IMMEDIATELY DANGEROUS to LIFE or HEALTH

IDLH

VALUE PROFILE

Hydrogen Iodide
CAS® No. 10034-85-2

U.S. Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

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IMMEDIATELY DANGEROUS TO LIFE OR HEALTH (IDLH) VALUE PROFILE

HYDROGEN IODIDE

[CAS® No. 10034-85-2]

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

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On June 22, 2023, NIOSH published a request for public review in the Federal Register [88 FR 40826] on the draft versions of the Immediately Dangerous to Life or Health Values for Hydrogen Bromide and Hydrogen Iodide. We invited comments from manufacturers, distributors/vendors, healthcare providers, government agencies, academia, professional organizations, non-government organizations, and members of the public. NIOSH did not receive public comments on the draft document for hydrogen iodide.

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Suggested Citation

NIOSH [2025]. Immediately dangerous to life or health (IDLH) value profile: hydrogen iodide, CAS® No. 10034-85-2. By Frank E, Chittiboyina S, Leshner M, Edmondson M, Niemeier RT. Cincinnati, OH: U.S. Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2025-109 (Revised 06/2025).

DHHS (NIOSH) Publication No. 2025-109 (revised 06/2025)

June 2025

Summary of changes: updated authorship and acknowledgements.

Worker Summary of the NIOSH Immediately Dangerous to Life or Health (IDLH) Value Profile for Hydrogen Iodide

CAS Number: 7647-01-0
IDLH Value: 45 parts per million (ppm) or 70 milligrams per cubic meter (mg/m^3)

General Substance Information

Other names:
- HI
- Hydroiodic acid
- Hydriodic acid
- Iodane

HI:
- is a colorless to yellow/brown gas with an irritating smell
- is corrosive
- is **not** flammable
- is used for chemical reactions and to manufacture medicines, iodine salts, and iodine-based cleaning products
- is stored as liquid or compressed gas
- liquid gives off strong fumes that sink in air

Health Effects of HI

Short-term exposure to dangerous levels causes:
- eye irritation (stinging and burning)
- coughing
- difficulty breathing
- symptoms get worse as exposure continues

As HI levels increase:
- nose and throat pain
- asthma-like symptoms
- lung injury and pulmonary edema (fluid in the lungs)

For more information on HI visit: LINK TO CHEMICAL DOCUMENT

What is an IDLH Value?

NIOSH develops IDLH values for workplace conditions carrying immediate, unacceptable risks. As a safety margin, IDLH values are based on the effects that might occur from 30-minute exposures. Workers should not stay in an IDLH environment longer than absolutely necessary. **EVERY EFFORT SHOULD BE MADE TO EXIT IMMEDIATELY!** Short exposures to highly concentrated chemicals in the air can quickly overwhelm workers and harm worker health. Harmful effects may include:
- Long-term health issues
- Inability to escape the area
- Death

Workers should **never** be exposed to air concentrations that exceed the IDLH value without proper respiratory protection. NIOSH sets IDLH values to make sure that a worker can escape **immediately** from an area before severe injuries occur.

Employers **must require workers** to wear a NIOSH Approved® full facepiece self-contained breathing apparatus (SCBA) or a combination supplied air respirator with SCBA when entering IDLH conditions. These respirators deliver clean air to the worker in dangerous conditions, and these provide the greatest protection.

NIOSH Approved is a certification mark registered in the United States and several international jurisdictions.

Basis for IDLH Value: The IDLH value for HI is based on data for a closely related chemical, hydrogen bromide (HBr), because the health effects of exposure to both chemicals are similar. In experiments done on rats, HBr vapor caused severe shortness of breath and trouble breathing. The concentration at which these effects began to occur was used to estimate an IDLH value. Because humans could be more sensitive than rats, the IDLH concentration was divided by an uncertainty factor to account for the expected difference. This IDLH value was calculated to be 35 ppm. Reports indicate that people exposed to this concentration may experience burning sensations in the nose and throat. Continuous exposure to this concentration is expected to cause corrosive injury to the airways and lungs.

Foreword

Chemicals are a frequent component of the modern workplace. Occupational exposures to chemicals have long been recognized as having the potential to adversely affect the lives and health of workers. Acute or short-term exposures to high concentrations of some airborne chemicals can quickly overwhelm workers, affecting their ability to escape from the exposure environment. These exposures can result in a range of negative health outcomes—from eye and respiratory tract irritation to severe, irreversible health effects—and in extreme cases, death.

