For additional information regarding this Fact Sheet, contact the U.S. Environmental Protection Agency's (EPA) Chemical, Biological, Radiological & Nuclear (CBRN) Consequence Management Advisory Division (CMAD) via the Emergency Operations Center's 24-Hour Number at 202-564-3850. This Fact Sheet was developed for EPA's Federal On-Scene Coordinators (OSCs) who may respond with, or provide technical advice to, local first responders who may encounter environmental contamination from fentanyl class compounds (fentanyls). The Fact Sheet's contents do not reflect the views, guidance or policies of the EPA. Technical content may change without prior notice. The EPA does not assume responsibilities for errors, misinterpretation of technical information, injury or illness as a result of use or misuse. Non-EPA personnel are encouraged to develop health & safety guidance for their own personnel based on the best available information. Mention of trade names or services does not convey official EPA approval or endorsement.

FENTANYLS CHARACTERISTICS

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

Fentanyl, salts & analogs: Fentanyl, Fentanyl citrate, Carfentanil, 3-Methylfentanyl, α- Methylfentanyl and numerous others

Synonyms: Fentanest; Fentanil; Fentanila (Spanish); Fentanylum (Latin); Leptanal; Pentanyl; Propanamide, Propionanilide, Sentonil; 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; N-phenyl-N-(1-(2-phenylethyl)-4-piperidinyl); N-(1-phenethyl-4-piperidyl)-;[1]

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

Persistence: While there have been few studies investigating 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 and materials impacted.

TABLE 1. FENTANYL, FENTANYL CITRATE, CARFENTANIL, 3 METHYLFENTANYL, α –METHYLFENTANYL PHYSICAL PROPERTIES

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

FENTANYL[5] **CAS: 437-38-7**		**Molecular Weight:** **336.5 g/mol**	**Formula:** **$C_{22}H_{28}N_2O$**
Boiling Point:	870.8°F / 466°C	**Soluble:**	Slightly soluble in water; soluble in alcohols[6]
Melt/Freezing Point:	181-183°F / 83-84°C	**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[7] **CAS: 990-73-8**		**Molecular Weight:** **528.6 g/mol**	**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[8]
Melt/Freezing Point:	307-313°F / 153-156°C	**Aqueous Solubility:**	Moderate, 1 g/40 milliliter (ml)
Flash Point:	367°F/186°C	**Density:**	Not available (NA)
CARFENTANIL[9] **CAS: 59708-52-0**		**Molecular Weight:** **394.5 g/mol**	**Formula:** **$C_{24}H_{30}N_2O_3$**
Boiling Point:	946.4°F / 508°C	**Soluble:**	Water and alcohols
Melt/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[10] **CAS: 42045-86-3**		**Molecular Weight:** **350.5 g/mol**	**Formula:** **$C_{23}H_{30}N_2O$**
Boiling Point:	883.4°F / 473°C	**Soluble:**	Water and alcohols
Melt/Freezing Point:	NA	**Aqueous Solubility:**	Low, 0.015 milligram per milliliters (mg/mL) at 25°C
Flash Point:	367°F / 186±19 °C	**Density:**	1.064 g/cm^3
α-METHYLFENTANYL[11] **CAS: 79704-88-4**		**Molecular Weight:** **350.5 g/mol**	**Formula:** **$C_{23}H_{30}N_2O$**
Boiling Point:	885.2°F / 474±38 °C	**Soluble:**	Water and alcohols
Melt/Freezing Point:	NA	**Aqueous Solubility:**	Low, 1.295 mg/mL at 25°C
Flash Point:	367°F / 185.1±19.1 °C	**Density:**	Slightly soluble in water; soluble in alcohols[12]

NOTE: Exposure values and technical content on Tables 2 and 3 are still under development. The occupational exposure limits are industry derived and have not been vetted by the appropriate regulatory agencies. They are subject to change which may occur without prior notice as new data becomes available. Use with caution.

