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BENZENE : Systemic Agent

CAS #: 71-43-2

RTECS #: CY1400000

UN #: 1114 (Guide 130)

Common Names:

- Benzol
- Coal naphtha
- Cyclohexatriene
- Phenyl hydride

Agent Characteristics

- **APPEARANCE**: Clear, colorless to light yellow liquid at room temperature. Benzene is a solid below 42°F (5.6°C).
- **DESCRIPTION**: Benzene is used to make chemicals used in the manufacture of industrial products such as dyes, detergents, explosives, pesticides, synthetic rubber, plastics, and pharmaceuticals. Benzene is found in gasoline and trace amounts are found in cigarette smoke. Benzene has been banned as an ingredient in products intended for use in the home, including toys. Benzene has a sweet, aromatic, gasoline-like odor. Most individuals can begin to smell benzene in air at 1.5 to 4.7 ppm. The odor threshold generally provides adequate warning for acutely hazardous exposure concentrations but is inadequate for more chronic exposures.
- **METHODS OF DISSEMINATION**:
  - Indoor Air: Benzene can be released into indoor air as a liquid spray (aerosol), mist, or vapor.
  - Water: Benzene can be used to contaminate water.
  - Food: Benzene can be used to contaminate food.
  - Outdoor Air: Benzene can be released into outdoor air as a liquid spray (aerosol), mist, or vapor.
  - Agricultural: If benzene is released into the air as a mist, it has the potential to contaminate agricultural products.
- **ROUTES OF EXPOSURE**: Benzene can be absorbed into the body by inhalation, ingestion, or skin contact. Inhalation is an important route of exposure.

Personal Protective Equipment

- **GENERAL INFORMATION**: First Responders should use a NIOSH-certified Chemical, Biological, Radiological, Nuclear (CBRN) Self Contained Breathing Apparatus (SCBA) with a Level A protective suit when entering an area with an unknown contaminant or when entering an area where the concentration of the contaminant is unknown. Level A protection should be used until monitoring results confirm the contaminant and the concentration of the contaminant.
  NOTE: Safe use of protective clothing and equipment requires specific skills developed through training and experience.
- **LEVEL A: (RED ZONE)**: Select when the greatest level of skin, respiratory, and eye protection is required. This is the maximum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than the AEGL-2.
  - A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle.
  - A Totally-Encapsulating Chemical Protective (TECP) suit that provides protection against CBRN agents.
  - Chemical-resistant gloves (outer).
  - Chemical-resistant gloves (inner).
  - Chemical-resistant boots with a steel toe and shank.
  - Coveralls, long underwear, and a hard hat worn under the TECP suit are optional items.
- **LEVEL B: (RED ZONE)**: Select when the highest level of respiratory protection is necessary but a lesser level of skin protection is required. This is the minimum protection for workers in danger of exposure to unknown chemical hazards or levels above the IDLH or greater than AEGL-2. It differs from Level A in that it incorporates a non-encapsulating, splash-protective, chemical-resistant splash suit that provides Level A protection against liquids but is not airtight.
  - A NIOSH-certified CBRN full-face-piece SCBA operated in a pressure-demand mode or a pressure-demand supplied air hose respirator with an auxiliary escape bottle.
  - A hooded chemical-resistant suit that provides protection against CBRN agents.
  - Chemical-resistant gloves (outer).
  - Chemical-resistant gloves (inner).
  - Chemical-resistant boots with a steel toe and shank.
  - Coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.
- **LEVEL C: (YELLOW ZONE)**: Select when the contaminant and concentration of the contaminant are known and the respiratory protection criteria factors for using Air Purifying Respirators (APR) or Powered Air Purifying Respirators (PAPR) are met. This level is appropriate when decontaminating patient/victims.
  - A NIOSH-certified CBRN tight-fitting APR with a canister-type gas mask or CBRN PAPR for air levels greater than AEGL-2.
  - A NIOSH-certified CBRN PAPR with a loose-fitting face-piece, hood, or helmet and a filter or a combination organic vapor, acid gas, and particulate cartridge/filter combination or a continuous

