IDLH

IMMEDIATELY DANGEROUS to LIFE or HEALTH

VALUE PROFILE

1,1-Dichloro-1-Fluoroethane (HCFC-141b)
CAS® No. 1717-00-6

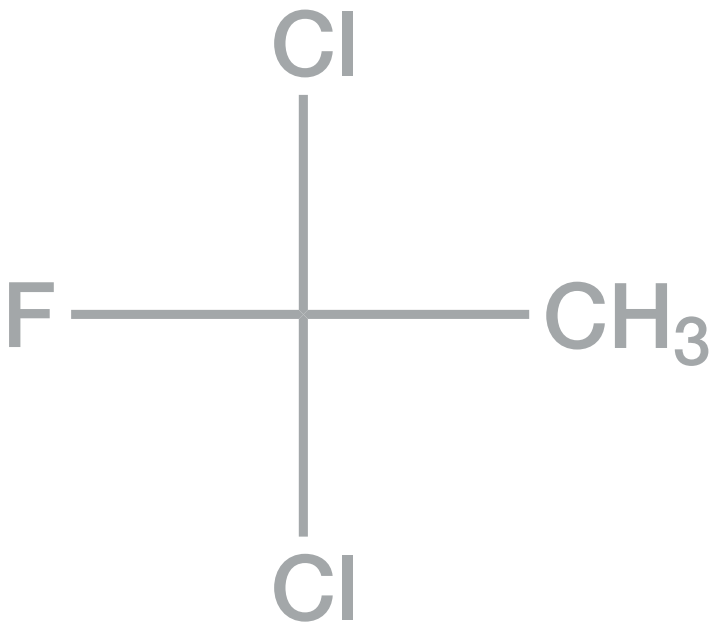
DEPARTMENT OF HEALTH AND HUMAN SERVICES
Center for Disease Control and Prevention
National Institute of Occupational Safety and Health

This page intentionally left blank.

Immediately Dangerous to Life or Health (IDLH) Value Profile

1,1-Dichloro-1-fluoroethane (HCFC-141b)

[CAS® No. 1717-00-6]



DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

Disclaimer

Mention of any company or product does not constitute endorsement by the National Institute for Occupational Safety and Health (NIOSH). In addition, citations of websites external to NIOSH do not constitute NIOSH endorsement of the sponsoring organizations or their programs or products. Furthermore, NIOSH is not responsible for the content of these websites.

Ordering Information

This document is in the public domain and may be freely copied or reprinted. To receive NIOSH documents or other information about occupational safety and health topics, contact NIOSH at

Telephone: 1-800-CDC-INFO (1-800-232-4636)
TTY: 1-888-232-6348
E-mail: cdcinfo@cdc.gov

or visit the NIOSH website at www.cdc.gov/niosh.

For a monthly update on news at NIOSH, subscribe to *NIOSH eNews* by visiting www.cdc.gov/niosh/eNews.

Suggested Citation

NIOSH [2016]. Immediately dangerous to life or health (IDLH) value profile: 1,1-dichloro-1-fluoroethane (HCFC-141b). By Dotson GS, Maier A, Parker A, Haber L. Cincinnati, OH: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 2016-168.

DHHS (NIOSH) Publication No. 2016-168

September 2016

Foreword

Chemicals are a ubiquitous component of the modern workplace. Occupational exposures to chemicals have the potential to adversely affect the health and lives of workers. Acute or short-term exposures to high concentrations of some airborne chemicals have the ability to quickly overwhelm workers, resulting in a spectrum of undesirable health outcomes that may inhibit the ability to escape from the exposure environment (e.g., irritation of the eyes and respiratory tract or cognitive impairment), cause severe irreversible effects (e.g., damage to the respiratory tract or reproductive toxicity), and in extreme cases, cause death. Airborne concentrations of chemicals capable of causing such adverse health effects or of impeding escape from high-risk conditions may arise from a variety of nonroutine workplace situations, including special work procedures (e.g., in confined spaces), industrial accidents (e.g., chemical spills or explosions), and chemical releases into the community (e.g., during transportation incidents or other uncontrolled-release scenarios).

The immediately dangerous to life or health (IDLH) air concentration values developed by the National Institute for Occupational Safety and Health (NIOSH) characterize these high-risk exposure concentrations and conditions [NIOSH 2013]. IDLH values are based on a 30-minute exposure duration and have traditionally served as a key component of the decision logic for the selection of respiratory protection devices [NIOSH 2004]. Occupational health professionals have employed these values beyond their initial purpose as a component of the NIOSH Respirator Selection Logic to assist in developing risk management plans for nonroutine work practices governing operations in high-risk environments (e.g., confined spaces) and the development of emergency preparedness plans.