TABLE 2. PROVISIONAL ADVISORY LEVELS (PALs) [13] AND INDUSTRY OCCUPATIONAL EXPOSURE LIMITS (OELs)			
Fentanyl: *Inhalation*	**µg/m³**	**Fentanyl: *Ingestion***	***mg/L***
24 Hour (≤24 hour exposure) PAL 2 (serious, possibly irreversible health effects)	0.0037	24 Hour PAL 1 (mild, transient, reversible effect, health effects)	0.03
24 Hour PAL 3 (lethal effects)	0.011	24 Hour PAL 2	0.23
Industry OEL 8-hr TWA	0.1[14]	30 Day (>24 hour, ≤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 Inc. Short Term Exposure Limit (15 minutes)	2.0 [15]	Effect levels do not exist	NA
Mallinckrodt Inc. Short-Term Exposure Guidelines (15-minute)	2.0 [16]		
USP Inc. 8hr TWA	0.1		
Mallinckrodt Inc. Occupational Exposure Guideline: 8hr TWA	0.7		
Carfentanil: *Inhalation*	**µg/m³**	**Carfentanil: *Ingestion***	***mg/L***
Cambrex, Inc. OEL TWA	0.04 [17]	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

NOTE: Dermal exposure values not available, although skin contact is assumed a significant exposure risk.

TABLE 3. RELATIVE POTENCY AND LETHAL DOSE OF SEVERAL FENTANYL DERIVATIVES[18,19, 20]		
Compound	**Estimated Relative Potency Compared with Morphine**	**Estimated Human Adult Lethal Dose Total Body Burden**
Morphine	1	Morphine: 200 mg
Fentanyl	100-300	Fentanyl: 2 mg total exposure (where 2 mg ~ 2-3 grains of salt)
Carfentanil	10,000	Carfentanil: 20 µg (0.020 mg) total exposure (where 20 µg ~ less than the weight of a human eyelash)
3-methylfentanyl	5,500	
α-methylfentanyl	400	Data on other fentanyl analogs currently unavailable

PERSONAL SAFETY

NOTE: The Occupational Safety and Health Administration (OSHA) and NIOSH recommend[21] the use of 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 sampling 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. **If you have questions about fentanyl signs and symptoms, please contact Poison Control Center at 1-800-222-1222**

- **DEPARTMENT OF TRANSPORTATION (DOT) EMERGENCY RESPONSE GUIDE (ERG)**: [22] 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 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 2016 Table of Initial Isolation and Protective Action Distances. In the DOT ERG 2016 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.

- **MEDICAL**: Within 5 minutes of intranasal inhalation individuals show effects from fentanyls. Prior fentanyls exposure can be assessed by measuring for the urinary metabolite (breakdown product) norfentanyl.[23] 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 and respiratory 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 after-effect (sequela) and patient/victims should be monitored for its development and treated accordingly.
- **FIRST AID**: Treatment consists of administration of the antidote (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:** [24] 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 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. Fentanyl and its analogs may require multiple administrations of Naloxone to minimize fatalities in the event of an overdose. Also, administration of naloxone may reverse the "wooden chest syndrome. [25] 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.[26] **DEA recommends that responders have portable NARCAN® kits with them and be trained[27] in its administration**. **In addition, British Columbia health authorities are requesting that first responders place the antidote kits at the front door so responders can access it quickly if potential exposure occurs.**
- **EYE**:[22] Remove the 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**:[1] 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 slurry (240 ml water/30 g charcoal). Usual dose: 25-100 grams (g) in adults/adolescents, 25-50 g in children (1-12 years old), and 1 g/kg in infants less than 1-year-old. Seek medical attention immediately.[28]

- **INHALATION**: [1] 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 poisoning appear, see the Ingestion section above for treatment recommendations. Seek medical attention immediately.
- **SKIN**: [1] Immediately remove the patient/victim from the source of exposure. Wash with copious amounts of water and soap. **Do not use hand sanitizers**![27] See the "**PERSONNEL DECONTAMINATION/INDIVIDUAL CONTAMINATION**" section below for more information. Monitor the patient/victim for signs of whole-body (systemic) effects. If signs of systemic poisoning appear, see the Ingestion Section above for treatment recommendations. Seek medical attention immediately.

