THE ASSOCIATED ETHYL COMPANY, LIMITED
LONDON

MEMORANDUM

ON THE

DECONTAMINATION OF MATERIALS

WHICH HAVE COME IN CONTACT

WITH

TETRAETHYL LEAD,

"ETHYL" ANTI-KNOCK COMPOUNDS

OR

SOLUTIONS OF THESE PRODUCTS

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INTRODUCTION

THE DISPOSAL of spilled tetraethyl lead or "Ethyl" anti-knock compound is a serious problem which involves immediate hazard to those who undertake the task of disposal, and to others who may be near at hand. There is also the hazard of later exposure to either intermediate or end products of the reactions of decontaminants on tetraethyl lead (T.E.L.)

The first consideration when T.E.L. or "Ethyl" anti-knock compound is spilled, is the protection of all who may be exposed to it. The area must be evacuated by all except adequately protected persons until all danger has been removed. In warm weather the hazard of prolonged exposure (hours) to vapours rising from spilled material may be considerable even at some distance from the area. (Undiluted air saturated with T.E.L. vapour in temperate weather, when breathed for ten minutes, may cause fatal poisoning, and when such saturated air is diluted fifty-fold it may still cause illness if breathed for an hour.) The help of policemen and/or firemen may be sought to ensure that all persons are excluded from the contaminated area. All persons whose duties require them to remain in the area must be protected against inhalation of vapour by the use of airline masks, self-contained oxygen masks, or masks equipped with canisters containing activated charcoal. Protective clothing in the form of impervious boots and gloves must be employed to prevent absorption through the skin.

The second point requiring careful, but prompt, consideration and action is

the limitation of the spillage to the least possible area. If a large spillage should occur in a populated area, it might conceivably be necessary—for the immediate protection of the public—to remove it quickly by flushing into a sewer. This should not be done unless absolutely necessary, since the contamination of sewers and sewage disposal plants will inevitably result, and decontamination thereof may be difficult. In general, attempts to wash away spilled material are ill-advised unless the quantity involved is so small that by sufficient dilution all danger of exposure thereto will have been eliminated.

The third and final step is to decontaminate the area. It is the object of this memorandum to summarize the available knowledge on this subject, and to suggest the measures which should be adopted under the various conditions which may be experienced.

GENERAL CONSIDERATIONS

Decontamination is the rapid conversion of T.E.L. to other lead compounds which are less dangerous and more readily eliminated. The conversion of this liquid lead compound to a solid reduces its capacity to vaporize, eliminates its ability to penetrate the skin, and renders it more or less soluble in water, thus allowing it to be diluted to harmless levels of concentration. Such conversion can be accomplished by chemical means and by burning.

The incomplete conversion of T.E.L. to intermediate inorganic lead compounds, greatly reduces the hazards of inhalation of vapour and of absorption through the skin, but these intermediate lead compounds must be handled with care as, in addition to their acting as an irritant to the skin, they will, under suitable conditions, react to produce T.E.L., thereby recreating the original hazard. For this reason, the job of decontamination is not completed until all T.E.L. has been converted to inorganic lead salts. This purpose is normally accomplished by providing such an excess of decontaminant that complete conversion is assured. It is advisable to ensure that the material will not be disturbed (e.g. by excavation) for some years to come. It is advisable to erect a sign marking such an area warning possible excavators. Pits into which partially decontaminated materials are placed for burial should be lined heavily on all sides and above and below with chloride of lime in order to prevent spreading of T.E.L. Every effort must be made to secure complete decomposition of all organic lead compounds.

DECONTAMINATING AGENTS

The decontaminating agents which are considered suitable for use in the field are listed in Table I. The choice of these decontaminants was made from the standpoint of efficacy in decontamination, commercial availability, and ease of handling.

TABLE I
DECONTAMINATING AGENTS

Decontaminating Agent	*Chemical Formula*	*Solvent*	*Concentration of Decontaminant Volume per cent*	*Relative Rate of Decontamination*
Potassium permanganate	$KMnO_4$	Water	5*	Rapid
Sulphuryl chloride	SO_2Cl_2	Kerosene	10	Fairly rapid
Calcium hypochlorite†	$CaOCl_2$	Water	Slurry	Slow

* The crystals of potassium permanganate may be sprinkled upon a contaminated area, after which water can be sprayed on (a 5 per cent solution being approximately a saturated one).

† Also known as chloride of lime or bleaching powder.

N.B. It must be emphasized that, with the exception of potassium permanganate, undiluted reagents must never be applied to spilled materials as this would lead to explosive reactions and resultant fire.