The approach used to derive IDLH values for high-priority chemicals is outlined in the *NIOSH Current Intelligence Bulletin (CIB) 66: Derivation of Immediately Dangerous to Life or Health Values* [NIOSH 2013]. CIB 66 provides (1) an update on the scientific basis and risk assessment methodology used to derive IDLH values, (2) the rationale and derivation process for IDLH values, and (3) a demonstration of the derivation of scientifically credible IDLH values, using available data resources.

The purpose of this technical report is to present the IDLH value for 1,1-dichloro-1-fluoroethane (HCFC-141b; CAS® #1717-00-6). The scientific basis, toxicologic data, and risk assessment approach used to derive the IDLH value are summarized to ensure transparency and scientific credibility.

John Howard, M.D.
Director
National Institute for Occupational
Safety and Health
Centers for Disease Control and Prevention

This page intentionally left blank.

Contents

Abbreviations

ACGIH®	American Conference of Governmental Industrial Hygienists
AEGLs	Acute Exposure Guideline Levels
AIHA®	American Industrial Hygiene Association
BMC	benchmark concentration
BMD	benchmark dose
BMCL	benchmark concentration lower confidence limit
C	ceiling value
°C	degrees Celsius
CAS®	Chemical Abstracts Service, a division of the American Chemical Society
ERPGs™	Emergency Response Planning Guidelines
°F	degrees Fahrenheit
HCFC-141b	1,1-dichloro-1-fluoroethane
IDLH	immediately dangerous to life or health
LC_{50}	median lethal concentration
LC_{LO}	lowest concentration that caused death in humans or animals
LEL	lower explosive limit
LOAEL	lowest observed adverse effect level
mg/m^3	milligram(s) per cubic meter
min	minutes
mmHg	millimeter(s) of mercury
NAC	National Advisory Committee
NAS	National Academy of Sciences
NIOSH	National Institute for Occupational Safety and Health
NOAEL	no observed adverse effect level
NOEL	no observed effect level
OSHA	Occupational Safety and Health Administration
PEL	permissible exposure limit
ppm	parts per million
RD_{50}	concentration of a chemical in the air that is estimated to cause a 50% decrease in the respiratory rate
REL	recommended exposure limit
SCP	Standards Completion Program (joint effort of NIOSH and OSHA)
STEL	short-term exposure limit
TLV®	Threshold Limit Value
TWA	time-weighted average
UEL	upper explosive limit
WEELs®	Workplace Environmental Exposure Levels
µg/kg	microgram(s) per kilogram of body weight

Glossary

Acute exposure: Exposure by the oral, dermal, or inhalation route for 24 hours or less.

Acute Exposure Guideline Levels (AEGLs): Threshold exposure limits for the general public, applicable to emergency exposure periods ranging from 10 minutes to 8 hours. AEGL-1, AEGL 2, and AEGL-3 are developed for five exposure periods (10 and 30 minutes, 1 hour, 4 hours, and 8 hours) and are distinguished by varying degrees of severity of toxic effects, ranging from transient, reversible effects to life-threatening effects [NAS 2001]. AEGLs are intended to be guideline levels used during rare events or single once-in-a-lifetime exposures to airborne concentrations of acutely toxic, high-priority chemicals [NAS 2001]. The threshold exposure limits are designed to protect the general population, including the elderly, children, and other potentially sensitive groups that are generally not considered in the development of workplace exposure recommendations (additional information available at http://www.epa.gov/oppt/aegl/).

Acute reference concentration (Acute RfC): An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure for an acute duration (24 hours or less) of the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. It can be derived from a NOAEL, LOAEL, or benchmark concentration, with uncertainty factors (UFs) generally applied to reflect limitations of the data used. Generally used in U.S. EPA noncancer health assessments [U.S. EPA 2016].

Acute toxicity: Any poisonous effect produced within a short period of time following an exposure, usually 24 to 96 hours [U.S. EPA 2016].

Adverse effect: A substance-related biochemical change, functional impairment, or pathologic lesion that affects the performance of an organ or system or alters the ability to respond to additional environmental challenges.

Benchmark dose/concentration (BMD/BMC): A dose or concentration that produces a predetermined change in response rate of an effect (called the benchmark response, or BMR) compared to background [U.S. EPA 2016] (additional information available at http://www.epa.gov/ncea/bmds/).

Benchmark response (BMR): A predetermined change in response rate of an effect. Common defaults for the BMR are 10% or 5%, reflecting study design, data variability, and sensitivity limits used.

BMCL: A statistical lower confidence limit on the concentration at the BMC [U.S. EPA 2016].

Bolus exposure: A single, relatively large dose.

Ceiling value ("C"): U.S. term in occupational exposure indicating the airborne concentration of a potentially toxic substance that should never be exceeded in a worker's breathing zone.

Chronic exposure: Repeated exposure for an extended period of time. Typically exposures are more than approximately 10% of life span for humans and >90 days to 2 years for laboratory species.