PERSONAL PROTECTIVE EQUIPMENT (PPE)[1,21, 27]

Level A is highly recommended when and if possible for all responses activities to fentanyls. If not, at a minimum, this Fact Sheet recommends that all EPA OSCs, EPA responders and others consider the use of "modified" Level B for all fentanyl related response activities. "Modified" Level C can be a secondary choice based on specific site conditions. For example, the decontamination (decon) of response personnel and equipment is an example of a task can be done safely using modified Level C.

ADVISORY: Many inhalation, dermal, and ocular exposure guidelines (IDLH, AEGLs, TLVs) **have not** been established for fentanyls. In the absence of these exposure values, this Fact SheetGuide recommends that site safety officers utilize alternative exposure values, such as the PALs and OELs listed in Tables 2 and 3, until appropriate OSHA / NIOSH exposure limits are established. Appropriate, controls, PPE and inhalation safeguards used for dusts and particulates should be employed. **NOTE: Both Levels B and C have been "modified" to include a taped or hooded chemical-resistant suit, with no exposed skin**. Downgrading PPE levels can be considered only when the contaminant identity, concentration and the risks of exposure are known, and must be accompanied by on-site monitoring., i.e., real-time aerosol monitoring for particulate matter (PM) equipment such as personal DataRAM,™ or other appropriate PM instrumentation. Assume all PM are fentanyl particulates.

GENERAL INFORMATION: Due to the more stringent fit factor, NIOSH-certified Chemical, Biological, Radiological, Nuclear (CBRN) Self Contained Breathing Apparatus (SCBA), Air Purifying Respirators (APR) or Powered Air Purifying Respirators (PAPR), full-face masks, and protective clothing are recommended for use when handling fentanyls. Pre-incident training and exercises on the proper use of PPE are recommended. Per NIOSH guidance, with recommended modifications, the following PPE levels should be used for site responses involving fentanyls:

- **LEVEL A:** NIOSH and DEA recommend Level A for the initial response where levels and exposure risks are unknown or grossly contaminated. Level A provides the greatest level of skin (fully encapsulating suit), respiratory (SCBA - which has an Assigned Protection Factor of 10,000), and eye protection when the contaminant identity or concentration is unknown.

  Select Level A when the concentration is unknown and when there is a potential of 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. **Typical Level A PPE ensemble consists of:**

  - A NIOSH-certified CBRN full-face-piece 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 chemical-resistant 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.

  The EPA would recommend "modified Level B" at a minimum, for most response activities to a known fentanyl release or entry into confined indoor area with indication of likely opioid contaminated area such as a laboratory or opiate/opioid handling area. This Fact Sheet is recommending that the Level B PPE ensemble be modified to utilize 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 are present and 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. Cautionary procedures must be taken and additional site information must be obtained to be able to downgrade below level B and to use Level C safely at a fentanyl response. **The "modified" Level B PPE ensemble includes:**

  - A NIOSH-certified CBRN full-face-piece 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 (encapsulated- 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 factors for the use of APR or PAPR are met, i.e., no IDLH conditions and 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.

  For this work, select Level C only when the specific opioids and a good understanding of likely airborne levels are known and the respiratory protection criteria factors for the use of APR are present. Use a NIOSH-approved CBRN PAPR with a tight-fitting face piece and a filter or a combination chemical cartridge/filter. When available, the use of a tight fitting, full face PAPR provides a higher Assigned Protection Factor (1000) than an APR (50). Therefore, a full-face tight fitting PAPR should be considered first. NIOSH-approved CBRN tight-fitting full face APR with organic vapor/acid gas/P100 cartridges/canisters can be used but is not preferred, and if used, must be in accordance with approved NIOSH criteria. Utilize 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 the "modified Level C" would be the minimum PPE level for decontaminating first responders at a fentanyl contaminated incident where the types and concentration of the contaminants are known. **The "modified" Level C PPE ensemble includes:**

  - A NIOSH-certified CBRN PAPR with a tight-fitting full face-piece, with P100 cartridges/canister.
  - 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.
  - Note: 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 is considered clean and 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; boots/shoes, 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

The DEA discourages field testing of containers or bags due to the possible presence of potent opioids, including fentanyl, which may become airborne when opened. Field screening or sampling may be considered if an emergency responder is appropriately outfitted as indicated in the PPE section above to eliminate or greatly minimize inhalation, skin, eye, and incidental ingestion exposure. Response personnel should utilize routine air monitoring [Photoionization detector (PID), flame ionization detector (FID), and/or combustible gas indicator] for other volatiles that might be used in the illegal manufacturer of drugs or other operations.

