The Fentanyl Fact Sheet was developed for U.S. Environmental Protection Agency (EPA) Federal On-Scene Coordinators (OSC) who may respond with, or provide technical advice to, local first responders who may encounter environmental contamination from fentanyl class compounds (fentanyl analogs). This fact sheet provides information regarding characteristics of fentanyl and fentanyl analogs; the physical properties of fentanyl, fentanyl citrate, carfentanil, 3-methylfentanyl and α-methylfentanyl; potential exposure pathways; provisional advisory levels (PAL) and industry occupational exposure limits (OEL); opioid relative potency, equianalgesic dose and estimated lethal dose; personal safety; personal protective equipment (PPE); field detection; sampling; analysis; decontamination/cleanup; personnel decontamination; waste management; and technical references. EPA does not assume responsibility for errors, misinterpretation of technical information, injury or illness as a result of use or misuse of this fact sheet. Technical content may change without prior notice. Non-EPA personnel are encouraged to develop health and safety guidance for their own personnel. Mention of trade names or services does not convey official EPA approval or endorsement. ***For additional information regarding this fact sheet, contact the EPA Chemical, Biological, Radiological and Nuclear (CBRN) Consequence Management Advisory Division (CMAD) via the EPA Emergency Operations Center (HQ-EOC) at 202-564-3850 (24-hr access).***

CHARACTERISTICS OF FENTANYL AND FENTANYL ANALOGS

Classification: A synthetic opioid; Schedule II, Controlled Substances Act.

Fentanyl, Salts and Analogs: Fentanyl, Fentanyl citrate, Carfentanil, 3-Methylfentanyl, α-Methylfentanyl and numerous others.

Synonyms: 1-Phenethyl-4-(N-phenylpropionamido)piperidine; 1-Phenethyl-4-(phenylpropionylamino)piperidine; 1-Phenethyl-4-N-propionylanilinopiperidine; DEA# 9801; Fentanest; Fentanil; Fentanila (Spanish); Fentanylum (Latin); Leptanal; N-(1-Phenethyl-4-piperidinyl)-N-phenylpropionamide hydrochloride; N-(1-phenethyl-4-piperidyl)-, hydrochloride; N-(1-Phenethyl-4-piperidyl)propionanilide; N-Phenethyl-4-(N-propionylanilino)piperidine; N-Phenyl-N-[1-(2-phenylethyl)-4-piperidinyl]propanamide hydrochloride; N-Phenyl-N-[1-(2-phenylethyl)-4-piperidinyl]propanamide; Pentanyl; Phentanyl; Propanamide, N-phenyl-N-(1-(2-phenylethyl)-4-piperidinyl); R4263; Sentonil.[1]

Description: Odorless, solid/crystalline powder.[2] Can be white or colored powder, or brown and pebbly.[3] Fentanyl is a member of a class of drugs known as fentanyl analogs, which are rapid-acting opioid (synthetic opiate) drugs that alleviate pain without causing loss of consciousness at therapeutic levels. Fentanyl analogs are also abused due to the euphoric effects they produce.[4] The U.S. Drug Enforcement Administration (DEA) has identified 15 common fentanyl derivatives, which are referred to in this document as fentanyl analogs. Fentanyl is a free standing base. As a result, the active forms of fentanyl often exist as fentanyl salts, e.g., fentanyl citrate. Fentanyl analogs may be dissolved in a polar organic solvent such as alcohol. With the exception of fentanyl salts, most fentanyl analogs show limited solubility in water. The fentanyl analogs may be present in solution, as powders, and in several other forms, e.g., pills and on blot paper.

Persistence: While there have been few studies investigating the environmental persistence of fentanyl, fentanyl is considered persistent on surfaces and in water under normal environmental conditions. Persistence will depend upon release, environmental conditions, and the types of surface(s) and materials affected.

PHYSICAL PROPERTIES OF FENTANYL, FENTANYL CITRATE, CARFENTANIL, 3-METHYLFENTANYL, α-METHYLFENTANYL

(Physical properties are listed at/near standard temperature and pressure unless otherwise indicated)

FENTANYL[5]	CAS: 437-38-7		
Molecular Weight:	336.5 g/mole	**Formula:**	$C_{22}H_{28}N_2O$
Boiling Point:	870.8°F / 466°C	**Soluble:**	Insoluble to slightly soluble in water; soluble in alcohols [6, 7]
Melting/Freezing Point:	181-183°F / 83-84ºC	**Aqueous Solubility:**	Low, 200 milligrams per liter (mg/L) at 25°C
Flash Point:	367°F/186°C	**Density:**	1.087 grams per cubic centimeter (g/cm^3)
FENTANYL CITRATE[8]	CAS: 990-73-8		
Molecular Weight:	528.6 g/mole	**Formula:**	$C_{22}H_{28}N_2O \cdot C_6H_8O_7$
Boiling Point:	870.8°F / 466°C	**Soluble:**	Soluble in water; soluble in alcohols[9]
Melting/Freezing Point:	307-313°F / 153-156ºC	**Aqueous Solubility:**	Moderate, 1 g/40 milliliter (mL)
Flash Point:	367°F/186°C	**Density:**	Not available (NA)
CARFENTANIL[10]	CAS: 59708-52-0		
Molecular Weight:	394.5 g/mole	**Formula:**	$C_{24}H_{30}N_2O_3$
Boiling Point:	946.4°F / 508°C	**Soluble:**	Water and alcohols
Melting/Freezing Point:	501.8°F / 261±30°C	**Aqueous Solubility:**	Low, 4.21 mg/L at 25°C
Flash Point:	502°F / 261°C	**Density:**	1.142 g/cm^3
3-METHYLFENTANYL[11]	CAS: 42045-86-3		
Molecular Weight:	350.5 g/mole	**Formula:**	$C_{23}H_{30}N_2O$
Boiling Point:	883.4°F / 473ºC	**Soluble:**	Water and alcohols
Melting/Freezing Point:	NA	**Aqueous Solubility:**	Low, 0.015 mg/mL at 25°C
Flash Point:	367°F / 186±19°C	**Density:**	1.064 g/cm^3
α-METHYLFENTANYL[12]	CAS: 79704-88-4		
Molecular Weight:	350.5 g/mole	**Formula:**	$C_{23}H_{30}N_2O$
Boiling Point:	885.2°F / 474±38°C	**Soluble:**	Water and alcohols
Melting/Freezing Point:	NA	**Aqueous Solubility:**	Low, 1.295 mg/mL at 25°C
Flash Point:	367°F / 185.1±19.1 °C	**Density:**	1.082 g/cm^3

