

NRT Quick Reference Guide: Methylisocyanate (MIC)

For References, Please See: Key References Cited/Used* in National Response Team (NRT) Quick Reference Guides (QRGs) for Chemical Warfare Agents. QRGs are intended for Federal OSC/RPMs

Agent Characteristics	<p>Agent Classification: Toxic Industrial Chemical CAS: 624-83-9; Formula: CH₃NCO ; Molecular Weight: 57.1 g/mol Description: Methylisocyanate (MIC) is a volatile colorless liquid with sharp, unpleasant odor that causes eyes to tear. MIC corrodes moist tissues (e.g. lungs, eyes) causing immediate symptoms; if tissues are drier (e.g. drier skin) symptoms may be delayed. MIC is an industrial intermediate in the production of various pesticides. Environmental breakdown products include N-carboxymethylamine, methylamine, hydrogen cyanide (HCN), and N,N'-dimethylurea, some of which may be toxic. Persistence: MIC is considered "non-persistent". Vapor: minutes-hours; liquid: 2-24 hours. Persistence will depend upon the amount & purity of the agent, method of release, environmental conditions & the types of surfaces & materials impacted. Caution: MIC is extremely flammable, reacts violently with water and is incompatible with oxidizers, acids, alkalis, amines, and metals. MIC can polymerize in the presence of heat, metals or catalysts. MIC can release toxic gases, including HCN, when burnt or during rapid decomposition with reactive materials.</p>																													
	<p>Physical properties are listed at/near STP unless otherwise indicated. Conversion Factors: ppm = mg/m³ x 0.427; mg/m³ = ppm x 2.34 Vapor Pressure: 348 mm Hg @ 20°C Vapor Density: 1.44 (air = 1) Aqueous Solubility: 6.7 % @ 20°C (decomposes) Volatility: very high, limited by mass transfer Boiling Point: 102°F/ 39°C Solubility: N/A (reactive) Freezing Point: -49°F /-45°C Flash Point: -7°C (flammable) Liquid Density: 0.9599 @ 20°C</p>																													
Release Scenarios	<p>AIR RELEASE SCENARIOS ARE ASSUMED MOST PROBABLE; HOWEVER OTHER RELEASE SCENARIOS & EXPOSURE ROUTES SHOULD BE CONSIDERED. Open Areas: Due to its volatility, MIC is relatively easy to disperse as a vapor, and the primary release/attack scenario is an airborne release. MIC is expected to disperse or to degrade by reaction with moist or reactive surfaces/materials. However, unreacted plumes can migrate several miles from the site of release by the wind while maintaining very dangerous, toxic, and potentially flammable concentrations of MIC. MIC vapors are slightly heavier than air, so vapors can accumulate in lower terrains. Water/Water Systems: MIC is reactive with water and hydrated material but is not typically considered a water hazard. When MIC is released into water, it decomposes rapidly, and the resulting compounds may exert toxic effects if present in high concentrations. Indoor Facility: Due to its volatility, MIC could potentially be dispersed inside a building or facility; HVAC systems could be impacted. MIC is heavier than air so vapors can accumulate in lower levels or utility corridors inside the building.</p>																													
Health Effects	Onset	Onset is dose & route dependent & may occur within seconds after exposure to vapors. Even relatively low dose exposure to MIC can be fatal. Skin and eye irritation can occur below odor threshold. MIC corrodes moist tissues (e.g. lungs, eyes) causing immediate symptoms; if tissues are drier (e.g. drier skin) symptoms may be delayed																												
	Signs/ Symptoms	<p>Information below is exposure route specific. Regardless of route the following range of effects may occur depending on dose. Mild: Eye and throat irritation begin to occur below odor threshold. Moderate: Shortness of breath, disorientation, coughing, and swollen eye lids. Severe: Chronic breathing difficulties, scarring of the cornea and death from pulmonary edema.</p>																												
	Exposure Routes	<p>Inhalation: Severely irritating and corrosive to the respiratory tract - pulmonary edema and bronchial spasms leading to pneumonia. Symptoms may include cough, chest pain, shortness of breath, coma, and death. Skin: Irritation of mucous membranes and chemical burns of the skin at high concentrations. Eyes: Immediate eye pain, tearing, photophobia, profuse lid edema, and corneal ulcerations. Ocular exposure may result in long-term or permanent eye damage. Ingestion: Cyanosis, nausea, vomiting and gastric irritation.</p>																												
