are rated 'High' met the criteria for high confidence as expected for this type of study, and may not require additional comments.

Study Citation:	Belanger, S. E.,Cherry, D. S.,Cairns J, J. R.. 1986. UPTAKE OF CHRYSOTILE ASBESTOS FIBERS ALTERS GROWTH AND REPRODUCTION OF ASIATIC CLAMS. Canadian Journal of Fisheries and Aquatic Sciences 43:43-52
Data Type:	Chronic (>21 days); Aquatic; Invertebrates
Hero ID:	3093600

Domain	Metric		Rating†	MWF⋆	Score	Comments††
Domain 1: Test Substance						
	Metric 1:	Test Substance Identity	High	× 2	2	Grade 5 chrysotile asbestos mined ore was used.
	Metric 2:	Test Substance Source	Low	× 1	3	The study authors did not report the specific commercial supplier or batch/lot # used to obtain the test substance.
	Metric 3:	Test Substance Purity	Low	× 1	3	The study authors mentioned "Grade 5 chrysotile asbestos" was used but did not define what the "Grade 5" represents.
Domain 2: Test Design						
	Metric 4:	Negative Controls	High	× 2	2	The study authors used an appropriate concurrent negative control groups for all experiments,.
	Metric 5:	Negative Control Response	High	× 1	1	The biological responses of the negative control groups were reported and had acceptable variations.
	Metric 6:	Randomized Allocation	Low	× 1	3	Study authors obtained clams from New River, Virginia and transported these clams to their lab at Virginia Tech. There were no discussions about separating these clams into formal randomized groups.
Domain 3: Exposure Characterization						
	Metric 7:	Experimental System/Test Media Preparation	High	× 2	2	The experimental system and methods for preparation of test media were described in adequate detail and appropriately accounted for the physical-chemical properties of the test substance. Specifically, the exposure system used for the asbestos experiments kept the asbestos fibers in suspension by employing a raised plexiglass tray above a stir bar.
	Metric 8:	Consistency of Exposure Administration	Low	× 1	3	Difficulties with measuring asbestos accurately posed challenges in consistent administration of test substance. Study authors used nominal concentrations of asbestos in their experiments and mentioned that the detection limits for all concentrations ranged from 1.79E4 to 6.91E4 fibers. However, they tested concentrations up to 10E8. This issue is an inherent challenge to asbestos, a difficult to test chemical.

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Hero ID:	3093600

Domain	Metric		Rating†	MWF⋆	Score	Comments††
	Metric 9:	Measurement of Test Substance Concentration	N/A		N/A	Due to the physical chemical properties and difficult to test nature of asbestos, the nominal values of asbestos are highly variable, i.e., the effect concentrations reported in this study may misrepresent the actual effect concentrations. Consequently, this metric is not applicable.
	Metric 10:	Exposure Duration and Frequency	High	× 1	1	For the 96-hr and 30 day experiments, the duration of exposures and exposure frequency were reported and appropriate.
	Metric 11:	Number of Exposure Groups/Spacing of Exposure Levels	High	× 1	1	The number of exposure groups and spacing of exposure levels were justified and adequate to observe the short-term and long-term effects of asbestos effects in Corbicula.
	Metric 12:	Testing at or Below Solubility Limit	N/A		N/A	Asbestos fibers are insoluble in water and organic solvents. The study authors cannot test the asbestos fibers at or below the solubility limit.
Domain 4: Test Organism						
	Metric 13:	Test Organism Characteristics	High	× 2	2	The Corbicula test organism was adequately described and obtained from a reliable source. Corbicula was an appropriate test organism to evaluate the environmental effects posed by asbestos to aquatic invertebrates for the following four reasons: 1) it resides in every major river system in the U.S and, therefore, is likely to be found within several chrysotile-contaminated waterways; 2) mollusks are known to accumulate asbestos; 3) clams are easy to collect and observe in laboratory environments; and 4) known effects of other toxicants on clams allow comparisons.
	Metric 14:	Acclimitization and Pretreatment Conditions	High	× 1	1	Clams were acclimatized to laboratory conditions for 1-2 weeks prior to experiments and all pretreatment conditions were the same for control and exposed populations
	Metric 15:	Number of Organisms and Replicates per Group	Medium	× 1	2	Minor uncertainties or limitations were identified regarding the number of test organisms and replicates used for each experiments. These uncertainties are unlikely to have a substantial impact on the test results.