Critical study: The study that contributes most significantly to the qualitative and quantita¬tive assessment of risk [U.S. EPA 2016].

Dose: The amount of a substance available for interactions with metabolic processes or biologically significant receptors after crossing the outer boundary of an organism [U.S. EPA 2016].

ECt_{50}: A combination of the effective concentration of a substance in the air and the exposure duration that is predicted to cause an effect in 50% (one half) of the experimental test subjects.

Emergency Response Planning Guidelines (ERPGs™): Maximum airborne concentra¬tions below which nearly all individuals can be exposed without experiencing health ef¬fects for 1-hour exposure. ERPGs are presented in a tiered fashion, with health effects ranging from mild or transient to serious, irreversible, or life threatening (depending on the tier). ERPGs are developed by the American Industrial Hygiene Association [AIHA 2006].

Endpoint: An observable or measurable biological event or sign of toxicity, ranging from biomarkers of initial response to gross manifestations of clinical toxicity.

Exposure: Contact made between a chemical, physical, or biological agent and the outer boundary of an organism. Exposure is quantified as the amount of an agent available at the exchange boundaries of the organism (e.g., skin, lungs, gut).

Extrapolation: An estimate of the response at a point outside the range of the experimental data, generally through the use of a mathematical model, although qualitative extrapolation may also be conducted. The model may then be used to extrapolate to response levels that cannot be directly observed.

Hazard: A potential source of harm. Hazard is distinguished from risk, which is the probability of harm under specific exposure conditions.

Immediately dangerous to life or health (IDLH) condition: A condition that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment [NIOSH 2004, 2013].

IDLH value: A maximum (airborne concentration) level above which only a highly reliable breathing apparatus providing maximum worker protection is permitted [NIOSH 2004, 2013]. IDLH values are based on a 30-minute exposure duration.

LC_{01}: The statistically determined concentration of a substance in the air that is estimated to cause death in 1% of the test animals.

LC_{50}: The statistically determined concentration of a substance in the air that is estimated to cause death in 50% (one half) of the test animals; median lethal concentration.

LC_{LO}: The lowest lethal concentration of a substance in the air reported to cause death, usually for a small percentage of the test animals.

LD_{50}: The statistically determined lethal dose of a substance that is estimated to cause death in 50% (one half) of the test animals; median lethal concentration.

LD_{LO}: The lowest dose of a substance that causes death, usually for a small percentage of the test animals.

LEL: The minimum concentration of a gas or vapor in air, below which propagation of a flame does not occur in the presence of an ignition source.

Lethality: Pertaining to or causing death; fatal; referring to the deaths resulting from acute toxicity studies. May also be used in lethality threshold to describe the point of sufficient substance concentration to begin to cause death.

Lowest observed adverse effect level (LOAEL): The lowest tested dose or concentration of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Mode of action: The sequence of significant events and processes that describes how a substance causes a toxic outcome. By contrast, the term mechanism of action implies a more detailed understanding on a molecular level.

No observed adverse effect level (NOAEL): The highest tested dose or concentration of a substance that has been reported to cause no harmful (adverse) health effects in people or animals.

Occupational exposure limit (OEL): Workplace exposure recommendations developed by governmental agencies and nongovernmental organizations. OELs are intended to represent the maximum airborne concentrations of a chemical substance below which workplace exposures should not cause adverse health effects. OELs may apply to ceiling limits, STELs, or TWA limits.

Peak concentration: Highest concentration of a substance recorded during a certain period of observation.

Permissible exposure limits (PELs): Occupational exposure limits developed by OSHA (29 CFR 1910.1000) or MSHA (30 CFR 57.5001) for allowable occupational airborne exposure concentrations. PELs are legally enforceable and may be designated as ceiling limits, STELs, or TWA limits.

Point of departure (POD): The point on the dose–response curve from which dose extrapolation is initiated. This point can be the lower bound on dose for an estimated incidence or a change in response level from a concentration-response model (BMC), or it can be a NOAEL or LOAEL for an observed effect selected from a dose evaluated in a health effects or toxicology study.

RD_{50}: The statistically determined concentration of a substance in the air that is estimated to cause a 50% (one half) decrease in the respiratory rate.

Recommended exposure limit (REL): Recommended maximum exposure limit to prevent adverse health effects, based on human and animal studies and established for occupational (up to 10-hour shift, 40-hour week) inhalation exposure by NIOSH. RELs may be designated as ceiling limits, STELs, or TWA limits.

Short-term exposure limit (STEL): A worker's 15-minute time-weighted average exposure concentration that shall not be exceeded at any time during a work day.

Target organ: Organ in which the toxic injury manifests in terms of dysfunction or overt disease.