POTENTIAL EXPOSURE PATHWAYS

Exposures by incidental ingestion and inhalation are most probable; however, other exposure routes should be considered.

- **Illicit Drugs:** Illicit drug operations present multiple exposure pathways. Responders may encounter packaged powder, loose powder, pill mills, aqueous liquids and hardened (described as concrete-like) fentanyl analogs. Bulk fentanyl is mixed with other narcotics because it is a cheap filler material.[13] Makeshift laboratories are found in apartments, houses, garages and storage facilities. These operations are known as cutting houses, and are commonly associated with heroin. As a result, responders should assume that heroin repackaging operations have fentanyl analogs present. Due to fentanyl's much higher potency as compared to heroin, extra care must be taken to eliminate/limit any inhalation or dermal contact with fentanyl. Illicitly synthesized fentanyl analogs are referred to as non-pharmaceutical fentanyls (NPF).[14] Responders may also find other chemicals including: N-bomb (glitter) LSD; U4770; 4-chloro-N-[1-[2-(4-nitrophenyl)ethyl]-2-piperidinylidene]-benzenesulfonamide (referred to as W-18); propionyl chloride; sodium borohydride; 4-piperidone hydrochloride; phenethyl bromide; phenethyl tosylate; and N-phenethyl-4-piperidone (NPP) or 4-anilino-N-phenethyl-4-piperidine (ANPP). NPP and ANPP are immediate precursors of fentanyl. The DEA restricts the purchase of NPP and is expected to do the same with ANPP. W-18 is used as a substitute for fentanyl or mixed with batches of fentanyl.[15] Responders should plan for the possible presence of these compounds when responding to incidents in illicit fentanyl manufacturing labs.
- **Open Areas:** While fentanyl is a solid powder at room temperature, it poses an inhalation or incidental ingestion exposure threat if sufficient powder becomes airborne. Fentanyl can also be dissolved in solvents and fentanyl citrate is soluble in water, which allows exposure in aerosol form. The literature indicates that police officers showed symptoms of opiate exposure after police activities created fentanyl dust/aerosol or when they worked in dusty areas.
- **Water/Water Systems:** Fentanyl in liquid solution creates a possible dermal exposure pathway and is commonly used in many medicinal forms of fentanyl. Literature reviews indicate that aqueous fentanyl may be found as an illicit drug in intravenous form, nasal sprays, eye drops, and vape pen liquids. While fentanyl could enter natural waters or a water system, neither is a likely exposure pathway.
- **Indoor Facility:** Fentanyl could potentially be dispersed as solid particulates or liquid spray (aerosol) inside a building or facility; HVAC systems may be affected. Fentanyl particulates are heavier (less buoyant) than air and will accumulate on lower levels and in utility corridors and/or deposit on surfaces inside a building.
- **Food:** While food is an unlikely exposure pathway, fentanyl can be released as a fine dust or aerosol that may contaminate food.
- **Other:** Fentanyl is sold commercially under several brand names and in various forms: lozenge (Actiq®); under the tongue (sublingual) tablet (Abstral®); a film applied to the inner lining of the cheek or lip (Onsolis®); a tablet that goes between the gum and cheek (Fentora®); nasal spray (Lazanda®); sublingual spray (Subsys®); and a transdermal skin patch (Duragesic®).[16] Use caution when handling these items because accidental exposures have occurred. These products may also be found at illicit drug operations where users cut up the patches to smoke, squeeze the fentanyl out of them, or crush them for illicit pill manufacturing operations.

PROVISIONAL ADVISORY LEVELS (PAL)[17] & INDUSTRY OCCUPATIONAL EXPOSURE LIMITS (OEL)

Advisory: Inhalation, dermal, and ocular exposure guidelines (IDLH, AEGLs, TLVs)* have not been established for fentanyl and fentanyl analogs. *Until appropriate Occupational Safety and Health Administration (OSHA) / National Institute of Occupational Safety and Health (NIOSH) exposure limits are developed, this fact sheet recommends that safety officers use alternative exposure values, such as the PALs** and industry derived OELs listed below. The OELs have not been vetted by the appropriate regulatory agencies and are subject to change without notice as new data become available. Please use with caution.* ***Note:*** *Dermal occupational exposure limits have not been established; however, skin contact is a potential exposure route based on limited dermal absorption rate data.* [18, 19, 20, 21]