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Domain	Metric	Rating†	MWF*	Score	Comments††
	Metric 16: Adequacy of Test Conditions	High	× 1	1	Clams were adequately housed and fed in a specially designed exposure system that employed a raised plexiglass tray above a stir bar that was used to keep the asbestos fibers in suspension.
Domain 5: Outcome Assessment					
	Metric 17: Outcome Assessment Methodology	High	× 2	2	The outcome assessment methodology addressed the intended biological effects.
	Metric 18: Consistency of Outcome Assessment	High	× 1	1	Details of the outcome assessment protocol were reported and outcomes were assessed consistently across study groups (e.g., at the same time after initial exposure) using the same protocol in all study groups.
Domain 6: Confounding / Variable Control					
	Metric 19: Confounding Variables in Test Design and Procedures	High	× 2	2	There were no reported differences among the study groups in environmental conditions or other factors that could influence the outcome assessment.
	Metric 20: Outcomes Unrelated to Exposure	High	× 1	1	Mortality of adult claims were not observed in the 96-hours experiments and not statistically significant in the 30-days experiments.
Domain 7: Data Presentation and Analysis					
	Metric 21: Statistical Methods	High	× 1	1	Kruskal-Wallis test used was adequate for test objectives. Statistical methods were clearly described and appropriate for datasets.
	Metric 22: Reporting of Data	High	× 2	2	Data for exposure-related findings were presented for each treatment and control group and were adequate to determine values for the endpoint(s) of interest.
	Metric 23: Explanation of Unexpected Outcomes	High	× 1	1	All unexpected outcomes were satisfactorily explained.
Overall Quality Determination‡		High		1.3	
Extracted		Yes			

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Domain	Metric	Rating†	MWF⋆	Score	Comments††

⋆ MWF = Metric Weighting Factor
† 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.

$$\text{Overall rating} = \begin{cases} 4 & \text{if any metric is Unacceptable} \\ \left\lfloor \sum_i (\text{Metric Score}_i \times \text{MWF}_i) \,/\, \sum_j \text{MWF}_j \right\rceil_{0.1} & \text{(round to the nearest tenth) otherwise} \end{cases},$$

where High: ≥ 1 to < 1.7; Medium: ≥ 1.7 to < 2.3; Low: ≥ 2.3 to ≤ 3. If the reviewer determines that the overall rating needs adjustment, the original rating is crossed out and an arrow points to the new rating.
†† Metrics that are rated 'High' met the criteria for high confidence as expected for this type of study, and may not require additional comments.

Study Citation:	Belanger, S. E.,Cherry, D. S.,Cairns J, J. R.. 1986. SEASONAL BEHAVIORAL AND GROWTH CHANGES OF JUVENILE CORBICULA-FLUMINEA EXPOSED TO CHRYSOTILE ASBESTOS. Water Research 20:1243-1250
Data Type:	Chronic (>21 days); Aquatic; Invertebrates
Hero ID:	3093856

Domain	Metric		Rating†	MWF⋆	Score	Comments††
Domain 1: Test Substance						
	Metric 1:	Test Substance Identity	High	× 2	2	Chrysotile asbestos
	Metric 2:	Test Substance Source	Low	× 1	3	Source of asbestos not specified
	Metric 3:	Test Substance Purity	High	× 1	1	Test is conducted with a fiber; Asbestos fiber stocks used in exposures were prepared by lightly milling 400 mg of asbestos, followed by sonicating 500 ml of a 0.060mgl -j chrysotile stock for 2h with a Fisher ultrasonic cleaner to eliminate large blocks and cleavage fragments. Micrographs were taken of the first 15-25 fibers encountered and subsequently measured for length, width and aspect ratio.
Domain 2: Test Design						
	Metric 4:	Negative Controls	High	× 2	2	
	Metric 5:	Negative Control Response	High	× 1	1	
	Metric 6:	Randomized Allocation	Medium	× 1	2	randomization procedure not specified, no evidence that this affected the results of the study
Domain 3: Exposure Characterization						
	Metric 7:	Experimental System/Test Media Preparation	High	× 2	2	Asbestos fiber stocks used in exposures were prepared by lightly milling 400 mg of asbestos, followed by sonicating 500 ml of a 0.060mgl -j chrysotile stock for 2h with a Fisher ultrasonic cleaner to eliminate large blocks and cleavage fragments. Suspension of asbestos fibers was maintained through magnetic stirring.
	Metric 8:	Consistency of Exposure Administration	High	× 1	1	Clams were exposed to 0, $10\hat{2}$, $10\hat{4}$, $10\hat{5}$, $10\hat{6}$ and $10\hat{8}$ fibers $\hat{}$1 m chrysotile asbestos. aquaria situated above a magnetic stirrer that kept asbestos in suspension.