flow respirator for air levels greater than AEGL-1.
    - A hooded chemical-resistant suit that provides protection against CBRN agents.
    - Chemical-resistant gloves (outer).
    - Chemical-resistant gloves (inner).
    - Chemical-resistant boots with a steel toe and shank.
    - Escape mask, face shield, coveralls, long underwear, a hard hat worn under the chemical-resistant suit, and chemical-resistant disposable boot-covers worn over the chemical-resistant suit are optional items.
- **LEVEL D: (GREEN ZONE)**: Select when the contaminant and concentration of the contaminant are known and the concentration is below the appropriate occupational exposure limit or less than AEGL-1 for the stated duration times.
    - Limited to coveralls or other work clothes, boots, and gloves.

Emergency Response

- **CHEMICAL DANGERS**:
    - See Explosion Hazards.
- **EXPLOSION HAZARDS**:
    - Benzene reacts violently with oxidants and halogens, causing an explosion hazard.
    - Benzene poses a vapor explosion hazard indoors, outdoors, or in sewers.
    - Vapors may form explosive mixtures with air.
    - Run-off to sewers may create an explosion hazard.
    - Containers may explode when heated.
    - Lower explosive (flammable) limit in air (LEL), 1.2%; upper explosive (flammable) limit in air (UEL), 7.8%.
- **FIRE FIGHTING INFORMATION**:
    - Benzene is highly flammable.
    - The agent will be easily ignited by heat, sparks, or flames.
    - Fire will produce irritating, corrosive, and/or toxic gases.
    - Benzene reacts violently with oxidants and halogens, causing a fire hazard.
    - Vapors may travel to the source of ignition and flash back.
    - Run-off to sewers may create a fire hazard.
    - Caution: The agent has a very low flash point. Use of water spray when fighting fires may be inefficient.
    - For small fires, use dry chemical, carbon dioxide, water spray, or regular foam.
    - For large fires, use water spray, fog, or regular foam. Do not use straight streams. Move containers from the fire area if it is possible to do so without risk to personnel.
    - For fire involving tanks or car/trailer loads, fight the fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after

the fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tanks. Always stay away from tanks engulfed in fire.
    - For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from the area and let the fire burn.
    - Run-off from fire control or dilution water may cause pollution.
    - If the situation allows, control and properly dispose of run-off (effluent).
- **INITIAL ISOLATION AND PROTECTIVE ACTION DISTANCES**:
    - If a tank, rail car, or tank truck is involved in a fire, isolate it for 0.5 mi (800 m) in all directions; also consider initial evacuation for 0.5 mi (800 m) in all directions.
    - This agent is not included in the DOT ERG 2004 Table of Initial Isolation and Protective Action Distances.
    - In the DOT ERG 2004 orange-bordered section of the guidebook, there are public safety recommendations to isolate a benzene (Guide 130) spill or leak area immediately for at least 150 ft (50 m) in all directions. For a large spill, consider initial downwind evacuation of at least 1000 ft (300 m).
- **PHYSICAL DANGERS**:
    - Benzene vapors are heavier than air. They will spread along the ground and collect and stay in poorly-ventilated, low-lying, or confined areas (e.g., sewers, basements, and tanks).
    - Hazardous concentrations may develop quickly in enclosed, poorly-ventilated, or low-lying areas. Keep out of these areas. Stay upwind.
    - Benzene liquid is less dense than water and will float on the surface of water.
- **NFPA 704 Signal**:

    - **Health:** 2
    - **Flammability:** 3
    - **Reactivity:** 0
    - **Special:**

- **SAMPLING AND ANALYSIS**:
    - OSHA: 12, 1005
    - NIOSH: 1500, 1501, 3700, 3800
- **ADDITIONAL SAMPLING AND ANALYSIS INFORMATION**:

References are provided for the convenience of the reader and do not imply endorsement by NIOSH.

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- OTHER
  No references were identified for this sampling matrix for this agent.

- SOIL MATRIX
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- SURFACES
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  Barary MH, Sabry SM, Wahbi AAM [1991]. Spectrophotometric determination of benzene in ethanol. J Clin Pharm Ther 16(20):111-116.

