

Analytical method for chloropicrin in ground, drinking, and surface water

Reports: ECM: EPA MRID No.: 49854401. Todd, M. 2007. CHLOROPICRIN - VALIDATION OF METHODOLOGY FOR THE DETERMINATION OF RESIDUES OF CHLOROPICRIN IN GROUND, DRINKING AND SURFACE WATER. Study No.: SXC 0007/072387. Report prepared by Huntingdon Life Sciences Ltd., Cambridgeshire, England, and sponsored and submitted by European Chloropicrin Group, Washington, D.C.; 45 pages. Final report issued June 27, 2007.

ILV: EPA MRID No. 50167601. Keenan, D. 2017. Independent Laboratory Validation of Chloropicrin in Ground, Surface, and Drinking Water. PTRL Project No.: 2854W. Report prepared by PTRL West (now doing business at EAG Laboratories), Hercules, California, sponsored and submitted by Chloropicrin Task Force, Niklor Chemical Co. Inc., Mojave, California; 78 pages. Final report issued January 18, 2017.


Document No.: MRIDs 49854401 & 50167601


Guideline: 850.6100


Statements: ECM: The study was conducted in accordance with OECD, UK and UK Department of Health Good Laboratory Practice (GLP) standards (p. 3; Appendix 7, p. 88 of MRID 49854401). Signed and dated No Data Confidentiality, GLP, and Quality Assurance statements were provided (pp. 2-4). A statement of authenticity was included with the QA statement.
ILV: The study was conducted in accordance with German GLP standards, which are based on OECD GLP standards, which are accepted by European communities, the USA (FDA and EPA, FIFRA GLP standards, 40 CFR, Part 160) and Japan (p. 3 of MRID 50167601). Signed and dated No Data Confidentiality, GLP, Quality Assurance, and Authenticity statements were provided (pp. 2-5).

Classification: This analytical method is classified as supplemental. An updated ECM should be submitted with the ILV modifications. The specificity of the method was not well-supported by the ECM representative chromatograms because of chromatogram readability. Two of the three ECM matrices were not characterized.

PC Code: 081501

EFED Final Reviewer: James Lin
Environmental Engineer
Signature: 
Date: 12/19/2018

CDM/CSS-Dynamac JV Reviewers: Lisa Muto, M.S.
Environmental Scientist
Signature: 
Date: 08/15/2018

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Environmental Scientist
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Date: 09/14/2018

This Data Evaluation Record may have been altered by the Environmental Fate and Effects Division subsequent to signing by CDM/CSS-Dynamac JV personnel. The CDM/CSS-Dynamac Joint Venture role does not include establishing Agency policies.

Executive Summary

The analytical method, Huntingdon Life Sciences Ltd. Study No. SXC 0007/072387, is designed for the quantitative determination of chloropicrin in water at the LOQ of 0.1 µg/L using GC/ECD (primary) and GC/MS (confirmatory). The LOQ is less than the lowest toxicological level of concern in water. The ECM validated the method using characterized surface water and uncharacterized ground and drinking waters; the ILV validated the method using characterized surface, ground, and drinking water matrices. The ILV validated the method in the second trial with two modifications to the sample processing procedure to increase analyte recovery: shortened extraction time and use of a smaller vessel to reduce headspace. The first trial failed due to low recoveries; therefore, the ECM should be updated with the ILV modifications. All ILV and ECM data regarding repeatability, accuracy, precision, and linearity were satisfactory for chloropicrin, except for the ILV linearity for the GC/MS analysis of chloropicrin in drinking water. ILV representative chromatograms were satisfactory, but ECM representative chromatograms were very difficult to interpret. The LODs of the ECM and ILV differed.

Table 1. Analytical Method Summary

Analyte(s) by Pesticide	MRID		EPA Review	Matrix	Method Date (dd/mm/yyyy)	Registrant	Analysis	Limit of Quantitation (LOQ)
	Environmental Chemistry Method	Independent Laboratory Validation						
Chloropicrin	49854401	50167601		Water ^{1,2}	27/06/2007	European Chloropicrin Group Chloropicrin Task Force (Niklor Chemical Co. Inc.)	GC/ECD & GC/MS	0.1 µg/L

1 In the ECM, surface (lake) water (pH 7.7; 180 mg equiv. CaCO₃/L total hardness and alkalinity; 15.2 mg/L total organic carbon; 12.7 mg/L dissolved organic carbon) was collected from Diss Mere, Diss, Norfolk, and used in the study (p. 10 of MRID 49854401). The water sample was characterized in a separate study (not specified). The drinking water was obtained from a tap in the Residue Analysis Department, and the ground water was obtained from a source in the Huntingdon area by Anglian Water. The drinking and ground water were not characterized; the source of the ground water was not further specified.

