

# Fentanyl: Incapacitating Agent

The information and recommendations below were developed to address a wide area release of fentanyl as a weapon of terrorism, and are not specifically intended to address exposures associated with fentanyl use as an illicit drug. NIOSH is currently in the process of reviewing more recent research and publications regarding appropriate emergency response guidelines for fentanyl. Consequently, some of the guidelines presented on this page may be different than recommendations for emergency response personnel responding to fentanyl used as an illicit drug. Please see this website for information for emergency response personnel responding to fentanyl as an illicit drug: <https://www.cdc.gov/niosh/topics/fentanyl/risk.html>.

CAS #: 437-38-7

Common Names:

RTECS #: UT5550000

- Not established/determined

UN #: UN 2811

## Agent Characteristics

- **APPEARANCE:** Crystals or crystalline powder.
- **DESCRIPTION:** Fentanyl is a member of the class of drugs known as fentanyls, rapid-acting opioid (synthetic opiate) drugs that alleviate pain without causing loss of consciousness (analgesic). Fentanyl depresses central nervous system (CNS) and respiratory function. Exposure to fentanyl may be fatal. Fentanyl is estimated to be 80 times as potent as morphine and hundreds of times more potent than heroin. It is a drug of abuse. Fentanyl (and other opioids) could possibly be used as an incapacitating agent to impair a person's ability to function. In October 2002, the Russian military reportedly used "a fentanyl derivative" against terrorists holding hostages in a Moscow theater; 127 of the hostages died. (It is unclear whether the gas used also included other chemical agent(s).) Fentanyl is odorless.
- **METHODS OF DISSEMINATION:**
  - Indoor Air: Fentanyl can be released into indoor air as fine particles or liquid spray (aerosol).
  - Water: Fentanyl can be used to contaminate water.
  - Food: Fentanyl can be used to contaminate food.
  - Outdoor Air: Fentanyl can be released into outdoor air as fine particles or liquid spray (aerosol).
  - Agricultural: If fentanyl is released into the air as fine particles or liquid spray (aerosol), it has the potential to contaminate agricultural products.
- **ROUTES OF EXPOSURE:** Fentanyl can be absorbed into the body via inhalation, oral exposure or ingestion, or skin contact. It is not known whether fentanyl can be absorbed systemically through the eye. Fentanyl can be administered intravenously (IV), intramuscularly (IM), or as a skin patch (transdermally).

## 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:**
  - Hazardous polymerization will not occur.
- **EXPLOSION HAZARDS:**
  - Not established/determined
- **FIRE FIGHTING INFORMATION:**
  - Burning may produce carbon monoxide, carbon dioxide, and nitrogen oxides.
- **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 evacuations 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 fentanyl (Guide 111) spill or leak area immediately for at least 330 ft (100 m) in all directions.

- **PHYSICAL DANGERS:**

- Not established/determined

- **NFPA 704 Signal:**

- Health: 4
- Flammability: 1
- Reactivity: 0
- Special:



- **SAMPLING AND ANALYSIS:**

- OSHA: Not established/determined
- NIOSH: Not established/determined

- **ADDITIONAL SAMPLING AND ANALYSIS INFORMATION:**

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

- **AIR MATRIX**

Heusler H [1985]. Quantitative analysis of common anaesthetic agents. *J Chromatogr: Biomed Appl* 340:273-319. Suzuki S [1989]. Spectrometric discrimination of five monomethylated fentanyl isomers including fentanyl by gas chromatography/Fourier transform-infrared spectrometry. *Forensic Sci Int* 43(1):15-19.

- **OTHER**

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

- **SOIL MATRIX**

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

- **SURFACES**

Henderson GL, Harkey MR, Jones AD [1990]. Rapid screening of fentanyl (China White) powder samples by solid-phase radioimmunoassay. *J Anal Toxicol* 14(3):172-175. Lambropoulos J, Spanos GA, Lazaridis NV [2000]. Development and validation of an HPLC assay for fentanyl, alfentanil, and sufentanil in swab samples. *J Pharm Biomed Anal* 23(2-3):421-428.

- **WATER**

Björkman S, Stanski DR [1988]. Simultaneous determination of fentanyl and alfentanil in rat tissues by capillary column gas chromatography. *J Chromatogr B: Biomed Sci Appl* 433:95-104. Bjorksten AR, Chan C, Crankshaw DP [2002]. Determination of remifentanyl in human blood by capillary gas chromatography with nitrogen-selective detection. *J Chromatogr B* 775(1):97-101. Caldwell R, Challenger H [1989]. A capillary column gas-chromatographic method for the identification of drugs of abuse in urine samples. *Ann Clin Biochem* 26(5):430-443. Choi HS, Shin HC, Khang G, Rhee JM, Lee HB [2001]. Quantitative analysis of fentanyl in rat plasma by gas chromatography with nitrogen-phosphorus detection. *J Chromatogr B: Biomed Sci Appl* 765(1):63-69.

