Final
09-03-2015

Provisional Peer-Reviewed Toxicity Values for

1,1-Dichloropropene
(CASRN 563-58-6)

Superfund Health Risk Technical Support Center
National Center for Environmental Assessment
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, OH 45268

AUTHORS, CONTRIBUTORS, AND REVIEWERS

CHEMICAL MANAGER

Dan D. Petersen, PhD, DABT
National Center for Environmental Assessment, Cincinnati, OH

DRAFT DOCUMENT PREPARED BY

National Center for Environmental Assessment, Cincinnati, OH

This document was externally peer reviewed under contract to

Eastern Research Group, Inc.
110 Hartwell Avenue
Lexington, MA 02421-3136

Questions regarding the contents of this document may be directed to the U.S. EPA Office of Research and Development's National Center for Environmental Assessment, Superfund Health Risk Technical Support Center (513-569-7300).

TABLE OF CONTENTS

COMMONLY USED ABBREVIATIONS AND ACRONYMS iv
BACKGROUND 1
DISCLAIMERS 1
QUESTIONS REGARDING PPRTVs 1
INTRODUCTION 2
REVIEW OF POTENTIALLY RELEVANT DATA (NONCANCER AND CANCER) 4
DERIVATION OF PROVISIONAL VALUES 5
DERIVATION OF ORAL REFERENCE DOSES 5
Feasibility of Deriving Subchronic and Chronic p-RfDs 5
DERIVATION OF INHALATION REFERENCE CONCENTRATIONS 5
Feasibility of Deriving Subchronic and Chronic p-RfCs 5
CANCER WEIGHT-OF-EVIDENCE (WOE) DESCRIPTOR 5
MODE-OF-ACTION (MOA) DISCUSSION 5
ALTERNATIVE METHODS 5
REFERENCES 7

COMMONLY USED ABBREVIATIONS AND ACRONYMS

α2u-g	alpha 2u-globulin
ACGIH	American Conference of Governmental Industrial Hygienists
AIC	Akaike's information criterion
ALD	approximate lethal dosage
ALT	alanine aminotransferase
AST	aspartate aminotransferase
atm	atmosphere
ATSDR	Agency for Toxic Substances and Disease Registry
BMD	benchmark dose
BMDL	benchmark dose lower confidence limit
BMDS	benchmark dose software
BMR	benchmark response
BUN	blood urea nitrogen
BW	body weight
CA	chromosomal aberration
CAS	chemical abstracts service
CASRN	chemical abstracts service registry number
CBI	covalent binding index
CHO	Chinese hamster ovary (cell line cells)
CL	confidence limit
CNS	central nervous system
CPN	chronic progressive nephropathy
CYP450	cytochrome P450
DAF	dosimetric adjustment factor
DEN	diethylnitrosamine
DMSO	dimethylsulfoxide
DNA	deoxyribonucleic acid
EPA	Environmental Protection Agency
FDA	Food and Drug Administration
FEV_1	forced expiratory volume of 1 second
GD	gestation day
GDH	glutamate dehydrogenase
GGT	γ-glutamyl transferase
GSH	glutathione
GST	glutathione-S-transferase
Hb/g-A	animal blood-gas partition coefficient
Hb/g-H	human blood-gas partition coefficient
HEC	human equivalent concentration
HED	human equivalent dose
i.p.	intraperitoneal
IRIS	Integrated Risk Information System
IVF	in vitro fertilization
LC_{50}	median lethal concentration
LD_{50}	median lethal dose
LOAEL	lowest-observed-adverse-effect level
MN	micronuclei
MNPCE	micronucleated polychromatic erythrocyte
MOA	mode of action
MTD	maximum tolerated dose
NAG	N-acetyl-β-D-glucosaminidase
NCEA	National Center for Environmental Assessment
NCI	National Cancer Institute
NOAEL	no-observed-adverse-effect level
NTP	National Toxicology Program
NZW	New Zealand white (rabbit breed)
OCT	ornithine carbamoyl transferase
ORD	Office of Research and Development
PBPK	physiologically based pharmacokinetic
PCNA	proliferating cell nuclear antigen
PND	postnatal day
POD	point of departure
POD_{ADJ}	duration-adjusted POD
QSAR	quantitative structure-activity relationship
RBC	red blood cell
RDS	replicative DNA synthesis
RfC	inhalation reference concentration
RfD	oral reference dose
RGDR	regional gas dose ratio
RNA	ribonucleic acid
SAR	structure activity relationship
SCE	sister chromatid exchange
SD	standard deviation
SDH	sorbitol dehydrogenase
SE	standard error
SGOT	glutamic oxaloacetic transaminase, also known as AST
SGPT	glutamic pyruvic transaminase, also known as ALT
SSD	systemic scleroderma
TCA	trichloroacetic acid
TCE	trichloroethylene
TWA	time-weighted average
UF	uncertainty factor
UF_A	interspecies uncertainty factor
UF_H	intraspecies uncertainty factor
UF_S	subchronic-to-chronic uncertainty factor
UF_D	database uncertainty factor
U.S.	United States of America
WBC	white blood cell