2 In the ILV, the ground water (PTRL ID 2706W-032; pH 7.3; 627 mg equiv. CaCO₃/L hardness; 960 ppm total dissolved solids) obtained from Northwood, North Dakota, drinking (tap) water (PTRL ID 2706W-072/054; pH 7.5; 30 mg equiv. CaCO₃/L hardness; 60 ppm total dissolved solids) obtained from Hercules, California, surface water (PTRL ID 2706W-069; pH 7.8; 1183 mg equiv. CaCO₃/L hardness; total dissolved solids not determined) obtained from Hercules, California, were used in the study (pp. 15-16 of MRID 50167601). The water samples were provided by EAG-Hercules and previously characterized by Agvise Laboratories.

I. Principle of the Method

Samples (20 mL) of water in 50-mL polypropylene tubes were fortified, as necessary (p. 11 of MRID 49854401). An aliquot (2 mL) of hexane was added, and the sample was shaken on a mechanical shaker for 30 minutes. After centrifugation (3500 rpm for 5 minutes), aliquots of the upper hexane phase were taken for analysis.

Samples were analyzed using a Hewlett Packard 6890 series gas chromatograph coupled to an electron capture detector (ECD; p. 12 of MRID 49854401). The GC/ECD conditions consisted of a Phenomenex Zebron ZB-50 column (0.53 mm x 30 m, 1- μ m), injector temperature 200°C, temperature program [40°C for 2 min. then 10°C/min. to 80°C then 30°C/min. to 200°C], carrier gas nitrogen, and 1 μ L injection volume. Expected retention time was *ca.* 4.3 minutes.

For confirmation, samples were analyzed using a Varian 1200 series gas chromatograph coupled to a mass spectrometer (p. 13 of MRID 49854401). The GC/MS conditions consisted of a RTX-5ms (0.25 mm x 30 m, 0.25- μ m), injector temperature 200°C, temperature program [40°C for 3 min. then 10°C/min. to 60°C then 30°C/min. to 200°C], carrier gas helium, 1 μ L injection volume, and Cl⁻ ionization mode. One ion was monitored: *m/z* 119. Expected retention time was *ca.* 4 minutes.

In the ILV, the ECM was performed as written, except for a shortened extraction time (1 minute with inversion and vortexing), use of a smaller vessel to reduce headspace, and use of a different analytical instrumentation (pp. 16-17, 19-21, 25; Figure 1, p. 31 of MRID 50167601). For GC/ECD analysis, an Agilent 6890 series GC [DB-17 column (0.53 mm x 30 m, 1- μ m)] coupled to an ECD was used. All other GC/ECD parameters were the same as those of the ECM. For GC/MS analysis, an Agilent 7890A series GC [DB-5ms column (0.25 mm x 30 m, 0.25- μ m)] coupled to a MS was used. All other GC/MS parameters were the same as those of the ECM. Expected retention times were *ca.* 4.7 minutes for GC/ECD and *ca.* 2.6 minutes for GC/MS.

The Limit of Quantification (LOQ) for chloropicrin in water was 0.10 μ g/L in the ECM and ILV (pp. 8, 12-13 of MRID 49854401; pp. 12, 22 of MRID 50167601). The Limit of Detection (LOD) was 0.05 μ g/L in the ECM; in ILV, the LOD was 0.004 μ g/L for ground water and 0.01 μ g/L for drinking and surface water.

II. Recovery Findings

ECM (MRID 49854401): Mean recoveries and relative standard deviations (RSDs) were within guideline requirements (mean 70-120%; RSD \leq 20%) for analysis of chloropicrin in three water matrices at fortification levels of 0.1 $\mu\text{g/L}$ (LOQ) and 1.0 $\mu\text{g/L}$ (10 \times LOQ; Tables 3-8, pp. 19-24). Chloropicrin was identified using GC/ECD and GC/MS for primary and confirmatory analyses, respectively. For GC/MS, one ion was monitored. Performance data (recovery results) from primary and confirmatory analyses were fairly comparable, but more varied for drinking water. The surface (lake) water (pH 7.7; 180 mg equiv. CaCO_3/L total hardness and alkalinity; 15.2 mg/L total organic carbon; 12.7 mg/L dissolved organic carbon) was collected from Diss Mere, Diss, Norfolk, and used in the study (p. 10). The water sample was characterized in a separate study (not specified). The drinking water was obtained from a tap in the Residue Analysis Department, and the ground water was obtained from a source in the Huntingdon area by Anglian Water. The drinking and ground water were not characterized; the source of the ground water was not further specified.