Effect Levels	<p>Air: Acute Exposure Guideline Levels (AEGs) for general population one-time exposure emergency scenarios for MIC (complete definitions are available in Key References Cited/Used* in NRT Quick Reference Guides for Chemical Warfare Agents):</p> <table border="1"> <thead> <tr> <th>AEGL Level in mg/m³, at exposure duration →</th> <th>10 min.</th> <th>30 min.</th> <th>1 hr.</th> <th>4 hr.</th> <th>8 hr.</th> </tr> </thead> <tbody> <tr> <td>AEGL 1: threshold mild effects</td> <td>NA</td> <td>NA</td> <td>NA</td> <td>NA</td> <td>NA</td> </tr> <tr> <td>AEGL 2: potentially irreversible effects or impaired ability to escape</td> <td>0.936</td> <td>0.304</td> <td>0.157</td> <td>0.04</td> <td>0.019</td> </tr> <tr> <td>AEGL 3: threshold for severe effects/medical needs/increasing potential for lethality</td> <td>2.808</td> <td>0.936</td> <td>0.468</td> <td>0.117</td> <td>0.059</td> </tr> </tbody> </table> <p>Exposure Guidelines: Occupational: IDLH= 7 mg/m³ PEL= (OSHA) 0.05 mg/m³ (8 hour TWA) Regional Screening Level (RSL) for residential air = 0.001 mg/m³ Soil: Industrial Exposure Scenario = 6x10⁶ mg/kg (noncancer, but may exceed ceiling limit) Residential Exposure Scenario = 1.4x10⁶ mg/kg. Soil exposure guidelines may exceed ceiling limits. Drinking Water: EPA IRIS States – insufficient data for evaluation no available guidelines.</p>						AEGL Level in mg/m ³ , at exposure duration →	10 min.	30 min.	1 hr.	4 hr.	8 hr.	AEGL 1: threshold mild effects	NA	NA	NA	NA	NA	AEGL 2: potentially irreversible effects or impaired ability to escape	0.936	0.304	0.157	0.04	0.019	AEGL 3: threshold for severe effects/medical needs/increasing potential for lethality	2.808	0.936	0.468	0.117	0.059
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Note	<p>Personal Protective Equipment (PPE) selection (levels A-D), medical surveillance requirements, First Aid options and personnel decon may vary depending upon the agent, site & the release scenario. Additional information on personnel safety and PPE selection criteria can be found at: www.cdc.gov/niosh/ershdb</p>																													
Medical	<p>Pre-incident: Annual physical, respiratory function exams. During Incident: Conduct periodic on-site medical monitoring, observe for any signs & symptoms as per Health Effects section above and treat accordingly as per First Aid section below.</p>																													
First Aid	<p>Immediately remove person from affected area, remove contaminated articles. Wash bare skin with warm soapy water, and rinse eyes with plain water for 15 minutes. No Antidote. In cases of ingestion, do not induce vomiting. Send person for follow up medical attention and evaluation. If cleared, continue to monitor for & treat accordingly.</p>																													
PPE	<p>GENERAL INFORMATION: NIOSH-certified Chemical, Biological, Radiological, Nuclear (CBRN) Self Contained Breathing Apparatus (SCBA), Air Purifying Respirators (APR) or Powered Air Purifying Respirators (PAPR), full-face masks, & protective clothing should be used. Pre-incident training & exercises on the proper use of PPE is recommended. Per NIOSH guidance - LEVEL A: Recommended for the initial response to a MIC incident. Level A provides the greatest level of skin (fully encapsulating suit), respiratory (SCBA), & eye protection when the contaminant identity or concentration is unknown. Select Level A when the MIC concentration is unknown or above the IDLH or AEGL-2, & when there is a potential of ocular or dermal exposure. LEVEL B: Provides the highest level of respiratory protection (SCBA) when a lesser level of skin protection is required. Select Level B when the MIC concentration is unknown or above the IDLH or AEGL-2 & dermal exposure is less of a risk. Level B differs from Level A in that it incorporates a non-encapsulating, splash-protective, chemical-resistant outer suit that provides protection against most liquids but is not airtight. LEVEL C: Select Level C when the contaminant identity & concentration are known & the respiratory protection criteria factors for the use of APR or PAPR (i.e.: < IDLH, warning properties) are met. Level C may be appropriate when decontaminating personnel or equipment. LEVEL D: Select Level D when the contaminant is known & the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times. Downgrading PPE levels can be considered only when the identity & concentration of the contaminant & the risks of dermal exposure are known, & must be accompanied by on-site monitoring.</p>																													
Field Detection	<p>Real-time field screening tools (results not confirmatory or quantitative): Currently no field detection equipment specifically for MIC exists. HCN, isocyanates, or volatile organic compounds (VOCs) may have to be monitored as markers for the presence of MIC. Caution should be given to equipment that has not been properly evaluated. False positive & false negatives may occur in the presence of interferences common in the environment. The following is a summary of minimum screening levels for equipment procured by most EPA response teams. Other screening tools may be used by other agencies & responders; some with similar capabilities & limitations.</p>																													