Airborne concentrations of chemicals capable of causing such adverse health effects or impeding escape from high-risk conditions may come from a number of nonroutine workplace situations affecting workers. These may include special work procedures (e.g., in confined spaces), industrial incidents (e.g., chemical spills or explosions), and chemical releases into the community (e.g., during transportation incidents or other uncontrolled-release scenarios).

This technical report presents the scientific basis, toxicologic data, and risk assessment methodology used to derive a health-based immediately dangerous to life or health (IDLH) value for hydrogen iodide (CAS No. 10034-85-2). The IDLH values are based on the scientific rationale and logic outlined in Current Intelligence Bulletin (CIB) 66: Derivation of Immediately Dangerous to Life or Health Values [NIOSH 2013].

This approach is intended to (1) update the scientific basis and risk assessment methodology used to derive IDLH values from quality toxicity and human health effects data and (2) provide transparency behind the rationale and derivation process for IDLH values. The IDLH value for hydrogen iodide has been established through the approach outlined in CIB 66. This value is intended to protect against health effects that impair escape, are irreversible, or result in death from exposures of 30 minutes or less.

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Director
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Centers for Disease Control and Prevention

Contents

Abbreviations*

ACGIH®	American Conference of Governmental Industrial Hygienists
AEGLs	acute exposure guideline levels
AIHA®	American Industrial Hygiene Association
Atm	atmosphere (a unit of pressure)
BMC	benchmark concentration
BMD	benchmark dose
BMCL	benchmark concentration lower confidence limit
BMD	benchmark dose
BMR	benchmark response
C	ceiling value
°C	degrees Celsius
CAS®	Chemical Abstracts Service, a division of the American Chemical Society
CIB	Current Intelligence Bulletin
ERPGs™	Emergency Response Planning Guidelines
°F	degrees Fahrenheit
g/mL	grams per milliliter
HBr	hydrogen bromide
HCl	hydrogen chloride (hydrochloric acid)
HF	hydrogen fluoride
HI	hydrogen iodide
hr	hour
IFA	Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung (Institute for Occupational Safety and Health of the German Social Accident Insurance)
IDLH	immediately dangerous to life or health
LC	lethal concentration
LC_{01}	1% lethal concentration
LC_{50}	median lethal concentration
LC_{LO}	lowest concentration that caused death in humans or animals
LD_{50}	median lethal dose
LD_{LO}	lowest dose 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
mm Hg	millimeter(s) of mercury
MSHA	Mine Safety and Health Administration
NAS	National Academy of Sciences
NIOSH	National Institute for Occupational Safety and Health
NLM	National Library of Medicine
NOAEL	no observed adverse effect level

NRC	National Research Council
OEL	occupational exposure limit
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
REACH	Registration, Evaluation, Authorization, and Restriction of Chemicals (European Union regulatory program)
REL	recommended exposure limit
RfC	reference concentration
STEL	short-term exposure limit
TEEL	temporary emergency exposure limit
TERA	Toxicology Excellence for Risk Assessment
TLV®	threshold limit value
TWA	time-weighted average
UEL	upper explosive limit
UF	uncertainty factor
WEEL®	Workplace Environmental Exposure Level

**Abbreviations listed are based on recurring use in IDLH documents and do not necessarily indicate usage in this assessment*

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 [NRC 2010]. AEGLs are intended to be guideline levels used during rare events or single once-in-a-lifetime exposure to airborne concentrations of acutely toxic, high-priority chemicals [NRC 2010]. The threshold exposure limits are designed to protect the general population, including the elderly, children, and other potentially sensitive groups who 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 EPA noncancer health assessments [EPA 2022].

Acute toxicity: Any poisonous effect produced within a short period of time following an exposure, usually 24 to 96 hours [EPA 2022].

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 with background [EPA 2022]. (Additional information available at https://www.epa.gov/bmds.)

Benchmark response (BMR): An adverse effect, used to define a benchmark dose from which a reference dose or concentration can be developed. The change in response rate over background of the BMR is usually in the range of 5%–10%, which is the limit of responses typically observed in well-conducted animal experiments [EPA 2022].

Benchmark concentration lower confidence limit (BMCL): A statistical lower confidence limit on the concentration at the BMC [EPA 2022].

Bolus exposure: A single, relatively large dose.

Ceiling value ("C"): 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 quantitative assessment of risk [EPA 2022].