ILV (MRID 50167601): Mean recoveries and RSDs were within guideline requirements for analysis of chloropicrin in three water matrices at fortification levels of 0.1 $\mu\text{g/L}$ (LOQ) and 1.0 $\mu\text{g/L}$ (10 \times LOQ; Table 1, p. 27). Chloropicrin was identified using GC/ECD and GC/MS for primary and confirmatory analyses, respectively. For GC/MS, one ion was monitored. Performance data (recovery results) from primary and confirmatory analyses were fairly varied, but more comparable for surface water. The ground water (PTRL ID 2706W-032; pH 7.3; 627 mg equiv. CaCO_3/L hardness; 960 ppm total dissolved solids) obtained from Northwood, North Dakota, drinking (tap) water (PTRL ID 2706W-072/054; pH 7.5; 30 mg equiv. CaCO_3/L hardness; 60 ppm total dissolved solids) obtained from Hercules, California, surface water (PTRL ID 2706W-069; pH 7.8; 1183 mg equiv. CaCO_3/L hardness; total dissolved solids not determined) obtained from Hercules, California, were used in the study (pp. 15-16). The water samples were provided by EAG-Hercules and previously characterized by Agvise Laboratories. The method was validated in the second trial with two modifications to the sample processing procedure to increase analyte recovery: shortened extraction time (1 minute with inversion and vortexing) and use of a smaller vessel to reduce headspace (pp. 11, 16-17, 19-21, 25). The first trial failed due to low recoveries; therefore, the ECM should be updated with the ILV modifications.

Table 2. Initial Validation Method Recoveries for Chloropicrin in Water*

Analyte	Fortification Level (µg/L)	Number of Tests	Recovery Range (%)	Mean Recovery (%)	Standard Deviation (%) ⁴	Relative Standard Deviation (%)
GC/ECD						
Ground Water						
Chloropicrin	0.1	5	82-90	86	3.0	3.5
	1.0	5	78-84	82	2.4	3.0
Drinking Water						
Chloropicrin	0.1	5	80-96	92	7.0	7.6
	1.0	5	84-100	94	7.1	7.6
Surface Water						
Chloropicrin	0.1	5	78-93	87	6.2	7.1
	1.0	5	77-93	85	6.2	7.3
GC/MS (m/z 119)						
Ground Water						
Chloropicrin	0.1	5	92-95	94	1.1	1.2
	1.0	5	81-88	85	2.6	3.1
Drinking Water						
Chloropicrin	0.1	5	76-89	80	5.2	6.4
	1.0	5	75-83	80	3.4	4.3
Surface Water						
Chloropicrin	0.1	5	75-89	83	6.2	7.5
	1.0	5	76-87	80	4.3	5.4

Data (uncorrected recovery results; p. 14) were obtained from Tables 3-8, pp. 19-24 of MRID 49854401.

* The surface (lake) water (pH 7.7; 180 mg equiv. CaCO₃/L total hardness and alkalinity; 15.2 mg/L total organic carbon; 12.7 mg/L dissolved organic carbon) was collected from Diss Mere, Diss, Norfolk, and used in the study (p. 10). The water sample was characterized in a separate study (not specified). The drinking water was obtained from a tap in the Residue Analysis Department, and the ground water was obtained from a source in the Huntingdon area by Anglian Water. The drinking and ground water were not characterized; the source of the ground water was not further specified.

Table 3. Independent Validation Method Recoveries for Chloropicrin in Water*

Analyte	Fortification Level (µg/L)	Number of Tests	Recovery Range (%)	Mean Recovery (%)	Standard Deviation (%) ⁴	Relative Standard Deviation (%)
GC/ECD						
Ground Water						
Chloropicrin	0.1	5	88-91	90	1	1
	1.0	5	85-89	88	2	2
Drinking Water						
Chloropicrin	0.1	5	88-97	94	4	4
	1.0	5	81-85	83	2	2
Surface Water						
Chloropicrin	0.1	5	73-77	75	1	2
	1.0	5	83-86	85	1	2
GC/MS (m/z 119)						
Ground Water						
Chloropicrin	0.1	5	71-76	74	2	3
	1.0	5	66-82	72	8	11
Drinking Water						
Chloropicrin	0.1	5	108-117	110	4	3
	1.0	5	61-89	79	11	14
Surface Water						
Chloropicrin	0.1	5	70-77	72	3	4
	1.0	5	73-84	79	5	6

Data (uncorrected recovery results, pp. 20-21) were obtained from Table 1, p. 27 of MRID 50167601.