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Signs/Symptoms

- **TIME COURSE**: Central nervous system (CNS) depression can occur immediately following inhalation of benzene vapors. Gastrointestinal (GI) irritation and CNS depression can occur between 30 and 60 minutes after benzene has been ingested. Loss of consciousness usually resolves once the patient/victim has been removed from the source of exposure, but may be prolonged. Patient/victims who have ingested benzene must be watched for a minimum of 72 hours to rule out the possibility of aspiration pneumonitis (inflammation of the lungs caused by inhalation of a chemical). Full recovery from benzene exposure may take from 1 – 4 weeks.
- **EFFECTS OF SHORT-TERM (LESS THAN 8-HOURS) EXPOSURE**: Benzene vapors are irritating to the respiratory tract and eyes. Breathing benzene vapors results in adverse health effects related to the central nervous system including drowsiness, dizziness, rapid heart rate, headache, lightheadedness, nausea, tremors, impaired gait, confusion, loss of consciousness, shortness of breath, respiratory depression, coma, and possibly death. Ingestion of benzene causes irritation of the gastrointestinal tract, nausea, vomiting, stomach pain, diarrhea, dizziness, sleepiness, seizures, rapid heart rate, and death.
- **EYE EXPOSURE**:
  - High concentrations of vapor: Irritation and blurred vision.
  - Liquid: Burning pain and possibly reversible loss (sloughing) and injury to the surface of the cornea.
- **INGESTION EXPOSURE**:
  - Nine to 12 g: Irritation of the stomach causing nausea, vomiting (emesis), and diarrhea; burning sensation to the mouth, esophagus, and stomach; abnormally rapid heart rate (tachycardia); staggering gait, drowsiness (somnolence), loss of consciousness, or altered mental status; and inflammation of the lungs and respiratory failure.
  - Slightly higher ingested doses: Dizziness and excitation followed by a flushed appearance, difficulty breathing or shortness of breath (dyspnea), feeling of chest tightness, headache, and generalized weakness.
  - At the highest ingested doses: In addition to the above adverse health effects, symptoms include euphoria and excitation followed by fatigue, coma, and death.
- **INHALATION EXPOSURE**:
  - 700 to 3,000 ppm: Drowsiness, dizziness, headaches, tremors, confusion, unconsciousness, abnormally rapid heart rate (tachycardia), and irritation of the moist linings (mucous membranes of the respiratory tract).

- 3,000 ppm and above: Slow and shallow breathing; a deeper level of unconsciousness, due to narcotic-like action on the CNS; and with prolonged exposures, seizures, paralysis, abnormal (potentially fatal) heart rhythms (cardiac arrhythmia), and cessation of breathing (apnea).
- 20,000 ppm for 5 minutes: Cessation of breathing (apnea) due to accumulation of fluid in the lungs (pulmonary edema).
- If benzene is ingested and vomited, inhalation of benzene-containing vomitus into the lungs (aspiration) may cause potentially fatal lung damage.

- **SKIN EXPOSURE**:
  - Mild to moderate: Irritation, redness (erythema), and burning sensation.
  - Severe: Fluid accumulation (edema), blistering (vesication), and inflammation (dermatitis).
  - Absorption through the skin is slow, but it may contribute to whole-body (systemic) toxicity.
  - See Inhalation Exposure

Decontamination

- **INTRODUCTION**: The purpose of decontamination is to make an individual and/or their equipment safe by physically removing toxic substances quickly and effectively. Care should be taken during decontamination, because absorbed agent can be released from clothing and skin as a gas. Your Incident Commander will provide you with decontaminants specific for the agent released or the agent believed to have been released.
- **DECONTAMINATION CORRIDOR**: The following are recommendations to protect the first responders from the release area:
  - Position the decontamination corridor upwind and uphill of the hot zone. The warm zone should include two decontamination corridors. One decontamination corridor is used to enter the warm zone and the other for exiting the warm zone into the cold zone. The decontamination zone for exiting should be upwind and uphill from the zone used to enter.
  - Decontamination area workers should wear appropriate PPE. See the PPE section of this card for detailed information.
  - A solution of detergent and water (which should have a pH value of at least 8 but should not exceed a pH value of 10.5) should be available for use in decontamination procedures. Soft brushes should be available to remove contamination from the PPE. Labeled, durable 6-mil polyethylene bags should be available for disposal of contaminated PPE.
- **INDIVIDUAL DECONTAMINATION**: The following methods can be used to decontaminate an individual:
  - Decontamination of First Responder:
    - Begin washing PPE of the first responder using soap and water solution and a soft brush. Always move in a downward motion (from head to toe). Make sure to get into all areas, especially folds in the clothing. Wash and rinse (using cold or warm water) until the contaminant is thoroughly removed.

