NRT Quick Reference Guide:
Yersinia pestis (Causes the disease Plague)

For reference, please see "Key References Cited/Used in National Response Team (NRT) Quick Reference Guides (QRGs) for Bacterial 2011 Revision."
QRGs are intended for Federal On-Scene Coordinators (OSCs) and Remedial Program Managers (RPMs).

<table>
<tr><td>Agent Characteristics</td><td colspan="2">Agent Classification: Biological Type: Bacteria (Y. pestis)
Description: Y. pestis is a pathogenic Gram-negative bacteria found in humans, rodents (e.g., rats, prairie dogs, various squirrels, & marmots) & black footed ferrets. Fleas act as the vector between infected animals & humans. Pets may also bring plague-infected fleas into the home. This zoonotic vector borne disease can present in three forms: 1) Pneumonic plague effects the respiratory system & is transmissible person to person & via a bio-terror aerosol. Pneumonic plague may occur secondarily to bubonic or septicemic plague. Pneumonic plague is naturally occurring but very rare; 2) Bubonic is an infection of the lymphatic system & is most common form; & 3) Septicemic is an infection of the bloodstream.</td></tr>
<tr><td></td><td>Bio-Safety Level: 3
CDC Class: A
HHS/USDA Select Agent: Yes
Incubation: 1-8 days (bubonic); 1-3 days (pneumonic via person to person or bio-terror)
Duration of Illness: Dependent on form of illness & treatment.
Person-to-Person Transmission: pneumonic: yes; bubonic: no
Treatment: Supportive with antibiotics such as streptomycin & doxycycline.</td><td>Infectivity/Lethality: High for pneumonic if untreated, > 90% will die within 24 hours of symptoms appearing. If prompt treatment received it drops < 5%. Lethality is approximately 14% for other forms.
Persistence/Stability: The way in which Y. pestis persists in certain animal hosts & vector insects is not well understood. Y. pestis can be engineered to be stable in the environment. Y. pestis is rapidly inactivated by sunlight, desiccation, & heating & doesn't survive long without a host. In a World Health Organization (WHO) analysis of a worst-case scenario, aerosolized Y. pestis was estimated to be viable & infectious for as long as 1 hour without a host.</td></tr>
<tr><td>Release Scenarios</td><td colspan="2">Air: Aerosolized Y. pestis is considered to be a bio-threat as it is the primary cause of pneumonic plague. Persons with pneumonic plague can infect others, within 6 feet of themselves, via droplets from coughing, sneezing, & breathing. If not "caught" by the BioWatch program, aerosolized releases of Y. pestis are likely to be confirmed only after patients present with pneumonic plague. During the incubation period, there would be minimal risk of further transmission of disease from the original aerosol release because Y. pestis is unstable in the environment.
Soil: Under controlled (temp & humidity) soil conditions, Y. pestis can remain viable & infectious for up to 40 weeks.
Surfaces: Under controlled conditions, Y. pestis can be viable for approx. 5 days after being suspended in solution, spread over a surface, & left to dry.
Water: May pose a water threat, Y. pestis has persisted 160 days in spring water under lab conditions.
Food: Infection can occur via contact with infected animals or contaminated animal products; this includes eating contaminated meat products.
Other: Vector & reservoir control will be required to mitigate potential of secondary plague outbreaks.</td></tr>
<tr><td rowspan="2">Health Effects</td><td>Onset</td><td>1-8 days (bubonic) or 1-3 days (pneumonic)</td></tr>
<tr><td>Signs/ Symptoms</td><td>General: It's critical for treatment to begin within 24 hours of first appearance of pneumonic symptoms.
Inhalation: Primary route of exposure for pneumonic plague. Transmission can take place if someone breathes in aerosolized bacteria via a dispersal device or if suspended in respiratory droplets from the cough, sneezing or breathing of an infected person or animal. High fever, chills, headache, hemoptysis (coughing blood), toxemia (blood poisoning), dyspnea (shortness of breath), stridor (noisy breathing), & cyanosis (bluish discoloration of the skin). Death results from respiratory failure, circulatory collapse, & bleeding.
Skin: Primary route of exposure for bubonic plague via infected flea bites, or via contact with materials contaminated with Y. pestis entering through a break or crack in skin. Swollen, tender lymph nodes (buboes) will result, in addition to fever; headache, chills, & weakness.
Ingestion: Very rare, large number of organisms needed to cause bubonic plague. Buboes appear in the neck lymph nodes.
Eyes: Infection can occur from exposure to aerosolized Y. pestis or contaminated body fluids.</td></tr>
<tr><td>Effect Levels</td><td colspan="2">Infectivity: The organism is highly infectious if aerosolized.