Available test kits are:

- **Nark II Fentanyl Reagent.** The Nark II Fentanyl Reagent has the capability of presumptively identifying some fentanyl compounds and heroin. Each pouch test is comprised of one or more chemical reagents. When a predictable color or series of colors occur within a specific testing sequence, a positive confirmation may be presumed. A forensic laboratory is then required to qualitatively identify an unknown substance. **It is only sold to law enforcement.** The fentanyl and fentanyl reagent kit along with other kits for specific opiates/opioids are available at: http://www.sirchie.com/nark20033-fentanyl-reagent.html#.WJDFndfyt0w. [29]

- **The NARK Fentanyl/Heroin Patrol Kit**. The Nark Fentanyl/Heroin Patrol Kit contains the appropriate PPE and Fentanyl II Reagent. The Fentanyl II Reagent is a presumptive test designed to identify heroin or fentanyl which is commonly cut into heroin or sold as a stand-alone substance. Like all NARK narcotic field tests, the Fentanyl II Reagent is a presumptive field drug testing that uses a predictable color or series of colors. A forensic laboratory is required to qualitatively identify an unknown substance. **It is only sold to law enforcement.** The Nark Fentanyl/Heroin Patrol Kit are available at: http://www.sirchie.com/nark-fentanyl-heroin-patrol-kit.html#.WMfkaG_yt0w [30]

- **Particulate Monitoring**. There are no available field detection methods for fentanyl in waters or for aerosol fentanyl. Similar to a lead site, the site safety officer may utilize particulate monitoring to detect dusty conditions that may pose a hazard to site personnel. If dusty conditions exist, work is ceased until the dusty conditions abate.

SAMPLING

Note: This section on sampling contains general guidelines and does not replace the need for a site-specific sampling plan. Because fentanyl is a solid, sampling for particulates in air in addition to surface wipes may be necessary to achieve many sampling goals to enhance health and safety. For sampling questions, contact the Environmental Response Laboratory Network (ERLN) Laboratory Compendium lists laboratories which will analyze fentanyl contaminated environmental samples (non-clinical). Contact ERLN through the EPA/HQ-EOC at 202-564-3850. NOTE: Sampling and analysis methods for fentanyl and other environmental contaminates can be queried using EPA's National Homeland Security Research Center (NHSRC) *Standard Analytical Methods for Environmental Remediation and Recovery* (SAM) on-line methods database at: https://www.epa.gov/homeland-security-research/sam