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Data Type: Chronic (>21 days); Aquatic; Invertebrates
Hero ID: 3093856

Domain		Metric	Rating†	MWF⋆	Score	Comments††
	Metric 9:	Measurement of Test Substance Concentration	High	× 2	2	Asbestos fiber concentrations in water were determined by the TEM method described above except that water samples were directly filtered onto Nudepore filters. Background and blanks were processed simultaneously. Measured asbestos concentration for 0, $10\hat{2}$, $10\hat{4}$, $10\hat{5}$, $10\hat{6}$ and $10\hat{8}$ fibers/L were below detection at 0, $10\hat{4}$, 5.7 x $10\hat{5}$, 1.3 x $10\hat{7}$ and2.1 ” $10\hat{8}$ fibers/L, respectively.
	Metric 10:	Exposure Duration and Frequency	High	× 1	1	30-day exposure
	Metric 11:	Number of Exposure Groups/Spacing of Exposure Levels	High	× 1	1	
	Metric 12:	Testing at or Below Solubility Limit	N/A		N/A	Insoluble fiber maintained in a suspension
Domain 4: Test Organism						
	Metric 13:	Test Organism Characteristics	Medium	× 2	4	Juvenile Corbicula (5.2-8.6 mm shell length) were collected from the New River, Va, by dip net adjacent to an industrial pumphouse station (Celanese Fibers Corp., Narrows, Va). It was uncertain if the collection site was polluted, but the controls showed no ill effects, or accumulated fibers so it was assumed that this collection site was appropriate.
	Metric 14:	Acclimitization and Pretreatment Conditions	High	× 1	1	Juvenile clams were sorted from adults and sediment in the field and returned to Virginia Tech where they were acclimated to constant temperature (20”C)laboratory conditions for 7 days in 40-1. aquaria.
	Metric 15:	Number of Organisms and Replicates per Group	High	× 1	1	10 clams/group
	Metric 16:	Adequacy of Test Conditions	High	× 1	1	Groups of 10 clams were placed in a raised plexiglass platform of 315 $cm\hat{2}$ surface area in each tank.
Domain 5: Outcome Assessment						
	Metric 17:	Outcome Assessment Methodology	High	× 2	2	
	Metric 18:	Consistency of Outcome Assessment	High	× 1	1	
Domain 6: Confounding / Variable Control						

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Domain	Metric		Rating†	MWF⋆	Score	Comments††
	Metric 19:	Confounding Variables in Test Design and Procedures	High	× 2	2	
	Metric 20:	Outcomes Unrelated to Exposure	High	× 1	1	
Domain 7: Data Presentation and Analysis						
	Metric 21:	Statistical Methods	High	× 1	1	Nonparametric statistical techniques were applied in allanalyses. The one-way analysis of variance rank-analogue,the Kruskal-Wallis Test, was used for one-way layout data. If significant differences were indicated (= 0.05), a rank-like Least Significant Differences Procedure was used to determine the relationships betweengroups. In cases of two sample data (e.g. planimetricanalysis of gill tissue), Wilcoxon's Rank Sum Test was usedto test differences between groups
	Metric 22:	Reporting of Data	High	× 2	2	
	Metric 23:	Explanation of Unexpected Outcomes	High	× 1	1	
Overall Quality Determination‡			High		1.1	
Extracted			Yes			

⋆ MWF = Metric Weighting Factor

† 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.

$$\text{Overall rating} = \begin{cases} 4 & \text{if any metric is Unacceptable} \\ \left\lfloor \sum_i (\text{Metric Score}_i \times \text{MWF}_i) \,/\, \sum_j \text{MWF}_j \right\rceil_{0.1} & \text{(round to the nearest tenth) otherwise} \end{cases},$$

where High: ≥ 1 to < 1.7; Medium: ≥ 1.7 to < 2.3; Low: ≥ 2.3 to ≤ 3. If the reviewer determines that the overall rating needs adjustment, the original rating is crossed out and an arrow points to the new rating.

†† Metrics that are rated 'High' met the criteria for high confidence as expected for this type of study, and may not require additional comments.