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- Kintz P, Mangin P, Lugner AA, Chaumont AJ [1989]. Simultaneous determination of fentanyl and its major metabolites and fentanyl analogues using gas chromatography and nitrogen-selective detection. *J Chromatogr B: Biomed Sci Appl* 489(2):459-461.
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Tobin T, Tai HH, Tai CL, Houtz PK, Dai MR, Woods WE, Yang JM, Weckman TJ, Chang SL, Blake JW, McDonald J, Gall R, Wiedenbach P, Bass VD, Deleon B, Ozog FJ, Green M, Brockus C, Stobert D, Wie S, Prange CA [1988]. Immunoassay detection of drugs in racing horses. IV. Detection of fentanyl and its congeners in equine blood and urine by a one step ELISA assay. *Res Commun Chem Pathol Pharmacol* 60(1):97-115.

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Yuansheng L, Yutian W, Jing Z, Zhenxing Z, Zhanxi Q, Shen G, Quinghong K, Xinhua W [1996]. Capillary GC determination of fentanyl and midazolam in human plasma. *Microchem J* 53(1):130-136.

## Signs/Symptoms

- **TIME COURSE:** Peak analgesia occurs within several minutes of intravenous (IV) administration. The duration of analgesia is 30 to 60 minutes after a single dose of up to 100 µg. Dermal exposure to fentanyl results in absorption over hours to days. Oral exposure occurs in two phases. Initial exposure will occur within a few minutes, with absorption through the intestinal tract occurring over 2 hours. Inhalation of fentanyl results in rapid absorption.
- **EFFECTS OF SHORT-TERM (LESS THAN 8-HOURS) EXPOSURE:** Fentanyl can produce delayed reduced respiratory function (respiratory depression) and respiratory arrest. With rapid intravenous (IV) administration, rigidity of the chest muscles ("wooden chest syndrome") may be produced, which interferes with normal breathing. A rise of blood pressure within the brain (intracranial hypertension) and muscle rigidity and spasms have been reported following fentanyl use.
- **EYE EXPOSURE:**
  - Irritation may occur.
- **INGESTION EXPOSURE:**
  - Contracted or pinpoint pupils (miosis) (may later become dilated), reduced level of consciousness (CNS depression), reduced respiratory function (respiratory depression), reduced blood oxygen content (hypoxia), accumulation of acid in the blood (acidosis), low blood pressure (hypotension), slow heart rate (bradycardia), shock, slowing of muscular movement of the stomach (gastric hypomotility) with intestinal obstruction due to lack of normal muscle function (ileus), accumulation of fluid in the lungs (pulmonary edema), lethargy, coma, and death.
- **INHALATION EXPOSURE:**
  - See Ingestion Exposure.
- **SKIN EXPOSURE:**
  - See Ingestion Exposure.
  - Absorption through the skin may contribute to whole-body (systemic) toxicity.
  - Absorption increases with skin temperature (based on medical use of transdermal patch).

## 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:** Treatment consists of administration of the antidote and aggressive support of respiratory function.
- **ANTIDOTE:** Naloxone (Narcan) in doses of 0.4 to 2.0 mg has been recommended for treatment of opioid overdose. Naloxone is commonly given intravenously. The onset of effect following IV naloxone administration is 1 to 3 minutes; maximal effect is observed within 5 to 10 minutes. Doses may be repeated as needed to maintain effect. Administration of naloxone may also reverse the "wooden chest syndrome."
- **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).
  - Administer naloxone under physician's direction or by following applicable EMS protocol. See Antidote section.
  - Administer charcoal as a slurry (240 mL water/30 g charcoal). Usual dose: 25 to 100 g in adults/adolescents, 25 to 50 g in children (1 to 12 years), and 1 g/kg in infants less than 1 year old.
  - 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.



- Monitor the patient/victim for signs of whole-body (systemic) effects and administer symptomatic treatment as necessary.
- If signs of whole-body (systemic) poisoning appear, see the Ingestion section for treatment recommendations.
- Seek medical attention immediately.
- **SKIN:**
  - Immediately remove the patient/victim from the source of exposure.
  - See the Decontamination section for patient/victim decontamination procedures.
  - Monitor the patient/victim for signs of whole-body (systemic) effects.
  - If signs of whole-body (systemic) poisoning appear, see the Ingestion section for treatment recommendations.
  - Seek medical attention immediately.