Dose: The amount of a substance available for interactions with metabolic processes or biologically significant receptors after crossing the outer boundary of an organism [EPA 2022].

ECt50: 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% of the experimental test subjects.

Emergency Response Planning Guidelines (ERPGs™): Maximum airborne concentrations below which nearly all individuals can be exposed without experiencing health effects 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 2016].

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 test animals.

LC_{50}: The statistically determined concentration of a substance in the air that is estimated to cause death in 50% 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 test animals.

LD_{50}: The statistically determined lethal dose of a substance that is estimated to cause death in 50% of the test animals, i.e., the median lethal concentration.

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

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

Lower explosive limit (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.

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 [OSHA 2019].

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). It can also 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% 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): An exposure concentration limit that shall not be exceeded at any time during a workday, usually based on a 15-minute time-weighted average unless otherwise noted.

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 [ACGIH 2021].

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 [ACGIH 2021].

Toxicity: The degree to which a substance can 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 Division of Science Integration, Christine Whittaker, PhD, Director. The authors of this report are Evan Frank, PhD, DABT; Shirisha Chittiboyina, PhD; Molly Leshner, MPH; Melissa Edmondson, PhD, CIH; and R. Todd Niemeier, PhD, CIH.

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

Theresa Boots, MS
Kathleen MacMahon, DVM
Sudha Pandalai, MD, PhD
Christine Whittaker, PhD

NIOSH would like to acknowledge the contribution of the following external subject matter experts for their critical technical review of this report:

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The basis for this document was a report contracted by NIOSH and prepared by Andrew Maier, PhD, DABT, CIH; Ann Parker; and Lynne Haber, PhD, DABT (Toxicology Excellence for Risk Assessment [TERA]).

Krystin Carlson, PhD (formerly of the Division of Science Integration) also contributed to earlier versions of this document.

IDLH Value for Hydrogen Iodide

IDLH Value: 35 ppm (183 mg/m^3)

Basis for IDLH Value: The immediately dangerous to life or health (IDLH) value for hydrogen iodide (HI) is based on the lethality of closely related hydrogen bromide (HBr). Lethal concentrations of halogen acid vapors such as HI and HBr cause severe dyspnea and respiratory distress. The immediate effects and potency of HI is expected to be similar to HBr and hydrogen chloride (HCl) gases. MacEwen and Vernot [1972] reported a one-hour LC_{50} of 814 ppm HBr in mice, the lower of two LC_{50} values available for HBr. This value was also lower than the most sensitive LC_{50} value identified for HCl, also in mice [Wohlslagel et al. 1976]. A 30-minute adjusted equivalent LC_{50} of 1,026 ppm was derived from the MacEwen and Vernot HBr study using the ten Berge method [1986] and was used as the basis for the IDLH value for HI. An uncertainty factor (UF) of 30 was applied to extrapolate the risk of immediately dangerous effects to human workers in an emergency scenario. The calculated risk value of 34 was rounded to 35 ppm for the final IDLH value for HI.

1 Introduction

1.1 Purpose

This *Immediately Dangerous to Life and Health (IDLH) Value Profile* presents (1) a brief summary of technical data associated with acute inhalation exposures to hydrogen iodide (HI), and (2) the scientific rationale behind the IDLH value for HI. IDLH values are developed based on the scientific rationale and logic outlined in the C*urrent Intelligence Bulletin (CIB) 66: Derivation of immediately dangerous to life or health (IDLH) values* [NIOSH 2013]. NIOSH performed in-depth literature searches (outlined generally in CIB 66 and further described in Section 1.2 of this document) to ensure that all relevant data from human and animal studies with acute exposures to the substance were identified. The data identified in this literature search were evaluated for relevance by considering the methods used in the studies (i.e., species, study protocol, exposure concentration, and duration), the health endpoint(s) evaluated, and the critical effect levels (e.g., NOAELs, LOAELs, LC_{50} values).

1.2 How IDLH Values Are Set

An IDLH situation is one 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]. An IDLH value is a maximum (airborne concentration) level above which only a highly reliable breathing apparatus providing maximum worker protection is permitted [NIOSH 2004]. IDLH values are based on a 30-minute (min) exposure duration and signal that every effort should be made to evacuate the area. These values are designed to protect workers from acute or short-term exposures to high concentrations of airborne chemicals that could quickly overwhelm them, affecting their ability to escape. These exposures could result in a range of undesirable outcomes from eye and respiratory irritation to severe, irreversible health effects, and in extreme cases, death. IDLH values also protect workers against

non-toxicological safety hazards, including deprivation of oxygen, impairment of visibility, and ignition in the air.