	<p>NOTE: Detection equipment does not measure contaminant levels. Rather they detect the presence of listed compounds at levels as low as listed below.</p> <table border="1"> <thead> <tr> <th>Minimum Screening Levels</th> <th>Honeywell SPM Diisocyanates/HCN</th> <th>MultiRAE (VOCs)</th> <th>MultiRAE (HCN)</th> <th>Dräger - isocyanates via Toluene diisocyanate tube</th> <th>Surface SKC - Wipes/Pads Swypes/ Perma-TEC, 0.5 mg total</th> <th>HACH Kits HCN-</th> </tr> </thead> <tbody> <tr> <td>ppm</td> <td>0.002/1.0</td> <td>0.10</td> <td>1.0</td> <td>0.02</td> <td>aliphatic</td> <td>0.002 mg/L (in H₂O)</td> </tr> <tr> <td>mg/m³</td> <td>0.005/2.34</td> <td>0.23</td> <td>2.34</td> <td>0.05</td> <td>aromatic isocyanates</td> <td></td> </tr> </tbody> </table>						Minimum Screening Levels	Honeywell SPM Diisocyanates/HCN	MultiRAE (VOCs)	MultiRAE (HCN)	Dräger - isocyanates via Toluene diisocyanate tube	Surface SKC - Wipes/Pads Swypes/ Perma-TEC, 0.5 mg total	HACH Kits HCN-	ppm	0.002/1.0	0.10	1.0	0.02	aliphatic	0.002 mg/L (in H ₂ O)	mg/m ³	0.005/2.34	0.23	2.34	0.05	aromatic isocyanates				
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Sampling	<p>Note: This section on sampling contains general guidelines & does not replace the need for a site-specific sampling plan. See reference list for specifics.</p> <p>Sampling Concerns: Detection, sampling equipment & procedures, & analytical techniques will be highly site-specific & depend on: 1) physical state of the agent; 2) type of surfaces contaminated (e.g., porous vs. nonporous); 3) the purpose of sampling (e.g. characterization, decon efficacy & clearance); & 4) specific laboratory requirements. Few laboratories currently have capability to determine MIC, particularly for large numbers of samples & in all types of media. The EPA is in the process setting up analytical assets for chemical agent analysis of environmental samples, see ANALYSIS below. For sampling questions, call the EPA/HQ-EOC at 202-564-3850</p>
	<p>Sample Locations & Planning: Initially consider air sampling to ensure worker safety & to determine if there is a vapor plume which could impact other areas. Characterization sampling is initiated by targeted or judgmental sampling to identify "hot spots", potential agent flow paths, & media or objects potentially acting as sinks. Additional biased or random sampling can be used to determine the extent of potential contamination or to verify the efficacy of decon. More thorough probabilistic sampling (e.g., grid, statistical approach) will be required for the clearance phase or if there are large areas of uncertainties. Because MIC is generally not persistent, air sampling to "clear areas" should be included in the sampling plan.</p>
	<p>Note: MIC breaks down in most environmental conditions to numerous breakdown products, including N-carboxymethylamine, methylamine, hydrocyanic acid, and N,N'-dimethylurea, which are relatively less non-toxic and may be used as a marker to determine the extent of contamination of the parent MIC. See ANALYSIS section below to ensure sampling procedures are compatible with all analytes.</p> <p>Types of Samples: Air: Samples are collected using appropriate solid phase absorbent (tubes) at breathing zone level (~5 ft.) to assess inhalation exposure and at ground levels (~ 6 in.) to assess off gassing at surfaces.</p> <p>Water: Water should be collected in appropriate containers with addition of appropriate de-chlorinating agents & preservatives.</p> <p>Soil: For localized "hot spot" areas where soil deposition may occur, surface soil samples should be taken from a non-vegetated area to a depth of less than one inch. Sub-surface soil samples may not be necessary unless a large amount of liquid was poured on the ground, or if an underlying aquifer is endangered.</p> <p>Surface Wipes: Wipe samples are often desired to indicate absence of MIC (degradates) on non-porous surfaces. Concurrent air monitoring is recommended.</p> <p>Bulk: For hot spot areas where liquid MIC deposition may occur on porous surfaces (e.g., concrete, asphalt), actual pieces or cores of contaminated surface may be obtained using appropriate tools (scabbling, coring or drills) for subsequent laboratory extraction analysis. Bulk samples of suspected sink materials may be recommended to rule out secondary vapor phase disposition or absorption of MIC into these materials.</p> <p>Other Sample Matrices: Contact EPA/HQ-EOC at 202-564-3850 for sampling instructions.</p>
	<p>Sample Packaging & Shipping: The packaging & shipping of samples are subject to strict regulations established by DOT, CDC, USPS, OSHA, & IATA. Contact the sample-receiving laboratory to determine if they have additional packaging, shipping or labeling requirements.</p>
Anal- ysis	<p>CAUTION: The Environmental Response Laboratory Network (ERLN) will use uniform, compatible sample prep & analytical methods. (See http://www.epa.gov/sam). For access to the nearest ERLN laboratory, contact the EPA/HQ-EOC at 202-564-3850.</p>