PROVISIONAL PEER-REVIEWED TOXICITY VALUES FOR 1,1-DICHLOROPROPENE (CASRN 563-58-6)

BACKGROUND

A Provisional Peer-Reviewed Toxicity Value (PPRTV) is defined as a toxicity value derived for use in the Superfund Program. PPRTVs are derived after a review of the relevant scientific literature using established Agency guidance on human health toxicity value derivations. All PPRTV assessments receive internal review by a standing panel of National Center for Environment Assessment (NCEA) scientists and an independent external peer review by three scientific experts.

The purpose of this document is to provide support for the hazard and dose-response assessment pertaining to chronic and subchronic exposures to substances of concern, to present the major conclusions reached in the hazard identification and derivation of the PPRTVs, and to characterize the overall confidence in these conclusions and toxicity values. It is not intended to be a comprehensive treatise on the chemical or toxicological nature of this substance.

The PPRTV review process provides needed toxicity values in a quick turnaround timeframe while maintaining scientific quality. PPRTV assessments are updated approximately on a 5-year cycle for new data or methodologies that might impact the toxicity values or characterization of potential for adverse human health effects and are revised as appropriate. It is important to utilize the PPRTV database (http://hhpprtv.ornl.gov) to obtain the current information available. When a final Integrated Risk Information System (IRIS) assessment is made publicly available on the Internet (http://www.epa.gov/iris), the respective PPRTVs are removed from the database.

DISCLAIMERS

The PPRTV document provides toxicity values and information about the adverse effects of the chemical and the evidence on which the value is based, including the strengths and limitations of the data. All users are advised to review the information provided in this document to ensure that the PPRTV used is appropriate for the types of exposures and circumstances at the site in question and the risk management decision that would be supported by the risk assessment.

Other U.S. Environmental Protection Agency (EPA) programs or external parties who may choose to use PPRTVs are advised that Superfund resources will not generally be used to respond to challenges, if any, of PPRTVs used in a context outside of the Superfund program.

This document has been reviewed in accordance with U.S. EPA policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

QUESTIONS REGARDING PPRTVs

Questions regarding the contents and appropriate use of this PPRTV assessment should be directed to the EPA Office of Research and Development's National Center for Environmental Assessment, Superfund Health Risk Technical Support Center (513-569-7300).

INTRODUCTION

1,1-Dichloropropene (1,1-DCPe) (CASRN 563-58-6) is an industrial chemical found at some Superfund sites. No repeat-dose studies are available in the scientific literature on which to base a hazard identification or a dose-response evaluation for the derivation of toxicity values. The related compound 1,3-dichloropropene is used as a pesticide, while the other four dichloropropenes have no reported uses and are present in lower concentrations (ATSDR, 2008). 1,1-DCPe is on the Tox 21 list [10,000 chemicals, U.S. EPA (2015b)] currently undergoing in vitro toxicity testing. The molecular formula of 1,1-DCPe is $C_3H_4Cl_2$ (see Figure 1). A list of physicochemical properties is provided in Table 1.

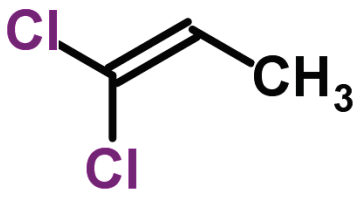

Figure 1. 1,1-Dichloropropene Structure

Table 1. Physicochemical Properties of 1,1-Dichloropropene (CASRN 563-58-6)[a]

Property (unit)	Value
Boiling point (°C)	76.5
Melting point (°C)	ND
Density (g/cm^3 at 20°C)	ND
Vapor pressure (mmHg at 20°C)	90.8
pH (unitless)	ND
Solubility in water (mg/L at 25°C)	749
Relative vapor density (air = 1)	ND
Molecular weight (g/mol)	110.97

[a]ChemIDplus (2015).