- **Sample Locations and Planning:** Initially consider air sampling to characterize airborne opioids and to determine if there is a plume which could impact 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 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: The laboratory must be accredited and meet the requirements of International Organization for Standardization (ISO) / International Electrotechnical Commission (IEC) 17025:2005 or current edition.** Detection, analysis, sampling equipment and procedures will be site-specific and depend on: 1) physical state of the agent; 2) type of surfaces contaminated (e.g., porous vs. non-porous); 3) the 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 (ANSI) - American Society for Quality (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/. In the search screen for this site, the location of site and type of laboratory (state, local, private) can be inputted. This will provide a list of accredited laboratories. Specify "drug chemistry" in the search. Additional assistance with identification of laboratories can be requested through the Forensics Department at American Society of Crime Laboratory Directors/Laboratory Accreditation Board (ASCLD/LAB), 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 sample-receiving laboratory to determine if they have additional packaging, shipping or labeling requirements. The packaging and shipping of samples are subject to strict regulations established by DOT, Centers for Disease Control, United States Postal Service, Occupational Safety and Health Administration, and International Air Transport Association. 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 fentanyls are suspected**. Opening a package could suspend the powder and cause exposure. If an emergency responder is appropriately outfitted as indicated above 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 evidence. Emergency response personnel should be aware that unadulterated fentanyls may resemble cocaine or heroin powder, fentanyls can be mixed with other substances which can alter its appearance. Therefore, wipe and air sampling may be more acceptable options.
  - **Air/Particulate Samples:** Similar to a lead site, particulate sampling may be performed. For lab analysis, samples are collected on air filters at 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 lpm. 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 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. Also see NIOSH Method 9106, Appendix C, for specific sampling instructions for Methamphetamine and Illicit Drugs, Precursors and Adulterants on Wipes by Liquid-Liquid Extraction; or NIOSH Method 9109, Appendix C, for specific sampling instructions for 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 American Indudtrial Hygiene Assoc. (AIHA) method NAT-2003-05515 uses pre-rinsed TX714X alpha swab for sampling surfaces, followed by LC/MS/MS for fentanyl analysis.
  - **Other Sample Matrices:** The contamination of the food supply chain, processing plants and agriculture livestock and products using fentanyl is possible. Sampling of these matrices may be required, in cooperation with other federal agencies (U.S. Department of Agriculture, Federal Drug Administration, etc.). Please contact the EPA's ERLN via the EPA HQ EOC 24-Hour Number 202-564-3850 for further assistance for sampling instructions.

ANALYSIS

The ERLN's Laboratory Compendium lists laboratories which will analyze fentanyl contaminated environmental samples (non-clinical). Contact ERLN for methods or see SAM methods at: https://www.epa.gov/homeland-security-research/sam

Wipes and Liquid samples:

- EPA (SW-846) Method 3520C: Continuous Liquid-Liquid Extraction[31] and Method 3535A: Solid-Phase Extraction[32]
- NIOSH Method 9106, Methamphetamine and Illicit Drugs, Precursors and Adulterants on Wipes by Liquid-Liquid Extraction. Issue 1[33]

Solid samples:

- EPA (SW-846) Method 3541: Automated Soxhlet Extraction[34] and Method 3545A: Pressurized Fluid Extraction [35]
- NIOSH Method 9109 Methamphetamine and Illicit Drugs, Precursors and Adulterants on Wipes by Solid Phase Extraction. Issue 1[36]

Other Methods:

- EPA, Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events, Revision 5, EPA/600/R-04/126E[37]
- EPA, GRANGE, A. H. AND G. SOVOCOOL. Detection of Illicit Drugs on Surfaces Using Direct Analysis in Real Time (DART)/Time-of-Flight Mass Spectrometry. Rapid Communications in Mass Spectrometry. Wiley InterScience, Silver Spring, MD, 25(9):1271-1281, (2011),[38]

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 between fentanyl compounds, decon/cleanup planning may be similar among different analogues. However, a universal approach to decon/cleanup should not be assumed given the proliferation of fentanyl compounds. Please contact EPA's HQ EOC 24-Hour Number 202-564-3850 for further assistance.