Threshold Limit Values (TLVs®): Recommended guidelines for occupational exposure to airborne contaminants, published by the American Conference of Governmental Industrial Hygienists (ACGIH®). TLVs refer to airborne concentrations of chemical substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed, day after day, over a working lifetime, without adverse effects. TLVs may be designated as ceiling limits, STELs, or 8-hr TWA limits.

Time-weighted average (TWA): A worker's 8-hour (or up to 10-hour) time-weighted average exposure concentration that shall not be exceeded during an 8-hour (or up to 10-hour) work shift of a 40-hour week. The average concentration is weighted to take into account the duration of different exposure concentrations.

Toxicity: The degree to which a substance is able to cause an adverse effect on an exposed organism.

Uncertainty factors (UFs): Mathematical adjustments applied to the POD when developing IDLH values. The UFs for IDLH value derivation are determined by considering the study and effect used for the POD, with further modification based on the overall database.

Workplace Environmental Exposure Levels (WEELs®): Exposure levels developed by the American Industrial Hygiene Association (AIHA®) that provide guidance for protecting most workers from adverse health effects related to occupational chemical exposures, expressed as TWA or ceiling limits.

Acknowledgments

This document was developed by the Education and Information Division (Paul Schulte, Ph.D., Director). G. Scott Dotson, Ph.D., was the project officer and lead NIOSH author. The basis for this document was a report contracted by NIOSH and prepared by Andrew Maier, Ph.D., Ann Parker, and Lynn Haber, Ph.D. (Toxicology Excellence for Risk Assessment [TERA]).

The following NIOSH staff are acknowledged for providing technical and editorial review of the report:

Education and Information Division

Devin Baker, M.Ed.
Charles L. Geraci, Ph.D.
Thomas J. Lentz, Ph.D.
Richard W. Niemeier, Ph.D. (retired)
Chris Whittaker, Ph.D.

NIOSH Office of the Director

John Decker, M.S., R.Ph.

NIOSH acknowledges the following subject matter experts for their critical technical reviews:

Jeremy Brower, Ph.D., Associate Research Scientist, Lovelace Respiratory Research Institute, Albuquerque, NM

Mary E. Davis, Ph.D., Professor, Pharmacology and Toxicology, Robert C. Byrd Health Sciences Center School of Medicine, West Virginia University, Morgantown, WV

Mary A. Fox, Ph.D., Assistant Professor, Co-Director, Risk Sciences and Public Policy Institute, Department of Health Policy and Management, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD

Randal J. Keller, Ph.D., C.I.H, D.A.B.T., Professor, Department of Occupational Safety and Health, Jesse D. Jones College of Science, Engineering, and Technology, Murray State University, Murray, KY

Mattias U. L. Öberg, Ph.D., Associate Professor, Institute of Environmental Medicine, Division of Work Environment Toxicology, Director of Risk Assessment, Swedish Toxicology Research Center (Swetox), Södertälje, Sweden

Richard B. Schlesinger, Ph.D., Fellow A.T.S., Senior Associate Dean for Academic Affairs and Research, Professor of Biology, Dyson College of Arts and Sciences, Pace University, New York, NY

This page intentionally left blank.

1 Introduction

1.1 Overview of the IDLH Value for 1,1-Dichloro-1-fluoroethane (HCFC-141b)

IDLH value: 1,700 ppm (8,245 mg/m^3)

Basis for IDLH value: Cardiac sensitization is the most sensitive indicator of toxicity and of a potentially lethal and irreversible health endpoint to serve as the basis for the IDLH value for 1,1-dichloro-1-fluoroethane (HFCF-141b). This effect was reported in monkeys exposed to 5,000 ppm for 10 minutes [Hardy et al. 1989] and in a dog exposed to 5,200 ppm for 10 minutes [Mullin 1977]. These values represent lowest observed adverse effect levels (LOAELs) associated with severe, potentially irreversible effects. No time-scaling factor was applied, based on data that the threshold for this effect is constant for durations longer than 5 to 10 minutes. Using the concentration of 5,000 ppm reported in Hardy et al. [1989] as the point of departure and applying a composite uncertainty factor of 3 to account for interspecies differences and human variability results in a derived value of 1,667 ppm, rounded to 1,700 ppm.

1.2 Purpose

This IDLH Value Profile presents (1) a brief summary of technical data associated with acute inhalation exposures to HCFC-141b and (2) the rationale behind the immediately dangerous to life or health (IDLH) value for HCFC-141b. IDLH values are developed on the basis of the scientific rationale and logic outlined in the *NIOSH Current Intelligence Bulletin (CIB) 66: Derivation of Immediately Dangerous to Life or Health (IDLH) Values* [NIOSH 2013]. As described in CIB 66, NIOSH performs in-depth literature searches to ensure that all relevant data from human and animal studies with acute exposures to the substance are identified. Information included in CIB 66 on the literature search includes pertinent databases, key terms, and guides for evaluating data quality and relevance for the establishment of an IDLH value. The information that is identified in the in-depth literature search is evaluated with general considerations that include description of studies (i.e., species, study protocol, exposure concentration and duration), health endpoint evaluated, and critical effect levels (e.g., NOAELs, LOAELs, and LC_{50} values). For HCFC-141b, the in-depth literature search was conducted through May 2016.