ND = no data.

Table 2 provides a summary of available toxicity values for 1,1-DCPe (CASRN 563-58-6) from U.S. EPA and other regulatory agencies or organizations.

Table 2. Summary of Available Toxicity Values for 1,1-Dichloropropene (CASRN 563-58-6)

Source/Parameter[a,b]	Value (applicability)	Reference
Noncancer		
ACGIH	NV	ACGIH (2015)
ATSDR	NV	ATSDR (2015)
Cal/EPA	NV	Cal/EPA (2015b); Cal/EPA (2014)
NIOSH	NV	NIOSH (2015)
OSHA	NV	OSHA (2011); OSHA (2006)
IRIS	NV	U.S. EPA (2015a)
DWSHA	NV	U.S. EPA (2012)
HEAST	NV	U.S. EPA (2011)
CARA HEEP	NV	U.S. EPA (1994)
WHO	NV	WHO (2015)
Cancer		
IRIS	NV	U.S. EPA (2015a)
HEAST/WOE	NV	U.S. EPA (2011)
IARC	NV	IARC (2015)
NTP	NV	NTP (2014)
Cal/EPA	NV	Cal/EPA (2015a); Cal/EPA (2011)

[a]Sources: ACGIH = American Conference of Governmental Industrial Hygienists; ATSDR = Agency for Toxic Substances and Disease Registry; Cal/EPA = California Environmental Protection Agency; CARA = Chemical Assessments and Related Activities; DWSHA = Drinking Water Standards and Health Advisories; HEAST = Health Effects Assessment Summary Tables; HEEP = Health and Environmental Effects Profile; IARC = International Agency for Research on Cancer; IRIS = Integrated Risk Information Systems; NIOSH = National Institute for Occupational Safety and Health; NTP = National Toxicology Program; OSHA = Occupational Safety and Health Administration; WHO = World Health Organization.
[b]Parameters: WOE = cancer weight of evidence (U.S. EPA, 1986).

NV = not available.

Literature searches were conducted on sources published from 1900 through April 2015 for studies relevant to the derivation of provisional toxicity values for 1,1-DCPe (CASRN 563-58-6). Searches were conducted using U.S. EPA's Health and Environmental Research Online (HERO) database of scientific literature. HERO searches the following databases: AGRICOLA; American Chemical Society; BioOne; Cochrane Library; DOE: Energy Information Administration, Information Bridge, and Energy Citations Database; EBSCO: Academic Search Complete; GeoRef Preview; GPO: Government Printing Office; Informaworld; IngentaConnect; J-STAGE: Japan Science & Technology; JSTOR: Mathematics & Statistics and Life Sciences; NSCEP/NEPIS (EPA publications available through the National Service Center for Environmental Publications [NSCEP] and National Environmental Publications Internet Site [NEPIS] database); PubMed: MEDLINE and CANCERLIT databases; SAGE; Science Direct; Scirus; Scitopia; SpringerLink; TOXNET

(Toxicology Data Network): ANEUPL, CCRIS, ChemIDplus, CIS, CRISP, DART, EMIC, EPIDEM, ETICBACK, FEDRIP, GENE-TOX, HAPAB, HEEP, HMTC, HSDB, IRIS, ITER, LactMed, Multi-Database Search, NIOSH, NTIS, PESTAB, PPBIB, RISKLINE, TRI; and TSCATS; Virtual Health Library; Web of Science (searches Current Content database among others); World Health Organization; and Worldwide Science. The following databases outside of HERO were searched for toxicity values: ACGIH, ATSDR, Cal/EPA, U.S. EPA IRIS, U.S. EPA HEAST, U.S. EPA HEEP, U.S. EPA OW, U.S. EPA TSCATS/TSCATS2, NIOSH, NTP, OSHA, and RTECS.

