DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

SAFETY
CARBON MONOXIDE POISONING

Department of the Army, Washington 25, D.C. 6 December 1956

1. General. Carbon monoxide results from the incomplete combustion of carbonaceous fuels or other organic matter. Automobile and motor exhaust in garages and shops is perhaps the best known source of carbon monoxide exposures. But indoor operations performed near furnaces, stoves, forges and kilns which are improperly fired and are located in poorly ventilated areas present equally serious potential health hazards. Carbon monoxide from indoor proof-firing of ammunition has particular significance in many military installations.

2. Control. Exposures to carbon monoxide are usually most severe during the cold months when doors and windows in buildings are usually closed. Consequently, unless control measures are based on winter operating conditions, excessive atmospheric concentrations of carbon monoxide may result because of insufficient ventilation to control the volume of combustion products being generated. The type and degree of control required must be determined from an evaluation of each specific operation and location. If only one small engine is operated for a short period of time in a large room of "X" cubic-foot volume, natural ventilation may be adequate to prevent an excessive carbon monoxide concentration. However, if three or four engines are operated in the same room of "X" cubic-foot volume, the amount of carbon monoxide in the atmosphere may rise to a dangerous level. Where natural ventilation is not adequate because of the size and number of engines being operated simultaneously, mechanical-exhaust ventilation may have to be installed. Gravity or mechanical exhaust tailpipe extensions are a common control

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in maintenance shops where vehicles are operated at fixed test or repair locations. When motor vehicles move within a building (e.g. materials handling equipment operating in a warehouse), carbon monoxide concentrations may be kept below the threshold limit value of 100 parts per million parts of air either by general dilution ventilation or by limiting the number of vehicles being operated at one time. Control of such other types of operations as forging, heat-treating, and proof-firing also must be accomplished by maintaining a balance, either naturally or mechanically, between generation and removal or dilution of fuel combustion products.

3. Severity of exposure. Some typical operations wherein the carbon monoxide exposure and basis for its control are common are described in the following table. These operations were evaluated during industrial hygiene surveys made by personnel of the Army Environmental Health Laboratory and illustrate the severity of exposure which may occur through improper control.

Operation	Controls present in addition to natural ventilation	Carbon monoxide concentration in PPM*
Testing and tuning small motor vehicle engines (less than 200 hp) was performed by three to five employees in a 36,000 cubic-foot room. Two or three engines were frequently operated simultaneously. It was reported that the workers suffered repeated headaches during the winter season when all doors and windows were closed.	None.....	200-500
Repair and tuning of heavy engineering equipment engines (greater than 200 hp) were performed by 20 mechanics in a 38,000 cubic-foot room. Atmospheric sampling was accomplished when four diesel engines and four large gasoline engines were operating simultaneously.	Four-inch diameter, gravity exhaust tailpipe extensions approximately 25 feet in length.	400-800
Testing and tuning truck, tank, and other large vehicle engines was done in a 200,000 cubic-foot room. Approximately 19 persons were exposed 2 to 3 hours daily.	*a*. Mechanical general ventilation by means of a 48-inch exhaust fan. *b*. Intermittent exposure.	100-500
Dynamometer testing of engines (greater than 500 hp) was performed by seven workers in a 50,000 cubic-foot room. Medical personnel reported that on one occasion four of the workers were overcome by carbon monoxide and were brought to the hospital where oxygen was administered. On another occasion a dynamometer test operator was hospitalized for one week because of carbon monoxide poisoning. Operations in the dynamometer shop were finally suspended until the ventilation system could be modified.	*a*. Mechanical general ventilation by means of two ceiling-exhaust fans. *b.* Four-inch diameter gravity-exhaust tailpipe extensions.	200-800

*Parts per million parts of air.

Operation	Controls present in addition to natural ventilation	Carbon monoxide concentration in PPM*
Three materials handling vehicles were operated in a 100,000 cubic-foot warehouse room. The three drivers and two other workers were exposed approximately 3 hours daily.	Intermittent exposure	200
Gasoline-powered motor-generator units were operated indoors	*a*. Mechanical-exhaust tailpipe extensions (15-20 cubic feet per minute of air removed through each extension). *b.* Mechanical general ventilation by means of two large wall exhaust fans.	100-150
Machine gun firing of 20-and 30-mm ammunition was performed by 40 persons indoors. The total time of exposure for each person averaged 1 hour per day. Occasionally special tests increased the exposure time to 5 to 6 hours per day.	*a*. Local-exhaust ventilation at some firing positions. *b.* Intermittent exposure.	500
Hand-forging metal parts was performed by one man approximately 8 hours per week.	*a.* Gravity-exhaust hood over the forge. *b.* Mechanical general ventilation by means of a wall-exhaust fan. *c*. Intermittent exposure.	200

*Parts per million parts of air.

4. Summary. Particular attention should be paid to operations involving exposures to carbon monoxide during the winter months, when windows and doors in buildings are generally closed and carbon monoxide concentrations may reach dangerously high levels. Where rates of generation of combustion products exceed the capacity of natural ventilation to maintain a sufficiently low atmospheric concentration of carbon monoxide, supplementary mechanical controls may be necessary.

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NG: State AG (5).

USAR: None.

For explanation of abbreviations used, see SR 320-50-1.

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