Fentanyl: Inhalation	**µg/m³**	**Fentanyl: Ingestion**	**mg/L**
24 Hour (≤ 24-hr exposure) PAL 2 (serious, possibly irreversible health effects)	0.0037	24 Hour PAL 1 (mild, transient, reversible health effects)	0.03
24 Hour PAL 3 (lethal effects)	0.011	24 Hour PAL 2	0.23
Industry OEL 8-hr TWA[22]	0.1	30 Day (>24 hr, ≤30 days) PAL 1	0.03
		30 Day PAL 2	0.23
		90 Day (>30 days, ≤90 days) PAL 1	0.03
		90 Day PAL 2	0.23
Fentanyl Citrate: Inhalation	**µg/m³**	**Fentanyl Citrate: Ingestion**	**mg/L**
USP Short-Term Exposure Limit (15 min)[23]	2.0	Effect levels do not exist	NA
Mallinckrodt Short-Term Exposure Guidelines (15 min)[24]	2.0		
USP 8-hr TWA	0.1		
Mallinckrodt Occupational Exposure Guideline: 8-hr TWA	0.7		
Carfentanil: Inhalation	**µg/m³**	**Carfentanil: Ingestion**	**mg/L**
Cambrex, Inc. OEL 8-hr TWA[25]	0.04	24 Hour PAL 2	0.007
		24 Hour PAL 3	1.1
3-Methylfentanyl: Inhalation	**µg/m³**	**3-Methylfentanyl: Ingestion**	***mg/L***
Effect levels do not exist	NA	24 Hour PAL 2	0.007
		24 Hour PAL 3	1.1
α-Methylfentanyl: Inhalation	**µg/m³**	**α-Methylfentanyl: Ingestion**	***mg/L***
Effect levels do not exist	NA	24 Hour PAL 2	0.007
		24 Hour PAL 3	1.1

* IDLH: immediately dangerous to life or health; AEGL: acute exposure guideline level; TLV: threshold limit value

** PALs: Please see EPA's technical brief for more information on PALs limitations and usage: https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=531760

OPIOID RELATIVE POTENCY, EQUIANALGESIC DOSE, ESTIMATED LETHAL DOSE [26, 27, 28]			
Compound	**Approximate Relative Potency Compared with Morphine**	**Effective Dose (analgesia, pain relief) Adult**	**Estimated Fatal Dose in Naïve** Adult**
Morphine	1	10 mg	200 mg
Heroin	2	5 mg*	Not established in naïve adults
Fentanyl	50 to 100	0.1 to 0.2 mg	2 mg
Carfentanil	10,000	0.002 mg (estimated)	Not established but lower than fatal dose for fentanyl.

Note: The information above is based on intravenous administration of the opioid. Absorption and biological efficacy by inhalation is similar but the opioid generally has slightly decreased potency by inhalation relative to the intravenous route of administration.

* Heroin does not have a clinical use.

** Naïve indicates an individual who does not use that drug or a drug with a similar mode of action. Since heroin users are typically not naïve users and there is no clinical use of heroin, there is no established fatal dose in naïve adults.

PERSONAL SAFETY

Note: If you have questions about fentanyl signs and symptoms, please contact the Poison Control Center at 1-800-222-1222.

- **General:** The Department of Transportation (DOT) Emergency Response Guide (ERG) recommends the following safety information for fentanyl and fentanyl analogs:[29] 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 large quantity of fentanyl is involved in a fire, isolate the area 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 2016 Table of Initial Isolation and Protective Action Distances. The DOT ERG 2016 Guides section (orange-bordered pages) includes public safety recommendations to isolate a fentanyl (Guide 111) spill or leak area immediately for at least 330 ft (100 m) in all directions.
- **Medical**: Within 5 minutes of intranasal exposure, individuals show effects from fentanyl analogs. Prior exposure to fentanyl analogs can be assessed by measuring the urinary metabolite (breakdown product) norfentanyl.[30] Patients/victims exhibiting significantly reduced respiratory function (respiratory depression), recurrent sedation, or any other complicating factors of opioid toxicity should be admitted to the hospital for a minimum of 12 to 24 hours of observation. Heart and respiratory function should be monitored, and the patients/victims 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 after-effect (sequela) and patients/victims should be monitored and treated accordingly.
- **First Aid**: Treatment consists of administration of the antidote naloxone (see below) and aggressive support of respiratory function. Because the depression of breathing caused by opioids can last longer than the action of the antidote, further treatment in a hospital is required.
- **Antidote:** Naloxone blocks or reverses the effects of opioid medication, including extreme drowsiness, slowed breathing, or loss of consciousness. It has been recommended for treatment of opioid overdose in doses of 0.4 to 2.0 mg and is commonly given intravenously. The onset of effect following intravenous 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.[31] **Fentanyl and its analogs may require multiple administrations of naloxone** to minimize fatalities in the event of an overdose. Administration of naloxone may also reverse chest wall rigidity known as "wooden chest syndrome."[32] NARCAN® (naloxone HCl) Nasal Spray is the first and only FDA-approved nasal form of naloxone for the emergency treatment of a known or suspected opioid overdose.[33] **DEA recommends that responders have portable NARCAN® kits with them and be trained in their administration**.[34] In addition, first responders in British Columbia are placing antidote kits at the building entrances so personnel can access them quickly if potential exposure occurs. [35, 36, 37]
- **Eye:**[38] 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:**[39] 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. Administer charcoal slurry (240 mL water/30 g charcoal). Usual dose: 25-100 g in adults/adolescents, 25-50 g in children 1-12 years old, and 1 g/kg in infants less than one year old. Seek medical attention immediately.[40]
- **Inhalation:**[41] Immediately remove the patient/victim from the source of exposure, evaluate respiratory function and pulse, and 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 and always use a barrier or bag-valve-mask device. If breathing has ceased, provide artificial respiration using a barrier or bag-valve-mask device. 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 Ingestion in this section for treatment recommendations. Seek medical attention immediately.
- **Skin:**[42] Immediately remove the patient/victim from the source of exposure. **Do not use hand sanitizers**; they may contain alcohol which may increase fentanyl absorption.[43] Wash with copious amounts of water and soap. See Personnel Decontamination/Individual Decontamination section for more information. Monitor the patient/victim for signs of whole-body (systemic) effects. If signs of whole body (systemic) poisoning appear, see Ingestion in this section for treatment recommendations. Seek medical attention immediately.