        - Remove PPE by rolling downward (from head to toe) and avoid pulling PPE off over the head. Remove the SCBA after other PPE has been removed.
        - Place all PPE in labeled durable 6-mil polyethylene bags.
    - Decontamination of Patient/Victim:
        - Remove the patient/victim from the contaminated area and into the decontamination corridor.
        - Remove all clothing (at least down to their undergarments) and place the clothing in a labeled durable 6-mil polyethylene bag.
        - Thoroughly wash and rinse (using cold or warm water) the contaminated skin of the patient/victim using a soap and water solution. Be careful not to break the patient/victim's skin during the decontamination process, and cover all open wounds.
        - Cover the patient/victim to prevent shock and loss of body heat.
        - Move the patient/victim to an area where emergency medical treatment can be provided.

First Aid

- **GENERAL INFORMATION**: Initial treatment is primarily supportive of respiratory and cardiovascular function.
- **ANTIDOTE**: There is no antidote for benzene toxicity.
- **EYE**:
    - Immediately remove the patient/victim from the source of exposure.
    - Immediately wash eyes with large amounts of tepid water for at least 15 minutes.
    - Seek medical attention immediately.
- **INGESTION**:
    - Immediately remove the patient/victim from the source of exposure.
    - Ensure that the patient/victim has an unobstructed airway.
    - Do not induce vomiting (emesis).
    - Take measures to avoid stomach contents being taken into the lungs (pulmonary aspiration); i.e., place the patient/victim on their side.
    - Activated charcoal has limited ability to decrease gastrointestinal absorption of benzene.
    - Once the airway is secured, consider using a soft flexible nasogastric tube to aspirate the stomach contents.
    - See the Inhalation section for first aid recommendations.
    - Seek medical attention immediately.
- **INHALATION**:
    - Immediately remove the patient/victim from the source of exposure.
    - Evaluate respiratory function and pulse.
    - Ensure that the patient/victim has an unobstructed airway.
    - If shortness of breath occurs or breathing is difficult (dyspnea), administer oxygen.
    - Assist ventilation as required. Always use a barrier or bag-valve-mask device.

- If breathing has ceased (apnea), provide artificial respiration.
- If cough, difficulty breathing, or shortness of breath (dyspnea) develop, evaluate for respiratory tract irritation, inflammation of the large airways (bronchitis), and inflammatory lung disease (pneumonia).
- Monitor for low blood pressure (hypotension), abnormal heart rhythms (dysrhythmias), and reduced respiratory function (respiratory depression).
- In cases of respiratory compromise, secure the airway and respiration by inserting a tube within the trachea (endotracheal intubation).
- If evidence of shock or low blood pressure (hypotension) is observed, begin intravenous (IV) fluid administration.
- Avoid use of epinephrine for alteration of heart rhythm (cardiac arrhythmias) due to possible sensitization of the heart muscle.
- If seizures develop administer benzodiazepines.
- Seek medical attention immediately.

- **SKIN**:
  - Immediately remove the patient/victim from the source of exposure.
  - See the Decontamination section for patient/victim decontamination procedures.
  - Seek medical attention immediately.

See ATSDR Medical Management Guidelines for Acute Chemical Exposures, Benzene, http://www.atsdr.cdc.gov/MHMI/mmg3.pdf, for detailed recommendations.