1.2.1 Health Effects Considered

For the purposes of setting an IDLH value, NIOSH typically considers health effects data for the following acute health endpoints [NIOSH 2013]:

- Lethality/death
- Acute deficits in neurological and/or psychomotor functions that impair escape by interfering with workers' ability to recognize escape routes and any actions needed to get away through those routes, such as the operation of lifts, elevators, and door mechanisms
- Eye irritation that is severe enough to affect workers' ability to see adequately and escape the area
- Respiratory irritation severe enough to impair breathing, assuming a non-rest scenario, or that results in long-term respiratory complications
- Cardiac and hematological effects, including cardiac sensitization
- Any other specific target organ effects that are incapacitating and escape impairing or have the potential for long-term injury, disability, or deficits in function

1.2.2 Time Scaling

Effect levels for acute exposures are adjusted to 30-min effect levels when needed using the ten Berge et al. [1986] method, where a "k" constant value is calculated from concentration (C) and time (t) using the equation $C^n \times t = k$. When the value of the exponent n can be derived from data, the data-based n is used. Otherwise, default values of 1 for adjusting from a shorter exposure to 30 min and 3 for adjusting from longer exposures are used as described in CIB 66. For effects that are understood to occur based on threshold concentration regardless of exposure duration, time scaling may not be required.

1.2.3 Uncertainty Factor Considerations

The time-scaled effect levels for immediately dangerous health effects are modified by an uncertainty factor (UF) to estimate the concentration correlating to an unacceptable risk of immediately dangerous health effects in workers and account for the possibility of underestimating the degree of risk. When estimating an overall UF, NIOSH considers the following types of uncertainty and variability (NIOSH 2013, 2020):

- Interspecies differences in sensitivity: When the effect level is obtained from animal data, the potential difference between animal and human responses should be accounted for. When data specific to the chemical are available, a factor may be calculated based on the known magnitude of toxicokinetic and/or toxicodynamic differences. If chemical-specific data are not available, NIOSH typically selects a value between 1 and 10 depending on the expectation of animal-to-human differences in toxic susceptibility.
- Human variability in sensitivity: To account for potential differences in sensitivity between individuals, NIOSH typically selects a value between 1 and 10 depending on the mode-of-action considerations in humans and, in cases where IDLH values are based directly on human subject data, whether variability among workers can be assessed from the experimental sample population. Because NIOSH generally assumes workers to be adults and in reasonable health, UFs for IDLH values generally do not account for particularly sensitive subgroups such as those with preexisting conditions.
- Severity of effect: A UF may be applied when the IDLH is based on health effects severe enough that overestimation of the threshold of immediately dangerous or lethal effects in workers becomes a concern. This may be done to ensure that the IDLH is sufficiently protective of workers' health when the boundary between adverse and immediately dangerous risk is difficult to interpret.

- Other factors or database deficiencies: If gaps in the database create the possibility of significantly overestimating the IDLH value, UFs may be used to account for this. In addition, in special cases other factors may arise that warrant inclusion of a UF.

1.3 Literature Search

Primary Literature Search

NIOSH performed an initial broad literature search and screened literature during September 2022 as outlined in NIOSH Current Intelligence Bulletin 66: Derivation of immediately dangerous to life or health (IDLH) values [NIOSH 2013]. This included several public databases consisting of non-peer reviewed literature that were reviewed for toxicity information on HI.

For searching the peer-reviewed primary literature, the following literature databases were used based on relevance and current availability. They were searched without limitations on publication date and most recently were queried in December 2024

- PubMed/Medline
- Scopus
- Embase

Search terms used to search the primary literature for effect level data for animal and human endpoints relevant to the IDLH assessment are given in Table 1.1. These terms were used in conjunction with the chemical identifiers of "hydrogen iodide," "hydroiodic acid," "hydriodic acid," or "iodane." The search terms were selected to best reflect the body of literature specific to HI and most effectively retrieve relevant toxicity data.