1.3 General Substance Information

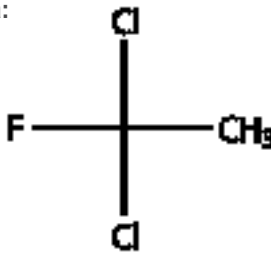
Chemical: 1,1-Dichloro-1-fluoroethane

CAS No: 1717-00-6

Synonyms: HCFC-141b; Freon-141; CFC 141b[*]

Chemical category: Aliphatic, saturated, halogenated hydrocarbons; Organic chlorine compounds; Organic fluorine compounds[†]

Structural formula:



References: [*]NLM [2016]; [†]IFA [2016]

Table 1 highlights selected physiochemical properties of HCFC-141b relevant to IDLH conditions. Table 2 provides alternative exposure guidelines for HFC-141b. Table 3 summarizes the Acute Exposure Guidelines Level (AEGL) values for HFC-141b.

Table 1: Physiochemical Properties of HCFC-141b

Property	Value
Molecular weight	116.95‡
Chemical formula	$C_2H_3Cl_2F$
Description	Colorless liquid
Odor	Weak, ethereal
Odor Threshold	250 ppm*
UEL	17.7%†
LEL	5.6%†
Vapor pressure	600 mmHg at 25°C (77°F)‡
Flash point	Not available
Ignition temperature	Not available
Solubility	Slightly soluble in water†

References: *Utell et al. [1997]; †IFA [2016]; ‡HSDB [2016]

Table 2: Alternative Exposure Guidelines for HCFC-141b

Guideline	Value
Revised (1994) IDLH value*	None
NIOSH REL†	None
OSHA PEL†	None
ACGIH TLV®‡	None
AIHA ERPGs™+	None
AIHA WEELs®+	500 ppm, TWA

References: *NIOSH [1994]; †NIOSH [2016]; ‡ACGIH [2015]; +AIHA [2014]

Table 3: AEGL Values for HCFC-141b

Classification	10-min	30-min	1-hour	4-hour	8-hour	Endpoint [Reference]
AEGL-1	1,000 ppm (4,850 mg/m^3)	1,000 ppm (4,850 mg/m^3)	1,000 ppm (4,850 mg/m^3)	1,000 ppm (4,850 mg/m^3)	1,000 ppm (4,850 mg/m^3)	No effect in humans [Utell et al. 1997]
AEGL-2	1,700 ppm (8,245 mg/m^3)	1,700 ppm (8,245 mg/m^3)	1,700 ppm (8,245 mg/m^3)	1,700 ppm (8,245 mg/m^3)	1,700 ppm (8,245 mg/m^3)	Threshold for cardiac [Mullin 1977] arrhythmia in the dog
AEGL-3	3,000 ppm (14,550 mg/m^3)	3,000 ppm (14,550 mg/m^3)	3,000 ppm (14,550 mg/m^3)	3,000 ppm (14,550 mg/m^3)	3,000 ppm (14,550 mg/m^3)	Threshold for severe cardiac response in the dog [Hardy et al. 1989a]

*Reference: NAS [2002]

2 Animal Toxicity Data

Acute inhalation toxicity tests for HCFC-141b were performed in rats and mice. A 4-hour rat LC_{50} value was reported for male and female rats at 58,931 and 64,991 ppm, respectively, with a combined LC_{50} of 61,647 ppm [de Rooij 1989; Brock et al. 1995]. Brock et al. [1995] also reported a 6-hour LC_{50} value of 56,700 ppm in rats. Both studies reported reduced motor activity, shallow breathing with rapid respiration, and anesthesia at concentrations greater than 29,000 ppm; tremors, incoordination, and convulsions were noted in some animals at concentrations above 50,000 ppm.

A 30-minute LC_{50} value of 100,000 ppm in mice was reported by Davies et al. [1976], with effects including narcosis. In a second study in mice [Vlachos 1988], the authors reported a 60% mortality among those exposed to 80,000 ppm for 6 hours. No clinical signs of exposure were observed up to 30,000 ppm. Lethargy and tremors were observed at 41,000 ppm, and narcosis occurred within 15 minutes at 80,000 ppm. Deaths were attributed to deep anesthesia.