PERSONAL PROTECTIVE EQUIPMENT (PPE)[44]

Advisory: *NIOSH's guidance is intended for local responders who typically do not have access to the PPE that is readily available to EPA OSCs. The guidance below is intended for EPA OSCs who have the necessary PPE and training for Level A and Level B entries.* ***Level A is preferred, but at a minimum, EPA recommends that all OSCs, EPA responders and others consider the use of modified Level B for all known fentanyl-related response activities. Modified Level C can be a secondary choice based on specific site conditions. In both cases, Levels B and C have been modified to include a taped or hooded chemical-resistant suit, with no exposed skin.*** *Downgrading PPE levels should only be considered when the contaminant identity, concentration and risks of exposure are known. For example, the decontamination (decon) of response personnel and equipment can typically be done safely using modified Level C when entry teams are in Level B. However, the use of a specific decon agent (e.g., peracetic acid or chlorine in a small unventilated space) may require responders to upgrade their level of personal protection.*

General Information: Appropriate controls, inhalation safeguards and PPE should be employed for dusts and particulates of fentanyl/fentanyl analogs. Due to the more stringent fit factor, NIOSH-certified CBRN Self Contained Breathing Apparatus (SCBA), Air Purifying Respirators (APR) or Powered Air Purifying Respirators (PAPR); full-face masks; and protective clothing are recommended for use. Pre-incident training and exercises on the proper use of PPE are highly recommended. Per NIOSH guidance, the following PPE levels and recommended modifications should be used for site responses involving fentanyl analogs:

Level A: OSHA and NIOSH recommend[45] the use of NIOSH-certified CBRN 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 sampling results confirm the contaminant(s) and their concentration. NIOSH and DEA recommend Level A for the initial response where levels and exposure risks are unknown or the scene is grossly contaminated. Additionally, EPA guidance and policy indicate that responses to uncharacterized potentially dangerous environments require additional caution. Level A is also selected when response personnel are unable to fully characterize the conditions suitable for Levels B, C and D.[46]

Select Level A when the concentration is unknown and when there is a potential for ocular or dermal exposure. While Level A provides the highest levels of inhalation and dermal protection, it is understood that this may not be feasible for many first responders and for all possible incidents where the identity, levels and exposure risks are unknown.

The typical Level A PPE ensemble includes:

- A NIOSH-certified CBRN full-facepiece (Assigned Protection Factor of 10,000) SCBA operated under positive pressure 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 and inner).
- Chemical-resistant boots with a steel toe and shank.
- Coveralls, long underwear, a hard hat worn under the TECP suit, and chemical-resistant disposable boot covers worn over the chemical-resistant suit are optional items.

Level B: NIOSH recommends Level B to provide the highest level of respiratory protection (SCBA) when a lesser level of skin protection is required. Select Level B when the concentration is unknown and 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.

EPA recommends the modified Level B for most response activities to a known fentanyl release or entry into a confined indoor area with indication of likely opioid contamination, e.g., a laboratory or opiate/opioid handling area. This fact sheet recommends that the Level B PPE ensemble be modified to use a hooded chemical-resistant suit with **no exposed skin** (i.e., taped or encapsulated B) that provides additional dermal and ocular protection against fentanyl liquids, particulates and powders that can be aerosolized. As with Level A, it is understood that many first responders may not be able to field a team equipped with Level B PPE. Precautions must be taken and additional site information must be obtained to be able to downgrade from level B and use Level C safely at a fentanyl response.

The modified Level B PPE ensemble includes:

- A NIOSH-certified CBRN full-facepiece SCBA operated under positive pressure or a pressure-demand supplied air hose respirator with an auxiliary escape bottle.
- A hooded chemical-resistant suit that provides protection against CBRN agents. Modified: Taped or encapsulated with no exposed skin.
- Chemical-resistant gloves (outer and inner).
- Chemical-resistant boots with a steel toe and shank.
- Coveralls, long underwear, a hard hat worn over the chemical-resistant suit (if encapsulated, worn under), and chemical-resistant disposable boot covers worn over the chemical-resistant suit are optional items.

Level C: NIOSH recommends Level C when the contaminant identity and concentration are known and the respiratory protection criteria for the use of APR or PAPR are met, i.e., no IDLH conditions and a normal oxygen level. Level C may be appropriate when decontaminating personnel or equipment. This fact sheet does not recommend Level C protection for entry activities for EPA personnel unless additional exposure information is available or site conditions dictate.

Select Level C when the specific opioids and airborne levels are known. EPA recommends the use of a NIOSH-approved CBRN PAPR with a tight-fitting facepiece and a filter or a combination chemical cartridge/filter. The use of a tight-fitting, full-face PAPR provides a higher Assigned Protection Factor (1000) than an APR (50). Therefore, a tight-fitting full-face PAPR should be considered first. Although not preferred, a NIOSH-approved CBRN tight-fitting full-face APR with organic vapor/acid gas/P100 cartridges/canisters can be used if a PAPR is not available. The APR must be used in accordance with approved NIOSH criteria. Personnel should use a hooded chemical-resistant suit with no exposed skin (i.e., taped) that provides protection from CBRN agents or fentanyl liquids, particulates and powders. This fact sheet suggests that modified Level C would be the minimum PPE level for decontaminating first responders at a fentanyl-contaminated incident where the types and concentrations of the contaminants are known.