Table 1.1: Search Terms Used to Find Human and Animal Acute Toxicity Data

Acute	Symptoms	Accident
Irritation	Lethality	Confusion
Behavioral	LC_{50}	Toxicity
Neuro*	RD_{50}	Occupational
Psycho*	Poisoning	Volunteers
Subjects	Clinical	Animal
Inhalation	ppm	Fatality

*Denotes terms searched as prefixes

Tree Search for Government Reports and Non-peer Reviewed Literature

In addition to the primary literature searches, NIOSH reviewed references cited in authoritative reviews and other literature to identify relevant toxicity data. For HI, NIOSH primarily used the acute exposure guideline level (AEGL) documentation for HI [NRC 2014]. The REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) chemical information dossier for HI [ECHA 2022] was also reviewed for toxicity data. All datasets identified through these means were reviewed by NIOSH to identify effect levels from endpoints relevant to the IDLH assessment.

Screening Methods and Study Inclusion Criteria

NIOSH used the following inclusion criteria to screen for relevant datasets:

- Populations included in the review were human adults, workers, and mammalian test species.
- Exposures included in the review were acute exposures, meaning less than ~1 day for

reports and <8 hr for experiments by any route where dose/concentration is known or estimated. Reports were excluded when the exposure concentration and/or duration were not estimated or reported.

- Comparators/controls included any comparisons between known doses/concentrations including comparisons between nonexposed, lower-exposed, and baseline prior to acute exposure.
- Outcomes included escape-impairing signs, symptoms, and endpoints in humans or animals; persistent adverse signs or symptoms in humans; persistent adverse effects in any organ/species; lethality; or RD_{50} values. For the purposes of the IDLH assessment, "escape-impairing" endpoints include acute neurological symptoms (e.g., recognition of letters and numbers, reaction time, psychomotor performance), irritation of the eyes and/or airways, or self-reported symptoms of the same.

2 General Substance Information

Chemical: Hydrogen Iodide

CAS No: 10034-85-2

Synonyms: HI, hydroiodic acid, hydriodic acid, iodane*

Chemical category: Iodine compounds, inorganic; inorganic acids†

Structural formula*:

References: *[NLM 2022] †[IFA 2019]

Hydrogen iodide (HI) is a colorless to yellow/brown, corrosive, nonflammable gas with an acrid, irritating odor. It is primarily used as a reducing agent, and in the manufacture of pharmaceuticals, iodine salts, and iodine-based disinfectants. It is also commonly used in analytical chemistry [NCB, no date]. HI is available as a compressed gas or a 10%–57% aqueous solution that forms corrosive vapors similarly to other halogen acids. Halogen acid fumes are heavier than air and can form pockets of high concentration [ACGIH 2021]. Table 2.1 summarizes the physicochemical properties of HI relevant to IDLH conditions.

Several agencies and other safety and health organizations develop OELs based on the human health effects of exposure to chemicals. These range from OELs for daily 8-hour (hr) exposures (NIOSH REL, OSHA PEL, ACGIH TLV) to short-term acute exposures (AIHA ERPGs). No exposure limits based directly on HI toxicity data have been developed.

AEGL values are emergency safety limits developed by the National Research Council and designed to protect members of the general public from adverse health effects from airborne chemicals for periods ranging from 10 min to 8 hr. AEGL values are estimated for three ranges of effects: nondisabling (AEGL-1), disabling (AEGL-2), and lethal (AEGL-3). The AEGL value most analogous to the IDLH is the 30-min AEGL-2 value, which is intended to protect people from irreversible, serious, or escape-impairing effects, including in susceptible individuals. Due to a lack of toxicity data for HI, its AEGL values are based on those derived from data for HBr and are listed in Table 2.2 [NRC 2010].

Table 2.1: Physiochemical Properties of Hydrogen Iodide

Property	Value
Molecular weight	127.9*†
Description	Colorless gas*†
Odor	Pungent*†
UEL	Not combustible*†
LEL	Not combustible*†
Vapor pressure	5,938 mm Hg @ 25°C†‡
Flash point	Not combustible*†
Ignition temperature	Not combustible*†
Solubility in water	42 g/100 mL @ 20°C; 234 g/100 mL @ 10°C; 900 g/100 mL @ 0°C * †‡
Relative gas density	4.4*†
Reactivities and Incompatibilities	Ignites on contact with perchloric acid, oxidants, metals; slowly decomposes to iodine gas*†‡

UEL: upper explosive limit; LEL: lower explosive limit
*ILO [2010]; † NLM [no date]; ‡NCBI [no date]