Long-Term Implications

- **MEDICAL TREATMENT**: Patient/victims with significant exposure to benzene should be followed for up to 72 hours to monitor for the development of delayed effects, including the accumulation of fluid in the lungs (pulmonary edema).
- **DELAYED EFFECTS OF EXPOSURE**: Long-term adverse health effects caused by exposure to moderate to high levels of benzene may include: trouble walking (ataxia), excessive nervousness and irritability, and shortness of breath. These adverse health effects may last up to 2 weeks. Additional adverse health effects may include abnormal heart rhythms and yellow coloration of the skin. These effects may persist for up to 4 weeks.
- **EFFECTS OF CHRONIC OR REPEATED EXPOSURE**: Benzene is carcinogenic to humans. It has been associated with cancer of the blood (leukemia), which may occur with chronic exposures to benzene of 10 ppm. Information is inconclusive but suggestive of developmental toxicity and reproductive toxicity risk with chronic or repeated exposure to benzene. Adverse health effects due to long-term benzene exposure are non-specific. Effects include fatigue, headache, dizziness, nausea, loss of appetite, loss of weight, and weakness. Repeated or prolonged skin contact with liquid benzene can remove the natural oils from the skin, causing it to crack and peel. Repeated exposure to levels of benzene below 200 ppm may cause chronic CNS effects (headache, drowsiness, and nervousness). Chronic benzene exposure in

the workplace has been associated with blood (hematologic) disorders, such as low platelet counts (thrombocytopenia), absence of red blood cells (aplastic anemia), and loss of all types of blood cells due to bone marrow damage.

On-Site Fatalities

- **INCIDENT SITE**:
  - Consult with the Incident Commander regarding the agent dispersed, dissemination method, level of PPE required, location, geographic complications (if any), and the approximate number of remains.
  - Coordinate responsibilities and prepare to enter the scene as part of the evaluation team along with the FBI HazMat Technician, local law enforcement evidence technician, and other relevant personnel.
  - Begin tracking remains using waterproof tags.
- **RECOVERY AND ON-SITE MORGUE**:
  - Wear PPE until all remains are deemed free of contamination.
  - Establish a preliminary (holding) morgue.
  - Gather evidence, and place it in a clearly labeled impervious container. Hand any evidence over to the FBI.
  - Remove and tag personal effects.
  - Perform a thorough external evaluation and a preliminary identification check.
  - See the Decontamination section for decontamination procedures.
  - Decontaminate remains before they are removed from the incident site.

See Guidelines for Mass Fatality Management During Terrorist Incidents Involving Chemical Agents, U.S. Army Soldier and Biological Chemical Command (SBCCOM), November, 2001 for detailed recommendations.

Occupational Exposure Limits

- **NIOSH REL**:
  - TWA (10-hour): 0.1 ppm
  - STEL (15-min): 1 ppm
- **OSHA PEL**:
  - TWA (8-hour): 1 ppm
  - STEL (15-min): 5 ppm
- **ACGIH TLV**:
  - TWA (8-hour): 0.5 ppm
  - STEL (15-minute): 2.5 ppm (skin)
- **NIOSH IDLH**: 500 ppm (potential occupational carcinogen)

- **DOE TEEL**:
  - TEEL-0: 3 mg/m^3
  - TEEL-1: 156 mg/m^3
  - TEEL-2: 470 mg/m^3
  - TEEL-3: 3,130 mg/m^3
- **AIHA ERPG**:
  - ERPG-1: 50 ppm
  - ERPG-2: 150 ppm
  - ERPG-3: 1,000 ppm

Acute Exposure Guidelines [Interim]

	10 min	30 min	60 min	4 hr	8 hr
AEGL 1 (discomfort, non-disabling) - ppm	130 ppm	73 ppm	52 ppm	18 ppm	9.0 ppm
AEGL 2 (irreversible or other serious, long-lasting effects or impaired ability to escape) - ppm	2,000* ppm	1,100 ppm	800 ppm	400 ppm	200 ppm
AEGL 3 (life-threatening effects or death) - ppm	**	5,600* ppm	4,000* ppm	2,000* ppm	990 ppm

Lower Explosive Limit (LEL) = 14,000 ppm
* = >10% LEL; ** = >50% LEL
AEGL 3 - 10 mins = ** 9,700 ppm
For values denoted as * safety considerations against the hazard(s) of explosion(s) must be taken into account.
For values denoted as ** extreme safety considerations against the hazard(s) of explosion(s) must be taken into account.

