USACHPPM
Readiness thru Health

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Just the Facts... Vehicle Exhaust Gases - Medical

GENERAL INFORMATION	There are three major types of vehicle engines: gasoline, diesel, and turbine. The fuels used in these engines are generally mixtures of many chemicals. There are several methods of providing and burning the fuel. The composition of the exhaust is based primarily on the fuel and the temperature at which it is burned. Fuels use additive chemicals for many different reasons—to aid in flow, prevent freezing, and clean internal parts. These additives are present in low concentrations but they may be important exhaust components. One additive, tetraethyl lead, was previously used extensively in gasoline and other motor fuels. It is no longer used for automobiles in the US, but it is still used in some aircraft fuels and may be used in vehicle fuels overseas. Diesel and turbine engines use similar fuels and produce similar exhaust gases; except that diesel engines generally release more unburned carbon as particulate matter. JP-8, a NATO and joint service fuel, is currently replacing diesel fuel in diesel engines and other turbine fuels (JP-4 and JP-5). Different chemical additives are blended in the JP-8 when it is used for different purposes (diesel engine fuel, cooking stoves, heating). Gasoline is a more refined fuel, but chemicals are still added. The major components of vehicle exhaust gases include carbon (as very small particles), unburned hydrocarbons, carbon dioxide, carbon monoxide, nitrogen oxides, sulfur oxides, water vapor, and thousands more "low-level" chemicals. The peculiar odor of diesel exhaust is due to aldehydes, acrolein, and sulfur compounds. Gasoline engines generally produce more carbon monoxide than diesel or turbine engines; diesel and turbine engines produce higher levels of nitrogen oxides. The use of emission control measures from fuel regulation, to air injection and catalytic conversion of the exhaust gases, greatly affects the types and amounts chemicals found in the exhaust gases.
ROUTINE USES IN THE DEPLOYED SETTING	Abrams M1A1/M1A2 Main Battle Tanks use gas turbine engines; Bradley Fighting Vehicles, HumVees, and most Army trucks use diesel engines; passenger and "light" motor vehicles, and small engine applications (water and transfer pumps; pesticide sprayers) use gasoline-fueled engines; Army marine applications (boats) are primarily diesel.
PERSONAL PROTECTIVE EQUIPMENT (PPE) and COUNTERMEASURES AVAILABLE FOR DEPLOYED PERSONNEL	Routine use of personal protective equipment is not necessary. The location of the exhaust discharge is considered in the vehicle's design to prevent or minimize exposure to personnel in the vehicle. However, under some operating conditions, exhaust gases may enter the driver or passenger area, or expose nearby personnel. Avoidance is the best countermeasure, but under some operational conditions, exposure to vehicle exhaust gases may be unavoidable.
QUESTIONS TO ASK REGARDING EXPOSURE	• What type of vehicle/internal combustion engine produced the exhaust gases? • How long did the exposure(s) last? • Was/Were there any acute effect(s) associated with the exposure(s); how long did it/they last? • Were any other individuals affected? • Was the exposure situation evaluated by the medical department?
EXPOSURE LEVELS HISTORICALLY ENCOUNTERED	**DATA IF AVAILABLE** Typical operation of motor vehicles does not result in excessive exposure to operators and passengers in the vehicle. Adjacent personnel may be in the exhaust stream, but the odor and irritation from diesel exhaust often compels movement to a site with fresher air. This may not be possible under some operational circumstances. In these instances, exposure to carbon monoxide, oxides of nitrogen, aldehydes, acrolein, and respirable carbon particles (soot) with adsorbed trace contaminants can occur.