* The ground water (PTRL ID 2706W-032; pH 7.3; 627 mg equiv. CaCO₃/L hardness; 960 ppm total dissolved solids) obtained from Northwood, North Dakota, drinking (tap) water (PTRL ID 2706W-072/054; pH 7.5; 30 mg equiv. CaCO₃/L hardness; 60 ppm total dissolved solids) obtained from Hercules, California, surface water (PTRL ID 2706W-069; pH 7.8; 1183 mg equiv. CaCO₃/L hardness; total dissolved solids not determined) obtained from Hercules, California, were used in the study (pp. 15-16). The water samples were provided by EAG-Hercules and previously characterized by Agvise Laboratories.

III. Method Characteristics

The LOQ for chloropicrin in water was 0.10 µg/L in the ECM and ILV (pp. 8, 12-13, 16 of MRID 49854401; pp. 12, 22; Tables 2-4, pp. 28-30 of MRID 50167601). In the ECM and ILV, the LOQ was defined as the lowest fortification level where an acceptable mean recovery is obtained. The LOD was reported as 0.05 µg/L (equivalent to 0.05 ng/mL) in the ECM; in ILV, the LOD was 0.004 µg/L for ground water and 0.01 µg/L for drinking and surface water. In the ILV, the LOD was calculated for each matrix using the following equation:

$$\text{LOD} = (t_{0.99} \times \text{SD})$$

Where, $t_{0.99}$ is the one-tailed t statistic for $n = 5$ (3.747) and SD is the standard deviation of the analyte recovery measurements at the target LOQ. No calculations or comparisons to background levels were reported to justify the LOQ for the method in the ECM or ILV; no calculations or comparisons to background levels were reported to justify the LOD for the method in the ECM.

Table 4. Method Characteristics

Analyte ¹		Chloropicrin	
		GC/ECD (Primary)	GC/MS (Confirmation)
Limit of Quantitation (LOQ)	ECM	0.10 µg/L	
	ILV		
Limit of Detection (LOD)	ECM	0.05 µg/L	
	ILV	0.004 µg/L (ground) 0.01 µg/L (drinking and surface)	
Linearity (calibration curve r^2 and concentration range)	ECM	$r^2 = 0.9990$ (0.5-100 ng/mL)	$r^2 = 0.9990$ (0.5-80 ng/mL)
	ILV	$r^2 = 0.9993$ (ground, drinking & surface)	$r^2 = 0.99503422$ (ground) $r^2 = 0.99202763$ (drinking) $r^2 = 0.99689992$ (surface)
		(0.5-100 ng/mL)	
Repeatable	ECM ¹	Yes at LOQ and 10×LOQ [characterized surface (lake) water matrix and uncharacterized drinking and ground water matrices]	
	ILV ^{2,3}	Yes at LOQ and 10×LOQ [characterized surface, drinking (tap), and ground water matrices]	
Reproducible		Yes at LOQ and 10×LOQ	
Specific	ECM	No matrix interferences were observed or quantified; however, chromatograms were very faint. Some non-interfering matrix contaminants were observed in the drinking water.	Matrix interferences appeared to be <10% of the LOQ peak (based on peak height); however, chromatograms were very difficult to interpret.
	ILV	Matrix interferences were <i>ca.</i> 7% of the LOQ (based on peak area) in drinking water. No matrix interferences were observed or quantified in ground and surface water.	No matrix interferences were observed or quantified.

Data were obtained from pp. 8, 12-13, 15-16 (specificity and LOQ/LOD); Tables 1-2, p. 18 (calibration data); Tables 3-8, pp. 19-24 (recovery data); Figures 3-14, pp. 27-32 (chromatograms) of MRID 49854401; pp. 12, 22; Tables 2-4, pp. 28-30 (LOQ/LOD); Table 1, p. 27 (recovery data); Figures 15-19, pp. 45-49 and Figure 32-34, pp. 62-64 (calibration data); Figures 2-14, pp. 32-44; Figures 20-31, pp. 50-61 (chromatograms) of MRID 50167601.

1 In the ECM, surface (lake) water (pH 7.7; 180 mg equiv. CaCO₃/L total hardness and alkalinity; 15.2 mg/L total organic carbon; 12.7 mg/L dissolved organic carbon) was collected from Diss Mere, Diss, Norfolk, and used in the study (p. 10 of MRID 49854401). The water sample was characterized in a separate study (not specified). The drinking water was obtained from a tap in the Residue Analysis Department, and the ground water was obtained from a source in the Huntingdon area by Anglian Water. The drinking and ground water were not characterized; the source of the ground water was not further specified.