Halogenated hydrocarbons, such as HCFC-141b, are commonly associated with the onset of cardiac sensitization. This effect is caused by coexposures to halogenated hydrocarbon via the inhalation route and high blood levels of endogenous epinephrine, resulting in the sudden onset of ventricular fibrillation, which is a potentially life-threatening endpoint [Brock et al. 2003]. Endogenous epinephrine acts as a cardiac stimulant and is released in both humans and animals in response to physical exertion or other forms of stress [Brock et al. 2003]. Animal toxicity tests that focus on cardiac sensitization commonly require the injection of epinephrine to stimulate the endogenous release of the cardiac stimulant, in conjunction with inhalation exposure to the halogenated hydrocarbon. A response in this cardiac sensitization assay is considered a sensitive measure of a severe effect. Arrhythmia in these cases is not produced by the halogenated hydrocarbon; rather, it is the result of the potentiation of the arrhythmogenic effects of endogenous epinephrine (adrenaline) by the chemical.

Cardiac sensitization tests were conducted in dogs and rats. NAS [2002] described an unpublished study in which Sprague-Dawley rats were exposed to 5,000, 10,000, or 20,000 ppm of HCFC-141b for 30 minutes and administered 12 μg/kg epinephrine. NAS [2002] reported that marked arrhythmia was observed in 4 of 11 animals at 5,000 ppm. Mullin [1977] exposed dogs to 2,600, 5,200, 10,000, or 21,600 ppm for 5 minutes, followed by an intravenous dose of 8 μg/kg epinephrine. Cardiac sensitization was induced in 1 of 10 dogs at 5,200 ppm; deaths occurred at higher concentrations. The authors also reported a no-effect level at 2,600 ppm. In a second cardiac sensitization study, dogs were exposed to 9,000, 12,000, 13,000, 14,000, 15,000, 18,000, 19,000, or 20,000 ppm for 5 minutes, followed by challenge with 10 μg/kg of intravenous epinephrine [Hardy et al. 1989]. A marked cardiac response was reported in 1 of 2 dogs at 9,000 ppm, but there was no response in eight other trials at 9,000 to 13,000 ppm. The one dog exposed to 20,000 ppm and then challenged with epinephrine developed severe ventricular fibrillation and died. Monkeys were exposed to 0, 3,000, 5,000, or 10,000 ppm for 10 minutes [Hardy et al. 1989]. After 5 minutes of exposures, the monkeys received epinephrine. No electrocardiogram effects were seen in the monkey exposed to 3,000 ppm, but the authors reported a marked cardiac response at 5,000 ppm.

Table 4 summarizes the LC data identified in animal studies and provides 30-minute-equivalent derived values for HCFC-141b. Table 5 provides nonlethal concentration data

reported from animal studies with 30-minute-equivalent derived values. Information in these tables includes species of test animals, toxicological metrics (i.e., LC, NOAEL, and LOAEL), adjusted 30-minute concentration, and the justification for the composite uncertainty factors applied to calculate the derived values.

Table 4: Lethal Concentration Data for HCFC-141b

Reference	Species	LC_{50} (ppm)	LC_{Lo} (ppm)	Time (min)	Adjusted 30-min LC value*	Composite Uncertainty Factor	30-min Equivalent Derived Value (ppm)†	Final Value (ppm)‡
Davies et al. [1976]	Mouse	100,000	—	30	100,000	30§	3,333	3,300
Brock et al. [1995]	Rat	56,700	—	360	129,811	30§	4,327	4,300
Brock et al. [1995]	Rat (both sexes)	61,647	—	240	123,294	30§	4,110	4,100

*For exposures other than 30 minutes, the ten Berge et al. [1986] relationship was used for duration adjustment ($C^n \times t = k$). No empirically estimated n values were available; therefore, the default values were used (n = 3 for exposures greater than 30 minutes and n = 1 for exposures less than 30 minutes).
†The derived value is the result of the adjusted 30-min value divided by the composite uncertainty factor. The composite uncertainty factor used varies for each study and is based on the nature and severity of the endpoint observed.
‡Values rounded to the appropriate significant figure.
§Composite uncertainty factor to account for adjustment of LC_{50} values to LC_{01} values, use of lethal concentration threshold in animals, interspecies differences, and human variability.

Table 5: Nonlethal Concentration Data for HCFC-141b

Reference	Species	Critical nonlethal effect	NOAEL (ppm)	LOAEL (ppm)	Time (min)	Adjusted 30-min Concentration*	Composite Uncertainty Factor	30-min Equivalent Derived Value (ppm)†	Final Value (ppm)‡
Mullin [1977]	Dog	Cardiac sensitization	—	5,200	10	5,200§	3¶	1,733	1,700
Hardy et al. [1989]**	Monkey	Cardiac sensitization	—	5,000	10	5,000§	3¶	1,667	1,700

*For exposures other than 30 minutes, the ten Berge et al. [1986] relationship is used for duration adjustment ($C^n \times t = k$). No empirically estimated n values were available; therefore the default values were used (n = 3 for exposures greater than 30 minutes and n = 1 for exposures less than 30 minutes). Additional information on the calculation of duration-adjusted concentrations can be found in NIOSH [2013].