1. POTASSIUM PERMANGANATE

a strong oxidizing agent, is an odourless salt of a dark purple colour.

Its use by the methods indicated above does not entail any hazard. The solution of the salt, however, will stain the hands and clothing, whilst a finely divided spray, if inhaled, may result in toxic absorption.

2. CALCIUM HYPOCHLORITE

is a white or greyish-white powder smelling strongly of chlorine. This product ordinarily contains about 35 per cent of available chlorine (the active ingredient) which reacts with T.E.L. to form non-volatile lead salts. Dry calcium hypochlorite reacts violently with T.E.L. and, therefore, must always be added in the form of a wet paste or slurry.

NOTE: Calcium hypochlorite readily gives up its chlorine when exposed to air or moisture. For this reason it should be kept in an air-tight container until just before use. Calcium hypochlorite should always be handled with care, for chlorine gas is toxic and also corrosive to most metals and cotton fabrics.

3. SULPHURYL CHLORIDE

is a colourless, pungent liquid which is slowly decomposed by water into sulphuric and hydrochloric acid. Caution should be observed in its use as it is both toxic and corrosive. Goggles and rubber gloves should be worn when handling the material; inhalation of the vapours should be avoided, and adequate ventilation should be provided.

Sulphuryl chloride liberates chlorine which reacts with T.E.L. to form non-volatile salts. The reaction can be accelerated by the addition of pyridine.

PREPARATION OF DECONTAMINATING MIXTURES

1. POTASSIUM PERMANGANATE

A 5 per cent solution (0·4 lb. per gallon) is roughly a saturated one. It is prepared by shaking an excess of potassium permanganate crystals with water until no more will dissolve. The resultant liquid is then ready for use.

2. CALCIUM HYPOCHLORITE

This decontaminant must be used as a slurry. It is prepared by mixing equal parts of calcium hypochlorite and water (the best means of making a smooth slurry is first to mix a part of the water with all of the calcium hypochlorite, working the mixture to a paste, then adding the remainder of the water while thoroughly stirring the mixture).

3. SULPHURYL CHLORIDE

Prepare 5 per cent or 10 per cent solutions of sulphuryl chloride in kerosene. The mixing is done in the open air, using goggles to protect the eyes, and heavy rubber or acid-proof gloves to protect the hands. The solution should always be made up fresh as it deteriorates rapidly during storage.

Sulphuryl chloride solution is decomposed by sunlight and, therefore, should be stored in dark-coloured bottles. Owing to the formation of gas during storage the solution should be lightly stoppered with a lead stopper, and stored in a well ventilated place where its vapours will not corrode nearby equipment.

MATERIAL REQUIREMENTS IN DECONTAMINATION

TABLE II

MINIMUM QUANTITY OF DECONTAMINANT REQUIRED FOR DESTRUCTION OF ONE POUND OF T.E.L.

Decontaminant	*Undiluted decontaminant, pounds*	*Prepared mixture, gallons*
Potassium permanganate	2	5
Calcium hypochlorite	2	–
Sulphuryl chloride	4	6

It must be stressed that the amounts listed are minimum *quantities and several times these quantities should be used during decontamination operations.*

DECONTAMINATION BY BURNING

The simplest and perhaps most effective decontamination is fire. When the contaminated object is of little value it is best to destroy the article by burning directly on an open fire. T.E.L. and "Ethyl" anti-knock compound should *never* be burned without dilution with kerosene, otherwise a violent reaction may result. [It is recommended that a safe burning mixture is 10 per cent T.E.L. in kerosene.] Several precautions should be observed when burning a contaminated article or diluted "Ethyl" anti-knock compound.

1. Burning should be carried out in the open air as far away as possible from buildings and persons, so that no hazard is created by the smoke.
2. Diluted fluid or sludge should be burned in a container which is wide open to the air, and in which the material is in actual contact with the flame.
3. The operator should work on the upwind side of the fire.
4. The fire should be kept burning briskly so that the T.E.L. will be consumed, and not merely evaporated, by the fire.

DECONTAMINATING PROCEDURES

1. DECONTAMINATION OF SOIL

If a large quantity of T.E.L. (greater than 1 gallon) has been spilled on the ground, it may be wise to remove as much as possible of the spilled material before applying a decontaminant. The following procedure is recommended:

(i) Flush the contaminated area with a generous amount of kerosene in such a manner as to dilute the spilled material and drain it into a trench. The kerosene which has accumulated is removed to an isolated pit and burned. The kerosene flushing is repeated and the drainage disposed of as before. Again flush the area with kerosene and burn.