Table 2.2: Acute Exposure Guideline Level Values for Hydrogen Iodide*

Classification	10-min	30-min	1-hr	4-hr	8-hr	Endpoint (Reference)
AEGL-1 (Nondisabling)	1.0 ppm 5.2 mg/m^3	1.0 ppm 5.2 mg/m^3	1.0 ppm 5.2 mg/m^3	1.0 ppm 5.2 mg/m^3	1.0 ppm 5.2 mg/m^3	Threshold of nasal irritation in humans [CT Dept of Health,1955, as cited in ACGIH 2021; NRC 2010]
AEGL-2 (Disabling)	150 ppm 785 mg/m^3	50 ppm 262 mg/m^3	25 ppm 131 mg/m^3	13 ppm 68 mg/m^3	13 ppm 68 mg/m^3	One-third of AEGL-3 values [NRC 2010]
AEGL-3 (Lethal)	740 ppm 3,874 mg/m^3	250 ppm 1,308 mg/m^3	120 ppm 628 mg/m^3	31 ppm 162 mg/m^3	31 ppm 162 mg/m^3	Threshold for lethality in rats [MacEwen and Vernot 1972; NRC 2010]

* All values based on toxicity data for hydrogen bromide [NRC 2010]

3 Health Effects of Hydrogen Iodide

Overview of Health Effects: Hydrogen halides, which include HCl, HBr, and HI, form corrosive gases and are respiratory tract irritants. As a class, they are highly soluble, so are rapidly absorbed in the upper airways. Fumes of gas or vapors have a pungent, acrid odor well below the threshold of immediately dangerous effects [Amoore and Hautala 1983]. The data identified for HI exposure were extremely limited. NIOSH based the IDLH for HI on extrapolation from the IDLH risk assessments for HBr and HCl. The acute effects of exposure to HI are expected to be similar to HBr and HCl based on the limited data available. Limited data comparing the relative toxicity of inhaled HCl and HBr indicate that HCl produces more severe nasal lesions in rodents than HBr [Kusewitt et al.1989; Stavert et al. 1991], It is likely that the toxic potency of HI is similar to HBr based on the similar chemical characteristics of these compounds.

3.1 Physical Safety

HI is noncombustible and ignition is not a safety hazard at any concentration.

3.2 Lethality

3.2.1 Overview

There are no available data on the lethality of HI exposure in human or animal reports. Lethality data for HBr consists of a study that obtained LC_{50} values in rats and mice [MacEwen and Vernot 1972]. The more sensitive of these was an LC_{50} value of 814 ppm derived from a 1-hr exposure in mice. In comparison, the lowest LC_{50} value identified for HCl was 1,108 ppm, also using a 1-hr exposure in mice [Wohlslagel et al. 1976]. Deaths in animals exposed to HBr and HCl were accompanied by severe dyspnea and respiratory distress.

3.2.2 Human Data

No reports of deaths in humans due to HI exposure were identified.

3.2.3 Animal Data

In the HBr lethality study, MacEwen and Vernot [1972] exposed male CFE (Sprague-Dawley derived) rats to 2,205 ppm; 2,328 ppm; 2,759 ppm; 3,253 ppm; 3,711 ppm; or 3,822 ppm of HBr for 1 hr and male CF1 (non-Swiss albino) mice to 507 ppm; 875 ppm; 1,036 ppm; or 1,163 ppm for 1 hr. Exposure concentrations were monitored continuously. The study reported a 1-hr LC_{50} of 2,858 ppm for rats and 814 ppm for mice, with no mortality at 507 ppm for mice. Nose and eye irritation, labored breathing, gasping, and convulsions were observed in exposed animals, but the concentration levels corresponding to these effects were not reported. During the 14-day post-exposure period, the surviving animals were prostrate and most lost weight. Delayed deaths were observed. Burns accompanied by autolysis were observed on exposed areas of the skin, such as feet, tails, scrotum, and ears. Severe liver and lung congestion with pulmonary edema was reported in rats exposed to 3,822 ppm. The authors also reported that rats exposed to 2,205 ppm had necrotic lesions on their feet and tails for up to 14 days. The only gross pathological effect in mice that survived the 14-day post-exposure period was tail necrosis. The authors also reported milky cornea opacity in both rats and mice that resolved by 24-hr post-exposure. In another HBr study, Kusewitt et al. [1989] reported no deaths in F344 rats exposed to up to 1,000 ppm HBr for 30 min. An examination of respiratory tract histology 8 hr and 24 hr following exposure showed corrosive damage limited to the nasal region.

Table 3.1 summarizes the LC data identified for HBr in animal studies.