†The derived value is the result of the adjusted 30-min value divided by the composite uncertainty factor. The composite uncertainty factor used varies for each study and is based on the nature and severity of the endpoint observed.

‡Values rounded to the appropriate significant figure.

§The cardiac sensitization response is a concentration-dependent threshold effect; dogs exposed to similar chemicals for longer durations responded in a similar manner, so no time adjustment was applied.

¶Composite uncertainty factor assigned to account for interspecies differences and human variability.

**Identified study is the primary basis of the IDLH value for HCFC-141b.

3 Human Data

Information regarding lethality in humans is limited to a single case report. Astier and Paraire [1997] reported a worker was found dead, with bluish-purple coloration and edema of the face, inside a degreasing tank in which pure HCFC-141b was used as the degreasing solvent. The concentration and exposure duration were not reported. In an experimental study, Utell et al. [1997] exposed eight volunteers to 0, 250, 500, or 1,000 ppm of HCFC-141b for 4 hours, with three 20-minute exercise periods. Endpoints evaluated included clinical chemistry, hematology, EKG, and spirometry. No effects were reported on these sensitive measures during exposures (aside from the expected response to exercise). In addition, two of the volunteers were exposed at 0 or 500 ppm for 6 hours and one volunteer was exposed to 1,000 ppm for 6 hours, and computerized neurobehavioral testing was performed during the last 2 hours of exposure. No effects were seen. Lee et al. [2009] investigated the pulmonary effects of HCFC-141b on 15 workers employed at an electronic appliances factory in Korea. HCFC-141b was used to clean printed circuit boards. Exposure measurements were not taken, but the authors estimated that the workers were exposed for at least 3 hours. All 15 workers were hospitalized with acute respiratory symptoms, including chest discomfort, malaise, and dyspnea, along with dizziness, headache, and sensory irritation. All workers were released from the hospital 4 to 5 days after the incident. Medical examinations revealed parenchymal lung damage that was characterized by ground-glass opacities and restrictive functional impairment. Lee et al. [2009] summarized that these effects were caused by the inhalation of sublethal concentrations of HCFC-141b.

4 Summary

Limited human data are available on HCFC-141b. Multiple animal studies revealed the onset of cardiac sensitization to HCFC-141b, which is a toxicological response commonly associated with halogenated hydrocarbons. This effect is caused in conjunction with inhalation exposure to the halogenated hydrocarbon and high blood levels of endogenous epinephrine, resulting in the sudden onset of ventricular fibrillation, a potentially life-threatening endpoint [Brock et al. 2003]. This potentially lethal and irreversible effect is the basis of the IDLH value. This effect has been observed in monkeys following exposure to 5,000 ppm for 10 minutes [Hardy et al. 1989] and in a dog exposed to 5,200 ppm for 10 minutes [Mullin 1977]. These values represent LOAELs associated with severe, potentially irreversible effects. NAS [2002] determined that the cardiac sensitization response is a concentration-dependent threshold effect; animals exposed to similar chemicals for longer durations responded in a similar manner. Therefore, a duration adjustment for time scaling is not applied, and the reported exposure concentration is used instead of a 30-minute equivalent. The 5,000-ppm concentration reported by Hardy et al. [1989] is used as the point of departure and basis of the IDLH value for HCFC-141b. Application of an uncertainty factor of 3 to account for extrapolation, given consideration of animal to human differences and human variability, results in a derived value of 1,667 ppm, rounded to 1,700 ppm.

5 References

ACGIH [2015]. Annual TLVs® (Threshold Limit Values) and BEIs® (Biological Exposure Indices) booklet. Cincinnati, OH: ACGIH Signature Publications.

AIHA [1989]. Odor thresholds for chemicals with established occupational health standards. Fairfax, VA: American Industrial Hygiene Association.

AIHA [2006]. AIHA Emergency Response Planning (ERP) Committee procedures and responsibilities. Fairfax, VA: American Industrial Hygiene Association, https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/ERP-SOPs2006.pdf.

AIHA [2014]. Emergency response planning guidelines (ERPG) and workplace environmental exposure levels (WEEL) handbook. Fairfax, VA: American Industrial Hygiene Association Press, https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2014%20ERPG%20Values.pdf.

Aster A, Paraire F [1997]. Fatal intoxication with 1,1-dichloro-1-fluoroethane. N Engl J Med *337*:940.

Brock WJ, Trochimowicz HJ, Millischer RJ, Farr C, Kawano T, Rusch GM [1995]. Acute and subchronic toxicity of 1,1-dichloro-1-fluoroethane (HCFC-141b). Food Chem Toxicol *33*:483–490.