- **General Considerations**: A cost vs. benefit evaluation should be undertaken for each decon strategy and approach which considers: public safety, total cost, impact on the facility, wastes generated, as well as the time the facility or item will be out of service, and any socio-economic, psychological, and/or security impacts that may result. Large volumes of decon wastes may be generated, which will need to be collected, treated, and disposed of properly. Waste handling and disposal must be addressed as early in the decon and cleanup process as possible (see Waste Management section below).
- **Disposal Option**: The urgency to quickly restore a facility may result in the outright 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. Fentanyls do not evaporate or degrade appreciably over weeks to months under typical environmental conditions.
- **Decon Strategy**: A decon can be developed by designating areas based on 1) visible presence of solid fentanyls; 2) residual solid fentanyls following initial removal; and 3) aqueous solutions containing fentanyls. This strategy is based on the assumption of encountering fentanyl salts as present in many pharmaceutical products. Alteration of the fentanyl product such as cooking of the fentanyl product may result in freebase fentanyl that would be less water soluble and may require different approaches.
    - **Strategy for Removal of Solid Fentanyls:** The spread of solid (dust) fentanyl can be minimized though the use of negative air machines (NAMs) to control the air flow from a contaminated area. Bulk fentanyls 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 remove fentanyls from hard, nonporous surfaces. However, the waste solution will contain fentanyls due to the stability in water under many environmental conditions. Cleaning porous surfaces with water and detergent solutions is also possible, but may potentially transfer fentanyls further into the porous material, making it more difficult to thoroughly decon.
    - **Strategy for Surface Decontamination** Literature on the decontamination of contaminated surfaces is limited to the degradation processes of fentanyl in controlled laboratory or clinical settings. Current 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 have to be undertaken to establish specific application conditions and methods. Literature indicates that fentanyls may be destroyed by oxidants such as chlorine bleach buffered to pH ~ 5 and peracetic acid buffered to pH ~ 8. Peracetic acid containing products (MINNCARE Cold Sterilant, Oxonia Active, Peridox RTU, Dahlgren Decon) may be efficacious when buffered to higher pH, but none of these products have been tested for use against fentanyl contaminated surfaces and conditions to reach complete degradation are unknown at this time. [39] [40]
    - **Strategy for Aqueous Solutions of Fentanyls:** Fentanyls may be removed from water by adsorption process, although the adsorbent will be related to the pH which will determine whether the fentanyl is present as an ion (salt) or free base form. [41]
    - **Sensitive Equipment and Items**: For difficult-to-clean equipment thought to be contaminated with small amounts, additional options for consideration include flushing with soap and water, although the residual aqueous solution may contain fentanyls which may be decontaminated as described above.
- **Verification of Decon:** Site and situation specific. Please contact EPA's HQ EOC 24-Hour Number 202-564-3850 for further assistance.

PERSONNEL DECONTAMINATION

DECONTAMINATION CORRIDOR: The following are generic NIOSH recommendations to protect first responders:

- Position the decon corridor upwind and uphill of the hot zone. The warm zone (affected area) should include two decon corridors. One decon corridor is used to enter the warm zone and the other for exiting the warm zone into the cold zone (support area). The decon zone for exiting should be upwind and uphill from the zone used to enter.
- Decon area workers should wear appropriate PPE. See the PPE section for detailed information.
- A solution of detergent and water (which should have a pH value 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 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. Do not use hand sanitizers or solutions containing solubilizing agents.
  - 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 decon 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 decon process, and 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 RCRA hazardous waste per 40 CFR Part 261. However, the fentanyls 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.[42] Fentanyl-containing materials may be disposed of by encapsulation, incineration, or by inertization (mix with water, cement, limestone to eventually form a solid mass).[43] [44]

- **Waste Management:** The EPA considers a waste to be hazardous: (1) if it exhibits the characteristics of ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 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). Under the Resource Conservation and Recovery Act (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 the hazardous waste characteristics. However, certain fentanyl-containing materials may be considered hazardous if they 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 also be used to determine if a waste is hazardous.
- **DEA Regulations for Disposal of Controlled Substances:** According to the DEA regulations at 21 CFR Part 1317, assuming that fentanyl waste are not the property of a DEA Registrant,[45] all formulations of fentanyl should be rendered non-retrievable,[46] (permanently altered and render 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 the DEA allowing them to prescribe/handle controlled substances.
- **Solid formulations:** Solid or powder formulations of fentanyl may be placed in a heavy-mil polyethylene (PE) bag or chemical resistant PE container. Fentanyl powder can be rendered non-retrievable with the addition of soapy water or light oil (which should have a pH value between 8 and 10.5). Use a sufficient volume of soapy water or light oil such that the powder is 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 saw dust to liquid solution. Addition of saw dust 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 www.phmsa.dot.gov/hazmat. 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]-)[47]
  - UN2810 Toxic Liquid, Organic, N.O.S. II (Propanamide, N-phenyl-N-[1,(2-phenylethyl-4-piperomdonyl]-)

Requirements: Requirements for transporting hazardous materials and procedure for exemption, are specified in https://www.fmcsa.dot.gov/regulations. The 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. Access to the EPA's web based disposal tool requires pre-registration (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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