The modified Level C PPE ensemble includes:

- A NIOSH-certified CBRN PAPR with a tight-fitting full facepiece, with P100 cartridges/canisters.
- A hooded chemical-resistant suit that provides protection against CBRN agents. Modified**:** Taped or encapsulated with no exposed skin.
- Chemical-resistant gloves (outer and inner).
- Chemical-resistant boots with a steel toe and shank.
- Escape mask, face shield, coveralls, long underwear, a hard hat worn over the chemical-resistant suit, and chemical-resistant disposable boot covers worn over the chemical-resistant suit are optional items.

Level D: NIOSH recommends Level D when the contaminant is known and the concentration is below any exposure guidelines for the stated duration times. For fentanyl work, Level D may be worn when the opioids are known and there is no likelihood of airborne or dermal exposure. Responders must continue to wear nitrile gloves or equivalent in an area where fentanyl or other opiates may have been handled. Additionally, coveralls and boots/shoes with a chemical-resistant steel toe and shank will be worn. First responders can further reduce the potential for dermal exposure by taping the wrists and ankles similar to the process used for Levels B and C above.

FIELD DETECTION

Advisory*: *The DEA discourages field testing of containers or bags that could possibly contain opioids, including fentanyl, because the opioids may become airborne when the containers/bags are opened.[47] *Field screening or sampling may be considered* ***if*** *an emergency responder is appropriately outfitted as indicated in the PPE section in order to greatly minimize exposure. Response personnel should always use routine air monitoring [photoionization detector (PID), flame ionization detector (FID), and/or combustible gas indicator] for detection of volatile organic compounds that might be used in the illegal manufacture of drugs or other operations.*

- When appropriately dressed as indicated in the PPE section, response personnel may use field test kits to screen for fentanyl. Note that field test kits will only identify the compounds that are indicated in the test kit literature. Many fentanyl analogs will not be detected because they are newly developed, unregulated, and/or the field analytical methods are not designed to detect them. As a result, response personnel should proceed with caution because dangerous compounds or other fentanyl analogs may be present in the samples. ***Available law enforcement test kits include, but are not limited to*:**
  - **NARK® II Fentanyl Reagent.** The NARK II Fentanyl Reagent is designed to presumptively identify some fentanyl compounds and heroin. Each test pouch contains one or more chemical reagents. When a predictable color or series of colors occurs within a specific testing sequence, a positive confirmation may be presumed. A forensic laboratory is required to qualitatively identify an unknown substance. **The NARK II Reagent is only sold to law enforcement.** The fentanyl reagent kit and other kits for specific opiates/opioids are available at: http://www.sirchie.com/nark20033-fentanyl-reagent.html#.WJDFndfyt0w.[48]
  - **NARK® Fentanyl/Heroin Patrol Kit.** The NARK Fentanyl/Heroin Patrol Kit contains the appropriate PPE and Fentanyl II Reagent**.** It is available at: http://sirchie.armorgt.com/product/nark-fentanylheroin-patrol-kit/.[49]
- **Particulate Monitoring**. Due to the potency of fentanyl analogs and lack of specificity and inadequate sensitivity, real-time particulate monitoring for fentanyl analogs is not useful and may cause responders to reach an incorrect conclusion.

SAMPLING

Note: The Sampling section contains general guidelines and does not replace the need for a site-specific sampling plan. Because fentanyl is a solid, particulate air sampling and surface wipes may be necessary to achieve many sampling goals. For specific sampling questions, contact the Environmental Response Laboratory Network (ERLN) laboratory analyzing the fentanyl-contaminated environmental samples (non-clinical) through the EPA/HQ-EOC at 202-564-3850. Sampling and analysis methods for fentanyl and other environmental contaminants can be queried using the EPA National Homeland Security Research Center (NHSRC) *Standard Analytical Methods for Environmental Remediation and Recovery* (SAM) online methods database at https://www.epa.gov/homeland-security-research/sam.

- **Sample Locations and Planning:** Sample planning for fentanyl is similar to other illicit drugs.[50] Initially consider air sampling to characterize airborne opioids and to determine if there is a plume, which could affect other areas. Characterization sampling is initiated by targeted or judgmental sampling to identify hot spots, potential agent flow paths, and media or objects potentially acting as a sink. Biased or random sampling can be used to determine the extent of potential contamination or to verify the efficacy of decon. Statistical approaches may be required in the clearance phase.
- **Sampling Concerns: Note: The laboratory conducting the analysis must be accredited and meet the requirements of the International Organization for Standardization (ISO) / International Electrotechnical Commission (IEC) 17025:2005 or current edition.** Detection, analysis, sampling equipment and procedures are site-specific and depend on: (1) physical state of the agent; (2) type of surface contaminated (e.g., porous vs. non-porous); (3) purpose of sampling (e.g., characterization, decon efficacy and clearance); and (4) specific laboratory requirements. Bulk wipe and environmental wipes can be analyzed at laboratories that are American National Standards Institute-American Society for Quality (ANSI-ASQ) accredited. Many of these laboratories are state and municipal laboratories. These laboratories meet the requirements of ISO/IEC 17025:2005, General Requirements for the Competence of Testing and Calibration Laboratories. The accreditation body can be contacted at http://www.ascld-lab.org/accredited-laboratory-index/. To generate a list of accredited laboratories, go to http://search.anab.org/. In the General section of the search page, select your state from the drop-down, and change the Status to "Active." In the Scopes of Accreditation section, select "Drug Chemistry" under Forensic Testing Labs and "Any" under Field Sampling and Measurement. Click the Search Now button. Additional assistance with identification of laboratories can be requested through the Forensics Department at the American Society of Crime Laboratory Directors/Laboratory Accreditation Board (ASCLD/LAB) at 919-773-2600.