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AVAILABLE EXPOSURE DATA	**DATA IF AVAILABLE** There are US Army guidelines for short- (as diesel smoke) and long-term (as diesel emissions) exposures are contained in TG 230. US occupational health and environmental exposure standards do not address "motor vehicle exhaust" as a single entity, but TG 230 and US occupational and environmental standards have exposure values limits for individual components of engine exhaust, such as carbon monoxide, sulfur dioxide, benzene, carbon dioxide, nitrogen dioxide, acrolein, and formaldehyde.
COMMON ACUTE AND CHRONIC HEALTH EFFECTS	Typical, acute by-stander exposures to low-to-moderate concentrations of vehicle exhaust gases (and particles) show a general progression of signs and symptoms. These start with irritation of the mucous membranes of the eyes, nose, and throat; and then other effects involving the respiratory, GI, or central nervous system: headache, dizziness, nausea, vomiting, difficulty in concentrating, feeling of intoxication, weakness, parathesias in extremities, chest tightness and wheezing, and shortness of breath. Coma, convulsions, and death can occur with significantly high level exposures. The usual acute effects resolve with movement to fresh air or administration of oxygen. However, exposure to high concentrations of oxides of nitrogen can result in chronic pulmonary disease even after resolution of the acute effects. Chronic health effects, such as broncholitis obliterans, reactive airway disease, and chronic bronchitis, can occur following acute exposure to moderate or high levels of vehicle exhaust, or chronic exposure to lower levels. Persistent neurological sequelae are possible from significant carbon monoxide poisoning usually associated with the operation of an engine in a confined space or direct inhalation of a high concentration of the exhaust gas components. Several components of vehicle engine exhaust are known to cause cancer. They may be present in very low concentrations, and the levels vary greatly.
REVERSIBILITY OF HEALTH EFFECTS	With typical low level exposure to exhaust gases, the minor toxic effects will resolve spontaneously with cessation of the exposure. Permanent health effects, chronic health effects, including cancer, may occur following significant exposure.
TREATMENT REQUIRED/AVAILABLE FOR EXPOSURE	Cessation of exposure is the essential treatment for acute or chronic exposure. Oxygen is used as indicated. Severe carbon monoxide poisoning may require additional treatment with hyperbaric oxygen. Symptomatic and supportive treatment may be required for neurological, respiratory, or other sequelae associated with severe acute exposure or significant chronic exposure. Exposure to diesel exhaust in combination with other cancer causing substances may potentiate the risk of developing lung cancer. Other exposures that are known to cause lung cancer include cigarette smoke, welding fumes and asbestos. These exposures may interact with diesel exhaust to increase the risk of lung cancer.
LONG TERM MEDICAL SURVEILLANCE REQUIREMENTS OF HEALTH EFFECTS MONITORING	Medical surveillance is not required for routine exposure. Following significant acute or chronic exposure, surveillance can be based upon a known component of the exhaust gases. Benzene, and its metabolites, and 1-hydroxypyrene can be used as biomarkers of fuel exposure, if warranted. Individuals who have been identified with a chronic lung or neurological disease require periodic medical evaluation and follow-up based on the specific exhaust gas component.
SPECIAL RISK COMMUNICATION ISSUES	Occasionally, black sooty material may be present in mucous and saliva. This represents the "soot" particles that have been trapped and do not necessarily indicate the severity of exposure. This material rapidly disappears with cessation of exposure. Smaller particles are not trapped in the upper respiratory tract and reach the deep lung area. These particles represent potential exposure from both the solid material, as well as, substances adsorbed to the particle surface. In chronic exposures, the amount of this small material can be significant with respect to cardio-respiratory disease or cancer. Carbon monoxide is a minor component of diesel and turbine exhaust, but it is a significant component of gasoline engine exhaust that is not passed through a catalytic converter. Exposure to diesel exhaust in combination with other cancer causing substances may increase the risk of developing lung cancer. Other exposures that are known to cause lung cancer include cigarette smoke, some metals in welding fumes, and asbestos. These substances may interact with diesel exhaust to increase the risk of lung cancer. Control of further exposure to these substances represents the only preventive intervention for past exposure to exhaust gases and this should be stressed during personal contact.