## Long-Term Implications

- **MEDICAL TREATMENT:** Patient/victims exhibiting significantly reduced respiratory function (respiratory depression), recurrent sedation, or any other complicating factors of opioid toxicity should be admitted for a minimum of 12 to 24 hours of observation. Heart function should be monitored, and the patient/victim should be evaluated for low blood pressure (hypotension), abnormal heart rhythms (dysrhythmias), and reduced respiratory function (respiratory depression). Accumulation of fluid in the lungs (pulmonary edema) is a common aftereffect (sequela), and patient/victims should be monitored for its development and treated accordingly.
- **DELAYED EFFECTS OF EXPOSURE:** Not established/determined
- **EFFECTS OF CHRONIC OR REPEATED EXPOSURE:** It is unknown whether chronic or repeated exposure to fentanyl increases the risk of carcinogenicity, reproductive toxicity, or developmental toxicity.

## 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:**
  - Not established/determined
- **OSHA PEL:**
  - Not established/determined
- **ACGIH TLV:**

- Not established/determined
- NIOSH IDLH: Not established/determined
- DOE TEEL:
  - TEEL-0: Not established/determined
  - TEEL-1: Not established/determined
  - TEEL-2: Not established/determined
  - TEEL-3: Not established/determined
- AIHA ERPG:
  - ERPG-1: Not established/determined
  - ERPG-2: Not established/determined
  - ERPG-3: Not established/determined
- Mallinckrodt Inc. lists Occupational Exposure Guidelines (OEG): 0.7 µg/m<sup>3</sup> as an 8-hour time-weighted-average.  
Mallinckrodt Inc. lists Short-Term Exposure Guidelines (STEG): 2 µg/m<sup>3</sup> as a 15-minute average.

## Acute Exposure Guidelines

	5 min	10 min	30 min	1 hr	4 hr	8 hr
<b>AEGL 1</b> (discomfort, non-disabling) – mg/m <sup>3</sup>	Not established/determined	Not established/determined	Not established/determined	Not established/determined	Not established/determined	Not established/determined
<b>AEGL 2</b> (irreversible or other serious, long-lasting effects or impaired ability to escape) – mg/m <sup>3</sup>	Not established/determined	Not established/determined	Not established/determined	Not established/determined	Not established/determined	Not established/determined
<b>AEGL 3</b> (life-threatening effects or death) – mg/m <sup>3</sup>	Not established/determined	Not established/determined	Not established/determined	Not established/determined	Not established/determined	Not established/determined

## 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:**  
C22H28N2O
- **Aqueous solubility:**  
Slightly soluble
- **Boiling Point:**  
Not established/determined
- **Density:**  
Not established/determined
- **Flammability:**  
Not established/determined
- **Flashpoint:**  
Not established/determined
- **Ionization potential:**  
Not established/determined
- **Log  $K_{\text{benzene-water}}$ :**  
Not established/determined
- **Log  $K_{\text{ow}}$  (estimated):**  
4.05
- **Melting Point:**  
181.4° to 183.2°F (83° to 84°C)
- **Molecular Mass:**  
336.47
- **Soluble In:**  
Not established/determined
- **Specific Gravity:**  
Not established/determined
- **Vapor Pressure:**  
Not established/determined
- **Volatility:**  
Not established/determined

## Hazardous Materials Warning Labels/Placards

- **Shipping Name:**  
Toxic solid, organic, N.O.S. (Propanamide, N-phenyl-N-[1-(2-phenylethyl)-4-piperomdonyl]-)
- **Identification Number:**  
UN 2811
- **Hazardous Class or Division:**  
6.1
- **Subsidiary Hazardous Class or Division:**  
Not applicable
- **Label:**  
Poison (Toxic)
- **Placard Image:**



## Trade Names and Other Synonyms

- DEA #9801 (Controlled Substances Schedule II)
- Duragesic
- Fentanest
- Fentanil
- Fentanila (Spanish)
- Fentanylum (Latin)
- Leptanal
- Pentanyl
- 1-Phenethyl-4-(N-phenylpropionamido)piperidine
- 1-Phenethyl-4-(phenylpropionylamino)piperidine
- N-(1-Phenethyl-4-piperidyl)propionanilide
- N-Phenethyl-4-(N-propionylanilino)piperidine
- 1-Phenethyl-4-N-propionylanilinopiperidine
- Phentanyl
- N-Phenyl-N-[1-(2-phenylethyl)-4-piperidinyl]propanamide
- Propanamide, N-phenyl-N-(1-(2-phenylethyl)-4-piperidinyl)
- Propionanilide, N-(1-phenethyl-4-piperidyl)-
- R 4263
- Sentonil

## 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 [emergency.cdc.gov](http://emergency.cdc.gov) 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.