- **Packaging and Shipping Samples: At the current time, no shipping of fentanyl or fentanyl analogs will be done without assistance from state police. In most cases, samples and likely-contaminated items will be hand carried to the laboratory for analysis.** The following proper DOT shipping descriptions should be applied to container labels (markings) and shipping documents: UN2811 Toxic Solid, Organic, N.O.S. II (Propanamide, N-phenyl-N-[1, (2-phenylethyl-4-piperomdonyl]-); UN2810 Toxic Liquid, Organic, N.O.S. II (Propanamide, N-phenyl-N-[1,(2-phenylethyl-4-piperomdonyl]-). Contact the laboratory receiving the sample to determine any additional packaging, shipping or labeling requirements. The packaging and shipping of samples is subject to strict regulations established by DOT, the Centers for Disease Control and Prevention (CDC), United States Postal Service, OSHA, and International Air Transport Association (IATA). These regulations can differ from state to state. Detailed state regulations can be found at www.envcap.org.
- **Types of Samples:**
  - **Packaged Material: If at all possible, do not take field samples of packaged materials if fentanyl and fentanyl analogs are suspected**. Opening a package could suspend the powder and cause exposure. If an emergency responder is appropriately outfitted as indicated in the PPE section to eliminate or greatly minimize inhalation, skin, eye, and incidental ingestion exposure, field screening or sampling may be considered. Submit the material directly to the laboratory for analysis and clearly indicate on the submission paperwork that the item is suspected of containing fentanyl. This will alert laboratory personnel to take the necessary safety precautions during the handling, processing, analysis and storage of the material(s). Emergency response personnel should be aware that unadulterated fentanyl analogs may resemble cocaine or heroin powder. Fentanyl and fentanyl analogs can be mixed with other substances, which can alter their appearance. Therefore, wipe and particulate sampling may be more acceptable options.
  - **Particulate Samples:** Particulate sampling may be performed using procedures similar to those used at a lead site. For lab analysis, samples are collected on air filters at the breathing zone level (~5 ft) to assess inhalation exposures. See EPA/625/R-96/010a, Compendium of Methods for the Determination of Inorganic Compounds in Ambient Air, for additional information. The preferred flow rate for air sampling is 2 L/min. For air sampling, the sampling medium may include either BEL2 (25 mm glass fiber filter, 3-piece cassette), IOM2 (25 mm inhalable dust sampler with glass fiber filter, cutpoint is 100 microns) or TFE3A (25 mm-1 micron Teflon filter, 3-piece cassette). The analytical method is specific to the air sampling medium used. Air samples can be analyzed by a UV/Vis detector or HPLC MS/MS.
  - **Wipe Samples:** Wipe sample collection and analysis should be done in a manner consistent with EPA Method 8290A, Appendix A (SW-846), Procedure for the Collection, Handling, Analysis, and Reporting of Wipe Tests Performed within the Laboratory. For specific sampling instructions, also see NIOSH Method 9106, Appendix C, Methamphetamine and Illicit Drugs, Precursors and Adulterants on Wipes by Liquid-Liquid Extraction; or NIOSH Method 9109, Appendix C, Methamphetamine and Illicit Drugs, Precursors and Adulterants on Wipes by Solid Phase Extraction. Fentanyl is among the drugs of abuse referenced within NIOSH Method 9109. The method NAT-2003-05515 uses pre-rinsed Texwipe® TX714X alpha swabs for sampling surfaces, followed by LC/MS/MS for fentanyl analysis.
  - **Other Sample Matrices:** Contamination of the food supply chain, processing plants, agriculture, livestock and products using fentanyl is possible. Sampling of these matrices may be required, in cooperation with other federal agencies (e.g., U.S. Department of Agriculture, U.S. Food and Drug Administration). At present, there are no approved methods for collection of environmental samples in soil and water. EPA methods (SW-846) may be appropriate for determination of fentanyl in these matrices. See Analysis section below.

ANALYSIS

Note: The ERLN's Laboratory Compendium lists laboratories that will analyze fentanyl-contaminated environmental samples (non-clinical). Contact ERLN through the EPA/HQ-EOC at 202-564-3850 for selected analytical methods.[51]

Wipes and Liquid Samples:

- EPA (SW-846) Method 3520C: Continuous Liquid-Liquid Extraction[52] and Method 3535A: Solid-Phase Extraction.[53] **Note:** pH changes in the aqueous sample may lead to solubility issues which can manifest themselves in poor analytical performance.
- NIOSH Method 9106: Methamphetamine and Illicit Drugs, Precursors and Adulterants on Wipes by Liquid-Liquid Extraction, Issue 1.[54]

Solid Samples:

- EPA (SW-846) Method 3541: Automated Soxhlet Extraction[55] and Method 3545A: Pressurized Fluid Extraction.[56]
- NIOSH Method 9109: Methamphetamine and Illicit Drugs, Precursors and Adulterants on Wipes by Solid Phase Extraction.[57]

Other Methods:

- EPA, Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events, Revision 5, EPA/600/R-04/126E.[58]
- EPA, Detection of Illicit Drugs on Surfaces Using Direct Analysis in Real Time (DART)/Time-of-Flight Mass Spectrometry.[59]