(ii) After the kerosene treatment the area is treated generously with potassium permanganate.

(iii) Finally, a slurry of chloride of lime is spread on the area and mixed with the soil by raking, after which sufficient chloride of lime is added to form a $\frac{1}{4}$-inch layer on top of the ground.

If the lead hazard persists the decontamination operation must be repeated.

2. DECONTAMINATION OF CONCRETE

T.E.L., when spilled on concrete, will require handling in one, or a combination, of the following procedures:

(*a*) When there is no opportunity or need for reclaiming or removing spilled material the contaminated area should be blanketed with potassium permanganate by applying crystals and a water spray, or an aqueous solution in great excess.

(*b*) Any material which has collected in deep pools, together with any kerosene or gasoline employed to wash off contaminated surfaces should be put into standard drums.

(*c*) Spilled material may be flushed to a convenient sump or pit from which it is removed and put into drums to be disposed of by burning.

(*d*) In order to avoid its further spread, spilled material may be absorbed with rags, sand, soil, sawdust, etc., and removed to an isolated spot, mixed with kerosene, and burned.

After the bulk of the spilled material has been removed, the contaminated area of concrete is treated with generous amounts of potassium permanganate. About two hours after this treatment, the area is thoroughly hosed with water. If it is advisable to remove the stain left by the potassium permanganate, this can be done with hydrochloric acid and generous flushing with water.

If the decontaminating operations did not fully remove the lead hazard, the entire procedure is repeated. Owing to the porous nature of concrete, absolute decontamination may not be possible. Should this be the case, it may be necessary to replace the contaminated concrete.

3. DECONTAMINATION OF WOOD

If a large area of wood has been contaminated for any considerable period of time, the wood cannot be decontaminated and must be burned. When the quantity spilled is small or prevented by reason of an intervening coat of paint from penetrating the wood, decontamination may be effected as follows:

(*a*) The bulk of the spilled material is absorbed using sawdust and/or rags which are then burned.

(*b*) After the bulk of the spilled fluid has been removed, the contaminated area is scrubbed with a slurry of chloride of lime, the slurry being allowed to remain on the surface. (Use potassium permanganate if the resultant stain is of no importance.)

(*c*) After several hours the slurry (or the potassium permanganate) is hosed off with water and scrubbed with soap or other detergent.

(*d*) If, after this process, the hazard has not been eliminated, the decontamination procedure is repeated, and if the second application fails, the contaminated wood must be removed and burned.

4. DECONTAMINATION OF TOOLS, FITTINGS AND METAL EQUIPMENT

Four methods of decontamination are recommended:

(*a*) Smooth all-metal articles can be cleaned by repeated immersion in clean kerosene.

(*b*) The contaminated article, if greasy, should first be washed in kerosene. If rusty, the article should be immersed in 20 per cent hydrochloric acid containing 0·1 per cent Sharples 1143 Pickling Inhibitor until the rust film is substantially removed, then rinsed in water. Decontamination can then be effected by prolonged immersion in potassium permanganate solution.

(*c*) After an initial rinsing in kerosene the contaminated article may be soaked in sulphuryl chloride solution for several hours, followed by a water rinse.

N.B. This method is not to be employed if the article may be injured by corrosion.

(*d*) Articles which will not be unduly injured thereby may be decontaminated by fire.

5. DECONTAMINATION OF PROTECTIVE EQUIPMENT

The methods prescribed in various formal regulations should be followed so far as possible. If kerosene is not available or desirable, decontamination can be effected by means of a slurry of calcium hypochlorite, followed by generous use of water.

CONCLUSION

Decontamination in the field is usually accomplished with great difficulty, due to the many dependent factors, e.g. temperature, time, proper mixing of contaminant and decontaminant, and porosity of the surface on which T.E.L. has been spilled. Particular note should be taken of the latter two factors; it is essential that good mixing of the decontaminating agent and T.E.L. be effected.

When a spillage occurs on solid porous surfaces, e.g. wood and concrete, T.E.L. readily penetrates the pores of these materials, and decontamination sometimes results merely in destroying the T.E.L. near the surface. The products of the reaction tend to seal the still unreacted T.E.L. in the materials. For this reason it is essential that decontamination be effected as soon as possible.

Owing to the possible re-formation of T.E.L. by rearrangement of the lead salts formed in the decontamination reaction, all areas which have been decontaminated should be revisited and inspected for possible recurrence of a lead hazard.