REVIEW OF POTENTIALLY RELEVANT DATA (NONCANCER AND CANCER)

The available data on 1,1-DCPe (CASRN 563-58-6) primarily focuses on its biodegradation, biotransformation by soil organisms, and use in the development of analytical methods. 1,1-DCPe is a contaminant in some drinking water sources. Because of this and the fact that no toxicological data were available for this compound, which is structurally similar to the rodent carcinogen 1,3-dichloropropene (1,3-DCPe), 1,1-DCPe was placed on the EPA's Contaminant Candidate List. No information is available on repeated-dose oral or inhalation exposure of humans or animals to 1,1-DCPe. A genetic toxicology study was conducted in several *Salmonella* strains (Granville et al., 2005). The study evaluated mutagenicity using the *Salmonella* assay, the deoxyribonucleic acid (DNA) damage (comet assay), and the apoptotic (caspase assay) activities in human lymphoblastoid cells. In *Salmonella,* 1,1-DCPe was not mutagenic in strains TA98, TA100, TA1535, or TA104 ±S9 mix. However, it was clearly mutagenic in strain RSJ100, which expresses the rat GSTT1-1 gene. 1,1-DCPe did not induce DNA damage in GSTT1-1-deficient human lymphoblastoid cells, and it induced apoptosis in these cells only at 5 mM. Consistent with its mutagenesis in RSJ100, 1,1-DCPe reacted with glutathione (GSH) in vitro, suggesting an addition-elimination mechanism to account for the detected GSH conjugate. 1,1-DCPe was approximately 5,000 times more mutagenic than 1,1-dichloroethylene (1,1-DCE). Neither 1,1-DCE nor 1,3-DCPe showed enhanced mutagenicity in strain RSJ100, indicating a lack of activation of these congeners by GSTT1-1. Thus, 1,1-DCPe appears to be a base-substitution mutagen, requiring activation by GSTT1-1, and possibly involving the production of a reactive episulfonium ion. This bioactivation mechanism of 1,1-DCPe is thus different from that of its congeners 1,1-DCE and 1,3-DCPe. 1,1-DCPe also has caused genotoxicity in fish (Winn et al., 2006). It is being tested as part of Tox 21, and is in the NTP 1408 compound library. However, following EPA guidance, the available mechanistic studies do not provide endpoints that are currently usable for identifying a point of departure (POD).

DERIVATION OF PROVISIONAL VALUES

DERIVATION OF ORAL REFERENCE DOSES

Feasibility of Deriving Subchronic and Chronic p-RfDs

No subchronic-duration, chronic-duration, developmental toxicity, reproductive toxicity, or carcinogenicity studies on 1,1-dichloropropene via the oral route were identified. Thus, no oral reference doses (RfDs) could be derived. However, as noted below, a computational toxicological surrogate approach was attempted.

DERIVATION OF INHALATION REFERENCE CONCENTRATIONS

Feasibility of Deriving Subchronic and Chronic p-RfCs

No subchronic-duration, chronic-duration, developmental toxicity, reproductive toxicity, or carcinogenicity studies on 1,1-dichloropropene via the inhalation route were identified. Thus, no inhalation reference doses (RfCs) could be derived. However, as noted below, a computational toxicological surrogate approach was attempted.

CANCER WEIGHT-OF-EVIDENCE (WOE) DESCRIPTOR

Limitations in the available data preclude development of a weight-of-evidence (WOE) descriptor.

MODE-OF-ACTION (MOA) DISCUSSION

Limitations in the available data preclude determination of a mode-of-action (MOA) discussion.

ALTERNATIVE METHODS

The surrogate approach allows for the use of data from related compounds to calculate screening values when data for the compound of interest are limited or unavailable. Details regarding searches and methods for surrogate analysis are presented in Wang et al. (2012). Three types of potential surrogates (structural, metabolic, and toxicity) are identified to facilitate the final surrogate chemical selection. The surrogate approach may or may not be route-specific or applicable to multiple routes of exposure. All information was considered together as part of the final weight-of-evidence (WOE) approach to select the most suitable surrogate both toxicologically and chemically.

An initial surrogate search focused on the identification of structurally similar chemicals with toxicity values from the Integrated Risk Information System (IRIS), PPRTV, and Health Effects Assessment Summary Tables (HEAST) databases to take advantage of the well-characterized chemical-class information. This was accomplished by searching the US EPA's DSSTox database (DSSTox, 2012) at similarity levels >60%, and the National Library of Medicine's ChemIDplus database (ChemIDplus, 2015) at similarity levels >70%. Both ChemIDplus (which uses 3D QSAR models) and DSSTox (which uses 2D QSAR models) identified an overlapping list of analogs (see Table 3).