DECONTAMINATION / CLEANUP

Decon/Cleanup Planning: Once site controls are in place, develop a site-specific decon/cleanup plan. Decon may require a tiered approach using a variety of techniques and products. Due to structural similarities among fentanyl compounds, decon/cleanup planning may be similar for different analogs. However, a universal approach to decon/cleanup should not be assumed given the proliferation of fentanyl compounds. **Please contact the EPA HQ/EOC at 202-564-3850 (24-hr access) for further assistance.**

- **General Considerations:** An evaluation should be undertaken for each decon strategy and approach, which considers: availability, specialized equipment needs, public safety, total cost, impact on the facility, wastes generated, the corrosivity and toxicity of the decon products, 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 should be addressed as early as possible in the decon and cleanup process (see Waste Management section). **Caution**: **Decontamination products may have their own unique safety/PPE requirements due to their corrosivity or toxicity or breakdown products created during use (e.g., use of hypochlorite results in chlorine vapors).**
- **Disposal Option:** The urgency to quickly restore a facility may require the 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.

- **Monitored Natural Attenuation:** Not recommended. Fentanyl analogs do not evaporate or degrade appreciably over weeks to months under typical environmental conditions.
- **Decon Strategy:** A decon strategy can be developed by designating areas based on: (1) visible presence of solid fentanyl analogs; (2) residual solid fentanyl analogs following initial removal; and (3) aqueous solutions containing fentanyl analogs. This strategy is based on the assumption of encountering fentanyl salts present in many pharmaceutical products. Alteration of the fentanyl analogs (e.g., cooking of the fentanyl product) may result in free base fentanyl that is less water-soluble and may require different approaches. Similarly, for fentanyl solutions a change in pH, whether intentional (e.g., mixing with buffer solutions) or coincidental (e.g., applying a decontamination solution), may result in changes in water solubility, thus altering the decon strategy.
  - **Strategy for Removal of Solids:** The spread of solid (dust) fentanyl analogs can be minimized though the use of negative air machines (NAM) to control the air flow from a contaminated area. Bulk fentanyl analogs can be removed by carefully transferring solids into appropriate containers, with care taken to limit the generation of dust. The residue may be cleaned up by dry vacuuming with HEPA filtration. Water and detergent solutions are likely to physically remove fentanyl from hard, nonporous surfaces. However, the waste solution will contain fentanyl due to its stability in water under many environmental conditions. Cleaning porous surfaces with water and detergent solutions is also possible, but may potentially transfer fentanyl further into the porous material, making it more difficult to thoroughly decon. Most of the current response cleanup efforts rely only on physical removal of fentanyl from materials.
  - **Strategy for Surface Decontamination:** Available literature related to the decontamination of contaminated surfaces is limited to degradation experiments for fentanyl conducted in aqueous solutions in controlled laboratory settings. Accordingly, these studies were not intended to address environmental cleanup and do not establish decon conditions such as application methods, contact times, or efficacy on various surface materials. Environmental decon studies would be needed to establish specific application conditions and methods. Solubility of fentanyl in solutions with pH greater than ~7, such as hypochlorite bleach, is greatly reduced. This lowered solubility may result in lessened effectiveness for fentanyl degradation and reaction rate. Literature indicates that fentanyl may be destroyed by oxidants, e.g., chlorine bleach buffered to pH ~5 and peracetic acid buffered to pH ~8. Peracetic acid-generating products (DF-200®) or peracetic acid-containing products (MINNCARE® Cold Sterilant, Oxonia Active®, Peridox RTU®, Dahlgren Decon) may be effective, but none of these products has been tested for use on fentanyl-contaminated surfaces and conditions to reach complete degradation are unknown at this time.[60, 61] Further, because of the importance of pH, it is necessary to ensure that the item/solution being decontaminated does not change the pH of the decontaminant to an incompatible value. Formulations should be chosen that do not allow the formation of potential toxic byproducts of fentanyl or reaction products of the underlying chemical process. Availability, cost and the need for specialized equipment may limit their use early in the response. Dirt, grime and other coatings can reduce the efficacy of decon. Pre-cleaning surfaces with soap and water may be needed before the application of decon formulations. However, the resulting rinsates from pre-cleaning may contain and spread toxic byproducts.
  - **Strategy for Aqueous Solutions:** Fentanyl analogs may be removed from water by adsorption processes, although the adsorbent will be related to the pH, which will determine whether the analog is present as an ion (salt) or free base form.[62] Due to the decreasing solubility of fentanyl analogs above pH 7, pH may have to be adjusted to ensure analogs stay in solution and do not remain as solids, potentially complicating disposal. Lowering the pH of bleach solutions will lead to release of chlorine gas, requiring appropriate PPE. **Note:** The pH required to ensure solubility varies among fentanyl analogs but is usually pH 5 to 7.
  - **Sensitive Equipment and Items:** For difficult-to-clean equipment thought to be contaminated with small amounts of fentanyl, options for consideration include flushing with soap and water. **Note:** While the residual aqueous solution may contain fentanyl analogs, which may be decontaminated as described above for aqueous solutions, the soap or detergent may change the pH significantly outside the range in which the fentanyl analogs are soluble.
- **Verification of Decon:** Site and situation specific.