Infective Dose: 50% of people exposed to 10E2 to 10E4 microorganisms may become ill.
Lethality: Untreated pneumonic plague >90% - with prompt treatment, <5%.</td></tr>
<tr><td rowspan="4">Personnel Safety</td><td>Concerns</td><td>Decisions regarding PPE, sampling, & decon should not be made without verifying if the plague outbreak was naturally occurring or from an engineered source. Check with the Health & Safety Officer regarding PPE, Medical Surveillance, & Health & Safety Plan (HASP). Level of PPE may vary depending upon the incident & site specific circumstances. The PPE Levels listed are general suggestions only & may not provide protection for some decon & other chemicals that workers may be exposed to during response/recovery operations. For decon of workers, use warm soapy water, taking care to avoid abrading the skin.</td></tr>
<tr><td>Medical</td><td>Baseline: Annual physical & respiratory function exams. THERE IS NO U.S. FOOD & DRUG ADMINISTRATION APPROVED HUMAN PLAGUE VACCINE.
Treatments Available: Supportive accompanied with antibiotics, such as streptomycin & doxycycline.</td></tr>
<tr><td>First Aid</td><td>During Incident: Conduct medical monitoring; use PPE as designated by the HASP; record the PPE Levels used; monitor for fever & other signs/symptoms as listed under Health Effects &, if necessary, ensure medical attention is obtained as soon as possible.
Post Incident: Monitor for signs/symptoms. If necessary, ensure medical attention is provided ASAP.</td></tr>
<tr><td>PPE</td><td>Emergency Response to a Suspected Biological Incident: Possible PPE Levels for emergency responders is based on scenario risks from highest level of protection to least: 1) Pressure-demand Self Contained Breathing Apparatus (SCBA) with Level A protective suit, when: a) Event is uncontrolled, b) The type(s) of airborne agent(s) is unknown, c) The dissemination method is unknown, d) Dissemination via an aerosol-generating device is still occurring, e) Dissemination via an aerosol-generating device has stopped, but there is no information on the duration of dissemination, or what the exposure concentration may be. 2) Pressure-demand SCBA with Level B protective suit, when: a) The suspected biological aerosol is no longer being released, b) Other conditions may present a splash hazard. 3) Full-facepiece respirator with P100 filter or PAPR with HEPA filters, when: An aerosol-generating device was not used to create high airborne concentrations. 4) Disposable hooded coveralls, gloves, & foot coverings, when: Dissemination was by a letter, package, or other material that can be bagged, contained, etc.
Other Workers: PPE recommendations for workers other than emergency responders must be developed in the HASP for the specific scenario. PPE recommendations will vary by job type (e.g., cleanup, decon, etc.), type of exposure (e.g., airborne or surface/liquid/soil hazard), & any other site hazards (e.g., chemical, physical, etc.).</td></tr>
<tr><td rowspan="2">Field Detection</td><td colspan="2">Fixed Aerosol Monitoring: An aerosol release of Y. pestis may be detected using air samples & PCR. Results may be delayed as much as 2 days from time of release. In the absence of reliable detection, a Y. pestis release will only be confirmed once patients present with symptoms and are diagnosed or animal die-off from Plague is confirmed. Consult EPA/HQ-EOC at 202-564-3850 for more information.</td></tr>
<tr><td colspan="2">Portable Aerosol Monitoring: Portable aerosol monitoring may use dry or wet sampling methods. Dry sampling (useful only for molecular analyses) includes gelatin, cellulose acetate & Teflon methods. Wet sampling methods include liquid impingers (low flow) & impactors (single or six stage). Refer to the manufacturer's aseptic sampling methods, flow rates, & sampling times. Ensure that the appropriate pump is used for the selected sampling method.</td></tr>
<tr><td>Sampling</td><td colspan="2">Concerns: BEFORE OBTAINING SAMPLES: Identify sample transportation requirements; Contact EPA/HQ-EOC (202-564-3850) for ERLN contract laboratories able to analyze these types of samples; Clearly identify & coordinate with the laboratory to be used since most labs cannot analyze all types of media (e.g., wipes, swabs, and HEPA vacuum samples); Coordinate with the sample disposal facility for acceptance criteria (i.e., sample decon requirements); Coordinate with investigative units (EPA-CID & FBI) to ensure sample chain-of-custody is maintained between the groups. Note: Detection/analytical equipment & sampling techniques will be highly site-specific & depend on: 1) the characteristics of the agent; 2) the type of contaminated surfaces (e.g., porous v. nonporous); 3) the phases/purposes of sampling (initial ID v. post-decon sampling); 4) the way in which samples are handled so as not to adversely affect viability; 5) transportation regulations 6) the acceptance criteria of the analytical laboratory & 7) the sample decon requirements for the waste disposal facilities to be used. See</td></tr>
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	LABORATORY ANALYSIS, below.