Table 3. Structural Analogues for 1,1-Dichloropropene		
Chemical Name	**Structural Similarity**	**Information Source**
1-Bromo-1-chloropropene	90%	ChemIDplus (2015)
1,1-Dibromopropene	88%	
1,1-Dichlorobutene	87%	
Trichloroethylene	80%	
1,1,2-Trichloropropene	77%	
1,2-Dichloro-1-flouroethylene	76%	
2-Bromo-1,1-dichloroethylene	75%	
1,1-Dichloroethylene	74%	
1-Chloropropene	80%	DSSTox (2012)
1,1-DCE	70%	
Dimethylvinyl chloride	67%	
Tetrachloroethylene	64%	
Trichloroethylene	64%	
1,3-Dichloropropene	62%	

While there was in vivo repeat-dose information on some of these closely related compounds, including 1,1-DCE, 1,3-DCPe, tetrachloroethylene, and trichloroethylene, there was no data on the parent compound 1,1-DCPe to match health effects. The structurally closely related chemicals' toxicity profiles also showed no consistent pattern of target organ toxicity, as shown in Table 4. Due to a lack of matching repeat-dose toxicity information for any of the potential structural surrogates, derivation of risk values (e.g., RfD, RfC, and oral cancer slope factor [OSF]) based on the computational toxicological surrogate approach Wang et al. (2012) is not feasible for 1-DCPe.

Table 4: The Target Organs and RfD of Potential Surrogates		
Potential Surrogate Chemical	**Target Organ**	**RfD**
Trichloroethylene	Immune system	5×10^{-4} mg/kg-d
Tetrachloroethylene	Nervous system	6×10^{-3} mg/kg-d
1,1-DCE	Liver	5×10^{-2} mg/kg-d
1,3-DCPe	Nasal respiratory epithelium chronic irritant	3×10^{-2} mg/kg-d

REFERENCES

ACGIH (American Conference of Governmental Industrial Hygienists). (2015). 2015 TLVs and BEIs. Based on documentation of the threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH. http://www.acgih.org/forms/store/ProductFormPublic/2015-tlvs-and-beis

ATSDR (Agency for Toxic Substances and Disease Registry). (2008). Toxicological profile for dichloropropenes. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, ATSDR. http://www.atsdr.cdc.gov/toxprofiles/tp40.pdf

ATSDR (Agency for Toxic Substances and Disease Registry). (2015). Minimal risk levels (MRLs) for hazardous substances. Atlanta, GA: Agency for Toxic Substances and Disease Registry (ATSDR). Retrieved from http://www.atsdr.cdc.gov/mrls/index.asp

Cal/EPA (California Environmental Protection Agency). (2011). Hot spots unit risk and cancer potency values. Appendix A. Sacramento, CA: Office of Environmental Health Hazard Assessment. http://www.oehha.ca.gov/air/hot_spots/2009/AppendixA.pdf

Cal/EPA (California Environmental Protection Agency). (2014). All OEHHA acute, 8-hour and chronic reference exposure levels (chRELs) as of June 2014. Sacramento, CA: Office of Health Hazard Assessment. http://www.oehha.ca.gov/air/allrels.html

Cal/EPA (California Environmental Protection Agency). (2015a). Current proposition 65 list (6/19/15). Sacramento, CA: Office of Health Hazard Assessment. http://oehha.ca.gov/prop65/prop65_list/Newlist.html

Cal/EPA (California Environmental Protection Agency). (2015b). OEHHA toxicity criteria database [Database]. Sacramento, CA: Office of Environmental Health Hazard Assessment. Retrieved from http://www.oehha.ca.gov/tcdb/index.asp

ChemIDplus. (2015). 1,1-Dichloropropene. Bethesda, MD: U.S. Department of Health and Human Services, National Library of Medicine. Retrieved from http://chem.sis.nlm.nih.gov/chemidplus/name/1%2C1-dichloropropene

DSSTox (Distributed Structure-Searchable Toxicity). (2012). DSSTox database [Database]. Research Triangle Park, NC: U.S. Environmental Protection Agency, National Center for Computational Toxicology. Retrieved from http://www.epa.gov/ncct/dsstox/

