Just the Facts... Engine Emissions – Health and Medical Effects

General Information

Combustion engine exhaust products originate from three major types of internal combustion engines: gasoline, diesel, and turbine. The combustion exhaust composition is based primarily on the composition of the fuel and the temperature at which it is burned. 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. For the purposes of this fact sheet, the use of the term "diesel fuel" includes JP-8.

Routine Uses in the Deployed Setting

Abrams M1A1/M1A2 tanks and helicopters use turbine engines; Bradley fighting vehicles, HMMWVs, generators, 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. Vehicles should be operated and parked as instructed per guidance and training. If a vehicle or piece of "power" equipment has special snorkels, extensions (e.g., exhaust extensions), adaptors, etc., they too should be used per guidance and training.

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 away from passengers and air intake(s) 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 may be unavoidable. Every effort should be made to maximize ventilation when operating in confined areas by opening doors or by directing exhaust outdoors. In addition, combustion engines should be properly maintained and not be operated in close proximity of people or building openings.

Exposures Historically Encountered

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 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.

Exposure Limits

For the individual components of exhaust emissions, the Army routinely uses the lower of Occupational Safety and Health Administration (OSHA) or American Conference of the Governmental Industrial Hygienists (ACGIH) exposure limits. For deployed personnel, TG 230 provides guidelines for diesel smoke and total emissions as well as for individual contaminants.

Common Acute and Chronic Health Effects

The effects of exposure to any hazardous substance depend on the dose, duration, exposure route, personal traits and habits, and whether other chemicals are present. Typical acute by-stander exposures to low-to-moderate concentrations of vehicle exhaust show a general progression of signs and symptoms. These start with irritation of the mucous membranes of the eyes, nose, and throat. Other effects may follow involving the respiratory, gastrointestinal, or central

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nervous system: headache, dizziness, nausea, vomiting, difficulty in concentrating, feeling of intoxication, weakness, burning/tingling sensations in extremities, chest tightness, 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 (inflammation and obstruction of the lungs caused by mucosal ulceration and fibrous granulation tissue), 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 effects are possible from significant carbon monoxide poisoning. These effects are usually associated with the operation of an engine in a confined space or direct inhalation of a high concentration of the exhaust gas components. Breathing diesel fuel vapors for long periods may cause kidney damage and lower the blood's ability to clot. Concerns involving specific exposures should be addressed by a medical professional.

Reversibility of Health Effects

With typical low level exposure to exhaust gases, the minor toxic effects will resolve spontaneously with cessation of the exposure. Chronic health effects, including cancer, may occur following significant exposure.

Questions Typically Asked by Medical Professionals Regarding Suspected Exposure

- What type of vehicle/internal combustion engine produced the exhaust gases?
- Was the engine properly maintained?
- Does air monitoring data for the operation exist?
- How long did the exposure(s) last?
- Was the exposure experienced in an enclosed space?
- Was/Were there any acute effect(s) associated with the exposure(s)?
- If so, how long did it/they last?
- Were any other individuals affected?
- Was medical treatment for the exposure sought?

Treatment Required/Available for Exposure

Cessation of exposure is the essential treatment for acute or chronic exposure. Oxygen maybe used as indicated by a medical professional. Severe carbon monoxide poisoning may require additional treatment with hyperbaric oxygen. Treatment may be required for neurological, respiratory, or other effects associated with severe acute exposure or significant chronic exposure.

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 emissions. 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, after exposure to vehicle exhaust, black sooty material may be present in mucus and saliva. This represents the "soot" particles that have been trapped and expelled. This does not indicate the severity of exposure. This material rapidly disappears with cessation of exposure. Smaller particles that are not trapped in the upper respiratory tract may reach the deep lung. In chronic high-level exposures, these smaller particles can be significant with respect to cardio-respiratory disease or cancer.

Long term exposure to diesel exhaust in combination with other substances such as tobacco smoke, some metals in welding fumes, and asbestos, may increase the risk of developing lung disease. Exposure to these substances should be avoided.