Technical Support Document (http://www.epa.gov/oppt/aegl/pubs/benzene_interim_dec_2008_v1.pdf)

IMPORTANT NOTE: Interim AEGLs are established following review and consideration by the National Advisory Committee for AEGLs (NAC/AEGL) of public comments on Proposed AEGLs. Interim AEGLs are available for use by organizations while awaiting NRC/NAS peer review and publication of Final AEGLs. **Changes to Interim values and Technical Support Documents may occur prior to publication of Final AEGL**

values. In some cases, revised Interim values may be posted on this Web site, but the revised Interim Technical Support Document for the chemical may be subject to change. (Further information is available through AEGL Process).

Decontamination (Environment and Equipment)

- **ENVIRONMENT/SPILLAGE DISPOSAL**: The following methods can be used to decontaminate the environment/spillage disposal:
  - Do not touch or walk through the spilled agent if at all possible. However, if you must, personnel should wear the appropriate PPE during environmental decontamination. See the PPE section of this card for detailed information.
  - Keep combustibles (e.g., wood, paper, and oil) away from the spilled agent. Use water spray to reduce vapors or divert vapor cloud drift. Avoid allowing water runoff to contact the spilled agent.
  - Do not direct water at the spill or the source of the leak.
  - Stop the leak if it is possible to do so without risk to personnel, and turn leaking containers so that gas rather than liquid escapes.
  - Prevent entry into waterways, sewers, basements, or confined areas.
  - Isolate the area until gas has dispersed.
  - Ventilate the area.
- **EQUIPMENT**: Agents can seep into the crevices of equipment making it dangerous to handle. The following methods can be used to decontaminate equipment:
  - Not established / determined

Agent Properties

- **Chemical Formula:**
  C_6H_6
- **Aqueous solubility:**
  Slightly soluble
- **Boiling Point:**
  176°F (80.1°C)
- **Density:**
  Vapor: 2.8 (air = 1)
  Liquid: 0.8787 at 59°F/39°F (15°C/4°C)
- **Flammability:**
  Flammable liquid
- **Flashpoint:**
  12°F (-11°C)
- **Ionization potential:**
  9.24 eV

- **Log $K_{benzene\text{-}water}$:**
  Not established/determined
- **Log K_{ow} (estimated):**
  2.13
- **Melting Point:**
  41.9°F (5.5°C)
- **Molecular Mass:**
  78.11
- **Soluble In:**
  Alcohol
  Carbon disulfide
  Chlorides
  Oils
- **Specific Gravity:**
  0.88
- **Vapor Pressure:**
  75 mm Hg at 68°F (20°C)
- **Volatility:**
  75 mm Hg at 68°F (20°C)

Hazardous Materials Warning Labels/Placards

- **Shipping Name:**
  Benzene
- **Identification Number:**
  1114 (Guide 130)
- **Hazardous Class or Division:**
  3
- **Subsidiary Hazardous Class or Division:**
- **Label:**
  Flammable liquid
- **Placard Image:**

Trade Names and Other Synonyms

- (6)Annulene
- Benzeen (Dutch)
- Benzen (Polish)
- Benzin
- Benzol 90
- Benzole
- Benzolene
- Benzolo (Italian)
- Bicarburet of hydrogen
- Carbon oil
- Coal tar naphtha
- Fenzen (Czech)
- Mineral naphtha
- Motor benzol
- Nitration benzene
- Phene
- Polystream
- Pyrobenzol
- Pyrobenzole

Who to Contact in an Emergency

In the event of a poison emergency, call the poison center immediately at 1-800-222-1222. If the person who is poisoned cannot wake up, has a hard time breathing, or has convulsions, call 911 emergency services.

For information on who to contact in an emergency, see the CDC website at http://emergency.cdc.gov/emcontact/index.asp (http://emergency.cdc.gov/emcontact/index.asp) or call the CDC public response hotline at (888) 246-2675 (English), (888) 246-2857 (Español), or (866) 874-2646 (TTY).

Important Notice

The user should verify compliance of the cards with the relevant STATE or TERRITORY legislation before use. NIOSH, CDC 2003.

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