Granville, CA; Ross, MK; Tornero-Velez, R; Hanley, NM; Grindstaff, RD; Gold, A; Richard, AM; Funasaka, K; Tennant, AH; Kligerman, AD; Evans, MV; Demarini, DM. (2005). Genotoxicity and metabolism of the source-water contaminant 1,1-dichloropropene: activation by GSTT1-1 and structure-activity considerations. Mutat Res 572: 98-112. http://dx.doi.org/10.1016/j.mrfmmm.2004.12.009

IARC (International Agency for Research on Cancer). (2015). IARC Monographs on the evaluation of carcinogenic risk to humans. Available online at http://monographs.iarc.fr/ENG/Monographs/PDFs/index.php

NIOSH (National Institute for Occupational Safety and Health). (2015). NIOSH pocket guide to chemical hazards. Index of chemical abstracts service registry numbers (CAS No.). Atlanta, GA: Center for Disease Control and Prevention, U.S. Department of Health, Education and Welfare. http://www.cdc.gov/niosh/npg/npgdcas.html

NTP (National Toxicology Program). (2014). Report on carcinogens. Thirteenth edition. Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service. http://ntp.niehs.nih.gov/pubhealth/roc/roc13/index.html

OSHA (Occupational Safety & Health Administration). (2006). Table Z-1 limits for air contaminants. Occupational safety and health standards, subpart Z, toxic and hazardous substances. (OSHA standard 1910.1000). Washington, DC: U.S. Department of Labor. http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992

OSHA (Occupational Safety & Health Administration). (2011). Air contaminants: occupational safety and health standards for shipyard employment, subpart Z, toxic and hazardous substances. (OSHA Standard 1915.1000). Washington, DC: U.S. Department of Labor. http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10286

U.S. EPA (U.S. Environmental Protection Agency). (1986). Guidelines for carcinogen risk assessment [EPA Report]. (EPA/630/R-00/004). Washington, DC: U.S. Environmental Protection Agency, Risk Assessment Forum. http://epa.gov/raf/publications/pdfs/CA%20GUIDELINES_1986.PDF

U.S. EPA (U.S. Environmental Protection Agency). (1994). Chemical assessments and related activities (CARA) [EPA Report]. (600/R-94/904; OHEA-I-127). Washington, DC: U.S. Environmental Protection Agency, Office of Health and Environmental Assessment. http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=60001G8L.txt

U.S. EPA (U.S. Environmental Protection Agency). (2011). Health effects assessment summary tables (HEAST). Washington, DC: U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. http://epa-heast.ornl.gov/

U.S. EPA (U.S. Environmental Protection Agency). (2012). 2012 Edition of the drinking water standards and health advisories [EPA Report]. (EPA/822/S-12/001). Washington, DC: Office of Water. http://water.epa.gov/action/advisories/drinking/upload/dwstandards2012.pdf

U.S. EPA (U.S. Environmental Protection Agency). (2015a). Integrated risk information system (IRIS) [Database]. Washington, DC: U.S. Environmental Protection Agency, Integrated Risk Information System. Retrieved from http://www.epa.gov/iris/

U.S. EPA (U.S. Environmental Protection Agency). (2015b). Tox21. Computational toxicology research. Washington, DC: Office of Science and Technology. http://www.epa.gov/ncct/Tox21/

Wang, CNY; Zhao, QJ; Wesselkamper, SC; Lambert, JC; Peterson, D; Hess-Wilson, JK. (2012). Application of computational toxicological tools and approaches in human health risk assessment. I. A tiered surrogate approach. Regul Toxicol Pharmacol 63: 10-19.

WHO (World Health Organization). (2015). Online catalog for the Environmental Health Criteria (EHC) monographs. Geneva, Switzerland: World Health Organization (WHO). http://www.who.int/ipcs/publications/ehc/en/

Winn, RN; Norris, MB; Lothenbach, D; Flynn, K; Hammermeister, D; Whiteman, F; Sheedy, B; Johnson, R. (2006). Sub-chronic exposure to 1,1-dichloropropene induces frameshift mutations in lambda transgenic medaka. Mutat Res 595: 52-59. http://dx.doi.org/10.1016/j.mrfmmm.2005.10.009