	CAUTION: ONLY MANUFACTURER CERTIFIED HEPA VACCUUM EQUIPMENT SHOULD BE USED. **A site-specific sampling plan should be reviewed & approved by appropriate Subject Matter Experts &/or through ICS channels.** **Sampling Location & Planning:** If release was limited to a small area due to opening a letter or container, start with an area thought to be free of contamination & work in concentric circles towards the initial point of contamination. Be concerned about other contaminated areas due to foot traffic/ventilation systems (e.g., elevator buttons, mail, corners of hallways, baseboards, light switches, door knobs, etc). Based on site characteristics & laboratory capacity, the sampling plan may be judgmental, probabilistic, or a combination thereof.
	Consult EPA/HQ-EOC at 202-564-3850 for Environmental Response Laboratory Network (a.k.a. ERLN laboratory) contact information for personnel who can explain/describe the sampling procedure most compatible with their current analytical procedure. **Types of Samples:** ***Note:*** While *Y. pestis* DNA can be detected long after the bacteria themselves have perished & might be of forensic interest, the presence of the DNA says little about the potential human risk in the days following the initial release. **Air:** Collect air samples with a gelatin, cellulose acetate, Teflon (**Note**: These 3 filter methods are only useful if conducting molecular analysis.), impinger or impactor methods. Refer to the manufacturer's aseptic sampling methods, flow rates, & sampling times. Ensure that the appropriate pump is used for the selected sampling method. **Water**: Potable water sources should be sampled. If the potable water is chlorinated, the chlorine needs to be neutralized immediately with a sodium thiosulfate or other neutralizer at the concentration specified by the selected analytical laboratory prior to shipment. As chlorine levels can vary substantially throughout a drinking water system, it is not always appropriate to assume that a sample is chlorinated based solely on a description of the water treatment processes in use. **Soil:** Surface soil samples, from a depth of less than 1 inch (2.54cm), should be obtained from a non-vegetated impacted area. **Surfaces: 1)** Wipe & Swab Sampling (for non-porous surfaces): Sterile macrofoam swabs moistened with sterile neutralization buffer. If this solution is not available, use sterile de-ionized water (DI). Do NOT use dry wipes or swabs. For shipment to the laboratory, place the wipe or swab sample in a tube containing sterile phosphate buffered saline supplemented with 0.05% Triton X-100 (PBSTX). **2)** HEPA Vacuum Sampling (for both porous & non-porous surfaces): collect samples in a HEPA sock designed to fit into an inlet nozzle of a manufacturer certified HEPA vacuum cleaner. Good for screening & determining the extent & location of contamination in large areas. **Agriculture & Wildlife:** Upon confirmation of an outbreak, ensure these agencies are notified immediately since plague is a zoonotic vector borne disease; USDA at 202-720-5711 & National Center for Emerging and Zoonotic Infectious Diseases at 800-232-4636 (after hours call the Directors Emergency Operations Center at 770-488-7100).
	Samples that test for Re-aerosolization: Re-aerosolization could be a concern if the *Y.pestis* was specially engineered. **1)** Wipe sampling of the air duct system (filters, areas of particulate deposition) if exposure occurred indoors. **2)** Air Samplers & Single Stage Impactors with settle plates can be used for capturing airborne particulates of respirable size (1-5 microns) on a series of agar plates. Agar plates are then sent to laboratory for culture analysis.
	Sample Packaging & Shipping: The packaging & shipping of samples are subject to strict regulations established by DOT, CDC, USPS, OSHA, & IATA. Contact the sample-receiving laboratory to determine if they have additional packaging, shipping or labeling requirements (e.g., DO NOT X-RAY). Samples should be packaged in an air-tight container & kept at temperatures of 40-50°F (4-10°C). Ensure samples are not placed directly on the ice used for cooling the shipping container.
Laboratory Analysis	**CAUTION: Many labs may not be able to perform analysis on all matrices (e.g., wipes & soil).** The goal of laboratory analysis for environmental sampling purposes is to determine if viable *Y. pestis* is present in the sample. **Note**: The selected laboratory may use a tiered approach. If a tiered approach is used, the initial analysis may only determine if select/particular components of the bacterium are present in the sample (e.g., presence or absence). It may take additional time (up to weeks depending on the laboratory) to determine if the bacterium are viable & still able to cause adverse effects.
	Laboratory Information: Contact EPA/HQ-EOC at 202-564-3850 for contact information for nearest ERLN laboratory specializing in biological sample analysis.