Study Citation:	Belanger, S. E.,Schurr, K.,Allen, D. J.,Gohara, A. F.. 1986. Effects of chrysotile asbestos on coho salmon and green sunfish: evidence of behavioral and pathological stress. Environmental Research 39:74-85
Data Type:	Chronic (>21 days); Aquatic; Fish
Hero ID:	3584231

Domain	Metric		Rating†	MWF⋆	Score	Comments††
Domain 1: Test Substance						
	Metric 1:	Test Substance Identity	High	× 2	2	Asbestos was in the form of mined chrysotile.
	Metric 2:	Test Substance Source	Medium	× 1	2	Asbestos used in this study was a gift from a major asbestos producer.
	Metric 3:	Test Substance Purity	Low	× 1	3	Purity and/or grade of test substance were not reported. The test chemical was in the form of mined chrysotile.
Domain 2: Test Design						
	Metric 4:	Negative Controls	High	× 2	2	Study authors reported using an appropriate concurrent negative control group.
	Metric 5:	Negative Control Response	High	× 1	1	The biological responses of the negative control group(s) were adequate (e.g., mortality of control fish ”20 percent in the chronic tests).
	Metric 6:	Randomized Allocation	High	× 1	1	The study reported that organisms were randomly allocated into study groups.
Domain 3: Exposure Characterization						
	Metric 7:	Experimental System/Test Media Preparation	High	× 2	2	The experimental system and methods for preparation of test media were described in adequate detail and appropriately accounted for the physical-chemical properties of the test substance.
	Metric 8:	Consistency of Exposure Administration	High	× 1	1	Test organisms were consistently dosed with asbestos (i.e., only once at the beginning of the experiment).
	Metric 9:	Measurement of Test Substance Concentration	N/A		N/A	Nominal values are highly uncertain due to the nature of the test substance. As a result, the effect concentrations reported in this study may misrepresent the actual effect concentrations.
	Metric 10:	Exposure Duration and Frequency	High	× 1	1	Test organisms were dosed with asbestos only once at the beginning of the experiment. This is sufficient because asbestos fibers are insoluble and the possibility of the fibers degrading during the experiment is low. The length of exposure was adequate for the objectives of the experiments.

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Data Type: Chronic (>21 days); Aquatic; Fish
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Domain	Metric		Rating†	MWF⋆	Score	Comments††
	Metric 11:	Number of Exposure Groups/Spacing of Exposure Levels	High	× 1	1	Two levels of exposure were used (i.e., 1.5E6 and 3E6 fibers/liter). These concentrations are similar to concentrations found in many aquatic environments at the time of the study.
	Metric 12:	Testing at or Below Solubility Limit	N/A		N/A	Asbestos fibers are insoluble in water and organic solvents. Nominal values are highly uncertain due to the nature of the test substance. The effect concentrations reported in these studies may misrepresent the actual effect concentrations.
Domain 4: Test Organism						
	Metric 13:	Test Organism Characteristics	High	× 2	2	This study was designed to evaluate the effects of chrysotile asbestos on recentlyhatched coho salmon larvae (Oncorhynchus kisutch) and juvenile greensunfish (Lepomis cyanellus). These species and life stages were chosen due tothe importance of salmonids (e.g., coho) in the Great Lakes ecosystem and theprobable susceptibility of young fish to asbestos intoxication. The test organisms were adequately described and were obtained from a reliable source.
	Metric 14:	Acclimitization and Pretreatment Conditions	High	× 1	1	Fish were allowed to acclimate for 5 days at room temperature (20.0 + 2.0"C) and were randomly divided into six groups of 20 fish each. The test organisms were acclimatized to test conditions and all pretreatment conditions were the same for control and exposed populations, such that the only difference was exposure to test substance.
	Metric 15:	Number of Organisms and Replicates per Group	Medium	× 1	2	The numbers of test organisms and replicates were sufficient to characterize toxicological effects, but minor uncertainties or limitations were identified regarding the number of test organisms and/or replicates that are unlikely to have a substantial impact on results.
	Metric 16:	Adequacy of Test Conditions	High	× 1	1	Organism housing, environmental conditions, food, water, and nutrients were conducive to maintenance of health and biomass loading was appropriate.
Domain 5: Outcome Assessment						

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Data Type:	Chronic (>21 days); Aquatic; Fish
Hero ID:	3584231