2 In the ILV, the ground water (PTRL ID 2706W-032; pH 7.3; 627 mg equiv. CaCO₃/L hardness; 960 ppm total dissolved solids) obtained from Northwood, North Dakota, drinking (tap) water (PTRL ID 2706W-072/054; pH 7.5; 30 mg equiv. CaCO₃/L hardness; 60 ppm total dissolved solids) obtained from Hercules, California, surface water (PTRL ID 2706W-069; pH 7.8; 1183 mg equiv. CaCO₃/L hardness; total dissolved solids not determined) obtained from Hercules, California, were used in the study (pp. 15-16 of MRID 50167601). The water samples were provided by EAG-Hercules and previously characterized by Agvise Laboratories.

3 The method was validated in the second trial with two modifications to the sample processing procedure to increase analyte recovery: shortened extraction time (1 minute with inversion and vortexing) and use of a smaller vessel to reduce headspace (pp. 11, 16-17, 19-21, 25 of MRID 50167601). The first trial failed due to low recoveries; therefore, the ECM should be updated with the ILV modifications.

Linearity is satisfactory when $r^2 \geq 0.995$.

IV. Method Deficiencies and Reviewer's Comments

1. An updated ECM should be submitted with the ILV modifications. The ILV validated the method in the second trial with two modifications to the sample processing procedure to increase analyte recovery: shortened extraction time (1 minute with inversion and vortexing) and use of a smaller vessel to reduce headspace (pp. 11, 16-17, 19-21, 25 of MRID 50167601). The first trial failed due to low recoveries.
2. In ILV, the linearity was not satisfactory for the GC/MS analysis of chloropicrin in drinking water ($r^2 = 0.99202763$; Figures 15-19, pp. 45-49 of MRID 50167601).
3. The specificity of the method was not well-supported by the ECM representative chromatograms. GC/ECD chromatograms were very faint, and GC/MS chromatograms were very difficult to interpret due to poor resolution and the over-laying of the peak area on the analyte peak.
4. Two of the three ECM water matrices were not characterized: drinking and ground water matrices (p. 10 of MRID 49854401).
5. The estimations of LOQ and LOD in ECM and ILV were not based on scientifically acceptable procedures as defined in 40 CFR Part 136 (pp. 8, 12-13, 16 of MRID 49854401; pp. 12, 22; Tables 2-4, pp. 28-30 of MRID 50167601). In the ECM and ILV, the LOQ was defined as the lowest fortification level where an acceptable mean recovery is obtained. The LOD was reported as 0.05 $\mu\text{g/L}$ (equivalent to 0.05 ng/mL) in the ECM; in ILV, the LOD was 0.004 $\mu\text{g/L}$ for ground water and 0.01 $\mu\text{g/L}$ for drinking and surface water. In the ILV, the LOD was calculated for each matrix using the following equation: $\text{LOD} = (t_{0.99} \times \text{SD})$, where, $t_{0.99}$ is the one-tailed t statistic for $n = 5$ (3.747) and SD is the standard deviation of the analyte recovery measurements at the target LOQ. No calculations or comparisons to background levels were reported to justify the LOQ for the method in the ECM or ILV; no calculations or comparisons to background levels were reported to justify the LOD for the method in the ECM. Detection limits should not be based on arbitrary values.
6. In the ECM, the storage stability of the final sample extracts of chloropicrin was determined to be 3 days when stored at -18°C ($n = 2$; p. 16; Tables 3-8, pp. 19-24 of MRID 49854401).
7. The matrix effects were determined to be insignificant in the ECM (p. 16; Tables 3-8, pp. 19-24 of MRID 49854401).
8. The ILV study author reported that no communications between the ILV and ECM occurred (p. 25 of MRID 50167601).
9. It was reported for the ILV that one sample set (10 fortified samples, 2 matrix controls, 1 solvent control, and 1 reagent blank) required *ca.* 12 hours (p. 22 of MRID 50167601).

Preparation of standard solutions and samples each required *ca.* 4 hours. GC/ECD analysis/data processing and GC/MS analysis/data processing each required *ca.* 2 hours.

V. References

U.S. Environmental Protection Agency. 2012. Ecological Effects Test Guidelines, OCSPP 850.6100, Environmental Chemistry Methods and Associated Independent Laboratory Validation. Office of Chemical Safety and Pollution Prevention, Washington, DC. EPA 712-C-001.

40 CFR Part 136. Appendix B. Definition and Procedure for the Determination of the Method Detection Limit-Revision 1.11, pp. 317-319.

Attachment 1: Chemical Names and Structures**Chloropicrin**

IUPAC Name: Trichloronitromethane

CAS Name: Not reported

CAS Number: 76-06-2

SMILES String: Not found