PERSONNEL DECONTAMINATION

Decontamination Corridor: The following are generic NIOSH recommendations to protect first responders:[63]

- Position the decon corridors upwind and uphill of the hot zone (exclusion zone). The warm zone (contamination reduction zone) should include two decon corridors. One decon corridor is used to enter the warm zone and the other to exit the warm zone into the cold zone (support zone). The decon corridor for exiting should be upwind and uphill from the corridor used to enter.
- Decon area workers should wear appropriate PPE. See the PPE section for detailed information.
- A solution of detergent and water (pH between 8 and 10.5) should be available for use in decon procedures. Soft brushes should be used to remove contamination from the PPE. Labeled, durable 6-mil polyethylene (PE) bags should be available for disposal of contaminated PPE.

Individual Decontamination: Personnel must consider the corrosivity and toxicity of the solutions used to decontaminate personnel. pH should be between 8 and 10.5 for the solutions to be effective against fentanyl. As such, first responders may need to change/modify PPE requirements due to the corrosive risk to both personnel and PPE.

- **Decontamination of first responder:**
  - Begin washing PPE 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 SCBA but keep mask in place. Remove PPE by starting at the head and rolling downward. Remove mask.
  - Place all PPE in labeled durable 6-mil PE bags.

- **Decontamination of patient/victim:**
  - Remove the patient/victim from the contaminated area and into the decon corridor.
  - Remove all clothing (at least down to undergarments) and place the clothing in a labeled durable 6-mil PE bag. Thoroughly wash and rinse (using cold or warm water) the patient/victim's contaminated skin using a soap and water solution. Be careful not to break the patient/victim's skin during the decon process. Cover all open wounds.
  - Cover the patient/victim to prevent shock and loss of body heat.

WASTE MANAGEMENT

Fentanyl and fentanyl analogs do not typically meet the definition of a Resource Conservation and Recovery Act (RCRA) hazardous waste per 40 CFR Part 261. However, the fentanyl analogs possess hazardous waste-like qualities, and EPA recommends that they be managed as hazardous waste when there is no longer a use for the material in a medical setting.[64] **Fentanyl-containing materials may be disposed of by encapsulation, incineration, or inertization (mix with water, cement, limestone to eventually form a solid mass).**[65, 66]

- **Waste Management:** Under RCRA, fentanyl and fentanyl analogs are not listed as a hazardous process waste or a hazardous commercial chemical product and do not generally meet the definitions of a characteristic hazardous waste. EPA considers a waste to be hazardous: (1) if it exhibits the characteristics of ignitability, corrosivity, reactivity or toxicity as defined in 40 CFR Part 261 §261.21-261.24; (2) if it is specifically listed as a hazardous process waste (§261.21 and §261.32); or (3) if it is listed as a commercial chemical product that is discarded or spilled (§261.33). In certain situations, some fentanyl-containing materials may meet the definition of characteristic hazardous waste. For example, waste fentanyl sublingual spray meets the definition of an ignitable hazardous waste (D001) because it is prepared in alcohol. Knowledge of unique hazards presented by a waste can be used to determine if a waste is hazardous. Note: the off-site rule itself contains an exemption for emergency CERCLA removal actions if the OSC determines that it is necessary to transfer CERCLA waste off-site without following the requirements of this section, 40 CFR 300.440(a)(2).
- **DEA Regulations for Disposal of Controlled Substances:** According to the DEA regulations at 21 CFR Part 1317,[67] assuming that fentanyl wastes are not the property of a DEA Registrant, all formulations of fentanyl should be rendered non-retrievable (permanently altered and rendered unavailable and unusable) to ensure acceptance by a licensed waste treatment storage and disposal facility (TSDF). A DEA Registrant is anyone (medical practitioner, optometrist, pharmacist, dentist, or veterinarian, etc.) who is assigned a registration number by DEA allowing them to prescribe/handle controlled substances.
- **Solid Formulations:** Solid or powder formulations of fentanyl may be placed in a heavy-mil PE bag or chemical-resistant PE container. Fentanyl powder can be rendered non-retrievable with the addition of soapy water or light oil (with pH between 8 and 10.5). Use a sufficient volume of soapy water or light oil for the powder to be absorbed by the liquid. After the powder has been absorbed by the liquid, place the bag or container into a DOT-approved container for shipping to a DEA-registered TSDF for destruction.
- **Liquid Formulations:** Liquid formulations of fentanyl may be rendered non-retrievable by the addition of kitty litter or sawdust to the liquid solution. Addition of sawdust or kitty litter should be accomplished in a chemical-resistant leak-proof container. The container must be placed in a DOT-approved outer package for transportation to a DEA-registered TSDF for destruction.
- **DOT Shipping Descriptions:** Current resources on packaging, labeling and shipping are available at https://www.cdc.gov/niosh/ershdb/emergencyresponsecard_29750022.html. Proper DOT shipping descriptions should be applied to container labels (markings) and shipping documents:
  - UN2811 Toxic Solid, Organic, N.O.S. II (Propanamide, N-phenyl-N-[1, (2-phenylethyl-4-piperomdonyl]-)
  - UN2810 Toxic Liquid, Organic, N.O.S. II (Propanamide, N-phenyl-N-[1,(2-phenylethyl-4-piperomdonyl]-)
- **Requirements:** Requirements for transporting hazardous materials and procedures for exemption are specified in https://www.fmcsa.dot.gov/regulations. EPA has developed a web-based Incident Waste Management Planning and 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, and guidance to minimize the potential for contaminating the treatment or disposal facility. **Note:** Access to this EPA tool requires pre-registration: http://www2.ergweb.com/bdrtool/login.asp.
- **Caution:** Hazardous waste transportation and disposal is federally regulated; however, more stringent regulations may exist under state authority. These regulations differ from state to state. Detailed state regulations can be found at http://www.envcap.org.

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