Domain	Metric		Rating†	MWF⋆	Score	Comments††
	Metric 17:	Outcome Assessment Methodology	High	× 2	2	The outcome assessment methodology addressed or reported the intended outcome(s) of interest and was sensitive for the outcomes(s) of interest.
	Metric 18:	Consistency of Outcome Assessment	Medium	× 1	2	Details of the outcome assessment protocol were reported but the outcomes were not assessed consistently across study. The experiments with higher concentrations of asbestos occurred for a lesser duration compare to the experiments with lower concentrations of asbestos.
Domain 6: Confounding / Variable Control						
	Metric 19:	Confounding Variables in Test Design and Procedures	High	× 2	2	There were no reported differences among the study groups in environmental conditions or other factors that could influence the outcome assessment.
	Metric 20:	Outcomes Unrelated to Exposure	Medium	× 1	2	Data on attrition and/or outcomes unrelated to exposure were not reported for each study group, but this deficiency is not likely to have a substantial impact on results.
Domain 7: Data Presentation and Analysis						
	Metric 21:	Statistical Methods	High	× 1	1	Statistical methods were clearly described and appropriate for dataset(s).
	Metric 22:	Reporting of Data	High	× 2	2	Data for exposure-related findings were presented for each treatment and control group and were adequate to determine values for the endpoint(s) of interest. Negative findings were reported qualitatively or quantitatively.
	Metric 23:	Explanation of Unexpected Outcomes	High	× 1	1	There were no unexpected outcomes, or unexpected outcomes were satisfactorily explained.
Overall Quality Determination‡			High		1.2	
Extracted			Yes			

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Data Type:	Chronic (>21 days); Aquatic; Fish
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Domain	Metric	Rating†	MWF⋆	Score	Comments††

⋆ MWF = Metric Weighting Factor
† 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.

$$\text{Overall rating} = \begin{cases} 4 & \text{if any metric is Unacceptable} \\ \left\lfloor \sum_i (\text{Metric Score}_i \times \text{MWF}_i) \,/\, \sum_j \text{MWF}_j \right\rceil_{0.1} & \text{(round to the nearest tenth) otherwise} \end{cases},$$

where High: ≥ 1 to < 1.7; Medium: ≥ 1.7 to < 2.3; Low: ≥ 2.3 to ≤ 3. If the reviewer determines that the overall rating needs adjustment, the original rating is crossed out and an arrow points to the new rating.
†† Metrics that are rated 'High' met the criteria for high confidence as expected for this type of study, and may not require additional comments.

Study Citation:	Belanger, S. E.,Cherry, D. S.,Cairns, J.. 1990. FUNCTIONAL AND PATHOLOGICAL IMPAIRMENT OF JAPANESE MEDAKA (ORYZIAS-LATIPES) BY LONG-TERM ASBESTOS EXPOSURE. Aquatic Toxicology 17:133-154
Data Type:	Chronic (>21 days); Aquatic; Fish
Hero ID:	3585046

Domain	Metric		Rating†	MWF⋆	Score	Comments††
Domain 1: Test Substance						
	Metric 1:	Test Substance Identity	Medium	× 2	4	Study authors mentioned "Grade 5 chrysotile asbestos" but did not define what the "Grade 5" means.
	Metric 2:	Test Substance Source	Low	× 1	3	Study authors did not report the specific commercial supplier or batch/lot # used to obtain the test substance. In addition, they only used nominal concentrations of asbestos in their experiments.
	Metric 3:	Test Substance Purity	Low	× 1	3	Purity and/or grade of test substance were not reported.
Domain 2: Test Design						
	Metric 4:	Negative Controls	High	× 2	2	Study authors reported using an appropriate concurrent negative control group (i.e., all conditions equal except chemical exposure).
	Metric 5:	Negative Control Response	High	× 1	1	The biological responses of the negative control group(s) were adequate (e.g., mortality of control fish "20 percent in the chronic tests).
	Metric 6:	Randomized Allocation	Medium	× 1	2	The study reported methods of allocation of organisms to study groups, but there were minor limitations in the allocation method.
Domain 3: Exposure Characterization						
	Metric 7:	Experimental System/Test Media Preparation	High	× 2	2	The experimental system and methods for preparation of test media were described in adequate detail and appropriately accounted for the physical-chemical properties of the test substance. Water and asbestos were completely changed every other week and loading (wet weight of fish per liter) did not exceed 0.33 g/l. Analyses of asbestos concentrations were performed before and after one water exchange every 4 weeks for 4 months of exposures, and 1 month of recovery following exposure (n = 20 for each concentration).
	Metric 8:	Consistency of Exposure Administration	High	× 1	1	Details of exposure administration were reported and exposures were administered consistently across study groups.