Decontamination/Cleanup	<p>CAUTION: USE WATER SPRAY ONLY TO REDUCE VAPORS OR DIVERT VAPOR CLOUD DRIFT; DO NOT PUT WATER IN DIRECT CONTACT WITH LIQUID MIC. AVOID ALLOWING WATER RUNOFF TO CONTACT REMAINING MIC LIQUID. MIC is so volatile and reactive that it will either dissipate and/or be consumed by reaction with materials it encounters. Hence, most decontamination will not necessarily be for the MIC itself, but for reaction byproducts, most of which have low toxicity, except for HCN, which is only produced by reaction of MIC with acids and bases. Separate, long-term decon strategies will need developed if those byproducts are of concern in a particular situation. This decon section refers to the MIC itself.</p> <p>Decon/Cleanup Planning: Once site controls are in place, develop a site specific decon/cleanup plan. Decontamination may require a "tiered approach" using a variety of techniques and products. Call the EPA/HQ-EOC at 202-564-3850 for more information.</p> <p>General Considerations: A cost vs. benefit evaluation should be undertaken for each decon strategy and approach which considers: public safety, total cost, impact on the facility, wastes generated, as well as the time the facility or item will be out of service and any socio-economic, psychological, and/or security impacts that may result. Large volumes of decon wastes may be generated which will need to be collected, treated and disposed of properly. Waste handling and disposal must be addressed as early in the decon and cleanup process as possible, see WASTE DISPOSAL section.</p> <p>Disposal Option: The urgency to restore a facility as quickly as possible may result in the outright and timely removal and disposal of contaminated materials. Certain materials may be resistant to decon formulations, or may be cheaper to discard and replace than to decon and restore.</p> <p>Monitored Natural Attenuation: MIC is degraded or dissipates via natural processes. Environmental monitoring must be maintained during decon and recovery phases. Monitored natural attenuation may require institutional controls (e.g. access restriction and contaminant containment measures). The time to achieve clearance must be considered in the overall cost/benefit evaluation. This option is more passive than other options but is nondestructive to materials.</p> <p>Decon Strategy: A decon strategy can be developed by designating contaminated areas based on presence of 1) liquid MIC, 2) gaseous MIC or 3) aqueous solution of MIC.</p> <p>Strategy for Liquid MIC: If in gaseous form, MIC is easier to decon or allow to dissipate; actions that promote safe volatilization may be useful. Volatilization may be a slow process depending on site conditions.</p> <p>Strategy for Gaseous MIC: Aerate spaces where gaseous MIC may be present. MIC has corrosive properties and attacks plastic, rubber, and coatings. Impact on materials should be assessed for mitigation efforts. Cleaning of corroded products may be needed. Forced ventilation methods are recommended for vapor plume contamination or low concentration of MIC in large volumetric spaces or open areas. Due to low flash point, hot air ventilation is not advised.</p> <p>Strategy for Aqueous Solutions of MIC: If MIC is present in aqueous solution; it will completely decompose in a matter of hours, although the reaction between MIC and water can be violent.</p> <p>Verification of Decon: Site & situation specific. Please contact ERT (732-321-6660) and/or NDT (513-487-2420) for further assistance.</p>
Waste Disposal	<p>CAUTION: Hazardous waste transportation & disposal are regulated federally; however more stringent regulations may exist under state authority. These regulations differ from state-to-state. Detailed state regulations can be found at www.envcap.org.</p> <p>Waste Disposal Planning: The U.S. EPA considers a waste to be hazardous if it exhibits any of the following characteristics: ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.21-261.24. Under the Resource Conservation and Recovery Act (RCRA) (40 USC 6901 et seq.), U.S. EPA has specifically listed chemical wastes as hazardous, MIC is listed under RCRA, chemical code P064. MIC is also regulated under CERCLA with a reportable quantity threshold of 10 pounds. Current resources on packaging, labeling, and shipping are available at http://www.phmsa.dot.gov/hazmat. A material known to contain or suspected of containing MIC must be classed as a U.S. Department of Transportation (DOT) Division (also known as Hazard Class) as a Division 6.1, 3 hazardous material, flammable liquid & is shipped as Inhalation Hazard Zone A, and as a poisonous, flammable substance (49 CFR 172.101). The U.S. EPA has developed a web-based Incident Waste Management Planning & Response Tool which contains links to guidance related to waste transportation, contact information for potential treatment, disposal facilities, & state regulatory offices, packaging guidance to minimize risk to workers, & guidance to minimize the potential for contaminating the treatment or disposal facility. Access to the EPA's web based disposal tool requires pre-registration (http://www2.ergweb.com/bdrtool/login.asp)</p>