Decontamination/Cleanup	**Note:** Vector & reservoire control may be required once a plague outbreak is confirmed. **CAUTION: ONLY MANUFACTURER CERTIFIED HEPA VACUUM EQUIPMENT SHOULD BE USED.** **Decon Planning:** Site-specific decon/cleanup plan should be developed & approved by all necessary organizations/SMEs via ICS channels. Responders should develop a plan that takes into account: **1)** Nature of contamination including purity, physical properties, how it entered the facility, etc.; **2)** Extent of contamination, including the amount & possible pathways that have spread the agent. It is advisable to isolate the contaminated area; & **3)** Objectives of decon, including decon of critical items for re-use & the treatment, removal, or packaging of other items for disposal. **Note:** Crisis exemptions from EPA's Office of Pesticide Programs might be necessary depending on decontaminating agents used. **CAUTION: DECON SOLUTIONS SHOULD NOT BE DEPLOYED AS A SPRAY WHENEVER POSSIBLE**. **Decon Methods:** Decon decisions will be site & situation specific but due to re-aerosolization concerns, ***under NO circumstances should a non-HEPA vacuum cleaner or a broom be used.*** EPA's National Decon Team (800-329-1841) can provide specific decontamination parameters & requirements for using readily available commercial items such as household bleach. **Methods used on surfaces: 1)** Source reduction steps, including HEPA vacuuming; **2)** Liquid antimicrobial products such as pH-amended bleach (mixture of 1 part household bleach (5.25% to 6.0%) to 1 part white vinegar to 8 parts water, is recommended). This product affects surfaces differently in terms of corrosiveness, staining, & residue. The product will be most efficient **a)** at higher temperatures (i.e., >70°F or 21°C) **b)** when plain bleach (e.g., no added fragrance) is used to make the pH-amended bleach solution, **c)** when pH is ≤ 7, **d)** when presence of other surface contaminants is minimal, & **e)** when surfaces remain wet with amended bleach solution for 60 minutes. **Note:** Store-bought bleach does degrade with time – check the expiration date. Alternate antimicrobial products include: chlorine dioxide, hydrogen peroxide, & peroxyacetic acid. **Fumigation:** Uses gas or vapor to decontaminate facilities in which there is evidence of high levels of contamination, re-aerosolization, or if decontamination of limited access areas is required (e.g. HVAC systems). **Fumigants:** chlorine dioxide, & vaporized hydrogen peroxide. Prior to use, the fumigant's compatibility with materials, penetration capacity, method of removal at the end of fumigation, as well as it's physical, chemical, & toxicological properties should be taken into account. Each chemical has a specified range for process variables (e.g., temperature, relative humidity, concentration & contact time) that must be followed. **Other Decon: 1)** Ethylene oxide sterilization is used to decontaminate items in an off-site sterilization chamber. **2)** Irradiation uses cobalt-60 & electron beam technologies to destroy agents at off-site locations. This procedure may destroy magnetic media. Irradiation & chemical sterilization may be useful in decontaminating items that are intended to be returned to owners. **Verification of Decon:** Site & situation specific. Please contact ERT (732-321-6660) & NDT (800-329-1841) for further assistance.
Waste Disposal	**CAUTION:** Hazardous waste transportation & disposal are regulated federally; however, more stringent regulations may exist under state authority. These regulations differ from state-to-state. Detailed state regulations can be found at http://www.envcap.org.
	Waste Disposal Planning: Waste generated from assessment & cleanup activities should be autoclaved, chemically disinfected, or fumigated & then tested to be sure the agent(s) were inactivated. Waste disposal for agent-contaminated wastes generated from decontamination & disposal activities will be problematic. Landfills willing to take these wastes may be limited & incineration may be prohibitively expensive or impractical. All waste disposal options should be investigated as early into the response process as possible. Transportation of the agent contaminated wastes from the site to the landfill or incinerator may be problematic as well. Agreements must be reached between the waste generator & acceptor BEFORE transport. Information regarding the agreements may be required to be available to the public. Transportation of hazardous waste may cross several states & localities, which may exceed federal regulations. Requirements for transporting hazardous materials, & procedures for exemption, are specified at: http://www.fmcsa.dot.gov/safety-security/hazmat/complyhmregs.htm. The EPA has developed a web-based Incident Waste Management Planning & Response Tool which contains guidance related to waste transportation & handling, carcass disposal, contact information for potential treatment, disposal facilities, & state regulatory offices, packaging guidance to minimize risk to workers, & guidance to minimize the potential for contaminating the treatment or disposal facility. Access to the EPA's web based disposal tool requires preregistration: http://www2.ergweb.com/bdrtool/login.asp.