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Data Type: Chronic (>21 days); Aquatic; Fish
Hero ID: 3585046

Domain	Metric		Rating†	MWF⋆	Score	Comments††
	Metric 9:	Measurement of Test Substance Concentration	N/A		N/A	Nominal values are highly uncertain due to the nature of the test substance. As a result, the effect concentrations reported in this study may misrepresent the actual effect concentrations.
	Metric 10:	Exposure Duration and Frequency	High	× 1	1	The duration of exposure and/or exposure frequency were reported and appropriate for the study type and/or outcome(s) of interest.
	Metric 11:	Number of Exposure Groups/Spacing of Exposure Levels	High	× 1	1	The number of exposure groups and spacing of exposure levels were justified by study authors and adequate to address the purpose of the study
	Metric 12:	Testing at or Below Solubility Limit	N/A		N/A	Asbestos fibers are insoluble in water and organic solvents. Nominal values are highly uncertain due to the nature of the test substance. The effect concentrations reported in these studies may misrepresent the actual effect concentrations.
Domain 4: Test Organism						
	Metric 13:	Test Organism Characteristics	High	× 2	2	The test organisms were adequately described and were obtained from a reliable source. The test species, strain, sex, age, size, life stage, and/or embryonic stage of the test organisms reported and appropriate for the evaluation of the specific outcome(s) of interest
	Metric 14:	Acclimitization and Pretreatment Conditions	High	× 1	1	The test organisms were acclimatized to test conditions and all pretreatment conditions were the same for control and exposed populations, such that the only difference was exposure to test substance.
	Metric 15:	Number of Organisms and Replicates per Group	High	× 1	1	The numbers of test organisms and replicates were reported and sufficient to characterize toxicological effects.
	Metric 16:	Adequacy of Test Conditions	High	× 1	1	Organism housing, environmental conditions, food, water, and nutrients were conducive to maintenance of health and biomass loading was appropriate.
Domain 5: Outcome Assessment						
	Metric 17:	Outcome Assessment Methodology	High	× 2	2	The outcome assessment methodology addressed or reported the intended outcome(s) of interest and was sensitive for the outcomes(s) of interest.

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Data Type:	Chronic (>21 days); Aquatic; Fish
Hero ID:	3585046

Domain	Metric		Rating†	MWF⋆	Score	Comments††
	Metric 18:	Consistency of Outcome Assessment	High	× 1	1	Details of the outcome assessment protocol were reported and outcomes were assessed consistently across study groups (e.g., at the same time after initial exposure) using the same protocol in all study groups.
Domain 6: Confounding / Variable Control						
	Metric 19:	Confounding Variables in Test Design and Procedures	High	× 2	2	There were no reported differences among the study groups in environmental conditions or other factors that could influence the outcome assessment.
	Metric 20:	Outcomes Unrelated to Exposure	Medium	× 1	2	Data on attrition and/or outcomes unrelated to exposure were not reported for each study group, but this deficiency is not likely to have a substantial impact on results.
Domain 7: Data Presentation and Analysis						
	Metric 21:	Statistical Methods	High	× 1	1	Statistical methods were clearly described and appropriate for dataset(s) (e.g., ANOVA).
	Metric 22:	Reporting of Data	High	× 2	2	Data for exposure-related findings were presented for each treatment and control group and were adequate to determine values for the endpoint(s) of interest. Negative findings were reported qualitatively or quantitatively.
	Metric 23:	Explanation of Unexpected Outcomes	High	× 1	1	There were no unexpected outcomes, or unexpected outcomes were satisfactorily explained.
Overall Quality Determination‡			High		1.3	
Extracted			Yes			

⋆ MWF = Metric Weighting Factor

† 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.

$$\text{Overall rating} = \begin{cases} 4 & \text{if any metric is Unacceptable} \\ \left\lfloor \sum_i (\text{Metric Score}_i \times \text{MWF}_i) \,/\, \sum_j \text{MWF}_j \right\rceil_{0.1} & \text{(round to the nearest tenth) otherwise} \end{cases},$$

where High: ≥ 1 to < 1.7; Medium: ≥ 1.7 to < 2.3; Low: ≥ 2.3 to ≤ 3. If the reviewer determines that the overall rating needs adjustment, the original rating is crossed out and an arrow points to the new rating.

†† Metrics that are rated 'High' met the criteria for high confidence as expected for this type of study, and may not require additional comments.