Table 3.1. Acute Lethality (LC_{50}) Data for Hydrogen Bromide*

Species	LC_{50} (ppm)	Time (min)
Mouse	814	60
Rat	2,858	60

*In lieu of hydrogen iodide; Reference: MacEwen and Vernot [1972]

3.3 Neurotoxicity

No animal or human data indicating neurological effects were identified for HI or related halogen acids.

3.4 Respiratory and Eye Irritation

3.4.1 Overview

Halogen acids are rapidly absorbed by airway surfaces and cause damage and corrosive injury to tissue in addition to causing typical sensory irritation symptoms (e.g., coughing, dyspnea, stinging/burning of eyes). Reports of human and animal exposures to gases or vapors of HCl or HBr indicate that eye and airway irritation symptoms are immediate, and symptoms can continue to develop after exposure to sufficiently high concentrations[NIOSH 2025a, b]. One report of incidental HI gas inhalation in a worker demonstrated similar respiratory effects, with symptoms of hoarseness of throat, cough, and dyspnea persisting long after exposure [Hannu et al. 2009].

For eye irritation, no data specific to HI were identified. In experiments using HCl or HBr, corneal opacity was reported in guinea pigs exposed to 680 ppm HCl for 30 mins [Burleigh-Flayer et al. 1985] and rats exposed to 507 ppm HBr for 60 min [MacEwen and Vernot 1972]. In cases of humans exposed to dangerous levels of hydrogen halide gases, eye irritation symptoms have generally been absent or not serious. Serious eye irritation effects appear unlikely at concentrations below at least several hundred ppm.

For respiratory irritation, data specific to HI are extremely limited. Human case report data for HCL, HBr, and HI reviewed for the IDLH project collectively demonstrate the airways and lungs as the most important targets in acute exposure[NIOSH 2025a, b]. These include reports from a variety of workplace and use scenarios where exposed individuals developed cough, chest pain, and shortness of breath following brief (less than 1 hr) exposure to mixed vapors of HI and other iodine compounds [Hannu et al. 2009], HBr [Feng et al. 2006], or HCl [Liu and Cheng 2014; Xia et al. 2019]. These reports are summarized in detail in the IDLH technical documents for these chemicals and are consistent with experimental effects in animals acutely exposed to irritating or dangerous concentrations of gases, as in the case of baboons exposed to high levels of HCl for short periods of time [Kaplan et al. 1985] or rats exposed to HBr [Stavert et al. 1991]. However, concentration-response data suitable for estimating the level at which immediately dangerous effects occur based on respiratory irritation endpoints are limited, particularly for HBr and HI.

3.4.2 Human Data

Hannu et al. [2009] reported the only case identified documenting effects of incidental exposure to HI gas in humans. Improper disposal of iodine-containing chemicals during a school chemistry class resulted in a chemical fire/reaction in a wastebasket that led to a 48-year-old female teacher being exposed to high levels of HI fumes and other iodine compounds during efforts to control the hazard. The teacher experienced immediate throat pain, cough, and respiratory distress that continued after the exposure.

Respiratory symptoms became chronic, and non-atopic bronchial hyper-responsiveness was observed up to seven years following the event. The authors concluded the patient's condition met the diagnostic criteria for reactive airways dysfunction syndrome (RADS) as described by Brooks et al. [1985]. The patient did not experience serious eye symptoms.

3.4.3 Animal Data

No animal data specific to HI were identified.

3.5 Cardiac and Hematological Effects

3.5.1 Overview

No evidence indicated direct cardiac or hematological effects.

3.6 Other Relevant Health Effects

No other target organ effects coming from acute exposure to HI were identified.

4 Determination of IDLH Value

4.1 Selection of Critical Data

The immediately dangerous health hazards of exposure to HI gas are eye and respiratory irritation and death. HI is noncombustible on its own and is not an asphyxiant. HI does not cause immediately dangerous effects to other target organs. Inhalation of dangerous levels of HI gas causes chemical burning of the airways and lungs, causing cough, chest pain, and respiratory distress in a profile of effects similar to other hydrogen halides. Because there are no data for HI suitable for deriving an IDLH value based on any relevant endpoint, acute toxicity data for HCl and HBr were used as read-across substitutes. The comparison study in rats by Stavert et al. [1991] demonstrated that acute injury to the respiratory tract did not differ significantly between HCl and HBr in both nose- and mouth-breathing scenarios, suggesting that the toxicity of HI is likely similar as well. NIOSH considered IDLH values for HI based on eye irritation and lethality using data from HCl and HBr toxicity literature:

Eye Irritation: Burleigh-Flayer et al. [1985] observed corneal opacity in guinea pigs following a 30-min exposure to 640 ppm HCl with a no-effect level of 320 ppm. This is the lowest reported no-effect level for corneal opacity identified in the available literature for HCl or HBr. The authors report confirming the test concentrations analytically using a colorimetric method. Because the effects of HCl on the eyes are expected to approximate those of HI, the no-effect level of 320 ppm was used as a read-across no-effect level for corrosive eye irritation induced by exposure to HI gas.