Brock WJ, Rusch GM, Trochimowicz HJ [2003]. Cardiac sensitization: Methodology and interpretation in risk assessment. Reg Toxico Pharm *38*:78–90.

Davies RH, Babnall RD, Bell W, Jones WGM [1976]. The hydrogen bond proton donor properties of volatile halogenated hydrocarbons and ethers and their mode of action in anaesthesia. Int J Quantum Chem Quantum Biol Symp *3*:171–185.

de Rooij CH [1989]. The toxicity of HCFC-141b. Proceedings of the 1989 European Meeting of the Toxicology Forum, Toulouse, France, September 18–22, pp. 204–216.

Hardy JC, Sharman IJ, Chanter DO [1989]. Assessment of cardiac sensitization potential in dogs and monkeys. Comparison of I-141b and F11. Huntingdon, UK: Huntingdon Research Centre Ltd., PWT 86/89437.

HSDB [2016]. Hazardous Substances Data Bank. Bethesda, MD: National Library of Medicine, http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB.

IFA (Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung) [2016]. GESTIS: database on hazardous substances, http://gestis-en.itrust.de/nxt/gateway.dll?f=templates&fn=default.htm&vid=gestiseng:sdbeng.

Lee J, Lee C, Kim CH [2009]. Uncontrolled occupational exposure to 1,1-dichloro-1-fluoroethane (HCFC-141b) is associated with acute pulmonary toxicity. Chest *135*(1):149–155.

Mullin LS [1977]. Cardiac sensitisation. Newark, DE: E.I. duPont de Nemours and Co., Haskell Laboratory Report 957-77.

NAS [2001]. Standing operating procedures for developing Acute Exposure Guidelines Levels for hazardous chemicals. National Academy of Sciences, National Research Council (NRC), Committee on Toxicology, Subcommittee on Acute Exposure Guideline Levels. Washington, DC: National Academy Press, IBSN: 0-309-07553-X, http://www.epa.gov/sites/production/files/2015-09/documents/sop_final_standing_operating_procedures_2001.pdf.

NAS [2002]. Acute Exposure Guideline Levels (AEGLs) for selected airborne chemicals. Volume 2: HCFC-141b (CAS Reg. No. 1717-00-6). National Academy of Sciences, National Research Council, Committee on Toxicology, Subcommittee on Acute Exposure Guideline Levels. Washington, DC: National Academy Press, http://www.epa.gov/sites/production/files/2014-11/documents/tsd9.pdf.

NIOSH [1994]. Documentation for immediately dangerous to life or health concentrations (IDLHs). Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, http://www.cdc.gov/niosh/idlh/intridl4.html.

NIOSH [2004]. NIOSH respirator selection logic. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2005-100, http://www.cdc.gov/niosh/docs/2005-100/pdfs/2005-100.pdf.

NIOSH [2013]. NIOSH Current Intelligence Bulletin 66: derivation of immediately dangerous to life or health (IDLH) values. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2014-100, http://www.cdc.gov/niosh/docs/2014-100/pdfs/2014-100.pdf.

NIOSH [2016]. NIOSH pocket guide to chemical hazards. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2005-149, http://www.cdc.gov/niosh/npg/.

NLM [2016]. ChemIDplus lite. Washington, DC: National Library of Medicine, http://chem.sis.nlm.nih.gov/chemidplus/.

ten Berge WF, Zwart A, Appelman LM [1986]. Concentration-time mortality response relationship of irritant and systematically acting vapors and gases. J Haz Mat *13*:301–309.

U.S. EPA [2016]. Integrated Risk Information System (IRIS). Washington, DC: U.S. Environmental Protection Agency, http://www.epa.gov/iris/.

Utell MJ, Anders MW, Morrow PE [1997]. Clinical inhalation studies with HCFC-141b. Final report: December 4, 1997. Rochester, NY: University of Rochester Medical Center, MA-RR-97-2406.

Vlachos DA [1988]. Mouse bone marrow micronucleus assay of FC-141b. Newark, DE: E.I. du Pont de Nemours and Company Inc., Haskell Laboratory Report No. 746-88.

This page intentionally left blank.

Delivering on the Nation's promise:
safety and health at work for all people
through research and prevention

To receive NIOSH documents or more information about occupational safety and health topics, contact NIOSH at

1–800–CDC–INFO (1–800–232–4636)
TTY: 1–888–232–6348
E-mail: cdcinfo@cdc.gov

or visit the NIOSH Website at www.cdc.gov/niosh.

For a monthly update on news at NIOSH, subscribe to *NIOSH eNews* by visiting www.cdc.gov/niosh/eNews.

DHHS (NIOSH) Publication No. 2016–168