Lethality: The HBr rodent lethality study by MacEwen and Vernot [1972] provides the best dataset to estimate the risk of death from exposure to HI. The study found 1-hr LC_{50} values of 814 ppm in mice and 2,858 ppm in rats with concentrations being determined by analytical measurement of the bromide ion. There were no deaths in mice exposed to 507 ppm. The more sensitive of the two LC_{50} values was used to derive a candidate IDLH value for HI. The LC_{50} from this study was used instead of attempting to estimate a lethality threshold (LC_{LO} or BMCL) because the distribution of data cast considerable uncertainty over whether a true no-lethal-effect concentration could be soundly estimated.

4.2 Application of Time Scaling

The no-effect level for corneal opacity to derive an IDLH value based on eye irritation was taken from a 30-min exposure study and did not need adjustment.

The LC_{50} value of 814 ppm is adjusted from 60 min to 30 min using the ten Berge defaults. A data-driven n exponent value is not available for HI. Exponents of 1.0 and 2.0 have been experimentally derived for HCl and HF, respectively [ten Berge et al. 1986]. An exponent for HI could not be clearly extrapolated from these data, so the default of 3 was used:

$$(814 \text{ ppm})^3 \times 60 \text{ min} = (C)^3 \times 30 \text{ min}$$

$$C = 1{,}026 \text{ ppm adjusted value}$$

4.3 Application of Uncertainty Factors

The UF for eye irritation is based on corneal opacity being a direct effect caused by the corrosivity of HCl (in lieu of HI) with no biotransformation or other biological steps needed to mediate the outcome. Therefore, variability in responses between individuals or between animals and humans are expected to be minimal. To account for greater sensitivity humans could potentially have when

compared with eye effects in guinea pigs, a UF of 3 was applied.

The UF for the candidate IDLH based on lethality is based on the severity of the effect and extrapolation from mouse to human. Animals exhibited severe dyspnea prior to passing when exposed to lethal concentrations of HBr, indicating gross damage to airways and lungs. Although pharmacokinetic differences between mice and humans are not expected to play a role in the lethal effects of HI gas, differences in rodent airway physiology create a considerable area of uncertainty when extrapolating to human risk, so a factor of 10 is applied [NIOSH 2013]. In addition, Malek and Alarie [1989] demonstrated that increased ventilation brought on by physical exertion exacerbated the lethality of halogen halide gas. To account for the likelihood that the exertion of escaping a workplace emergency may increase the susceptibility of workers to severe effects from HI, an additional modifying factor of 3 was applied for a total UF of 30.

Table 4.1: Potential IDLH Values Based on Immediately Dangerous Health Outcomes of Hydrogen Iodide Exposure

Health outcome	Immediately dangerous effect level (ppm)		30-Min adjusted value (ppm)	Uncertainty factor	Candidate IDLH value (ppm)
Eye irritation	320	NOAEL*	320	3	107
Lethality	814	LC_{50}	1,026	30	34

*No observed adverse effect level

4.4 Final IDLH Calculation

Table 4.1 summarizes the immediately dangerous health outcomes of HI exposure and potential IDLH values. After applying UFs, NIOSH chose to base the IDLH value for HI on lethality of HBr as a read-across dataset, yielding a value of 34 ppm. The IDLH value for HI is based on the closest possible chemical analogue and also results in the most protective value. Data from comparison studies of HF, HCl, and HBr suggest that halogen acids with higher molecular weights (HBr and HI) appeared to be more efficiently absorbed and less lethal compared with HCl and HF [MacEwen and Vernot 1972; Stavert et al. 1991; Wohlslagel et al. 1976]. Therefore, an IDLH based on HBr lethality is not expected to underestimate the immediate dangers of HI.

The IDLH for HI is set at a rounded value of 35 ppm based on the risk of severe and/or lethal respiratory effects in humans assumed to be in a state of exertion.

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