

May 15, 1925

E. W. Webb

Surgeon General Hugh S. Cumming
Bureau of Health Service
Washington, D. C.

Dear Sir:

Replying to your request for a summarization of results of our experimental work, contained in your letter of the 11th, we hope it is appropriate in connection therewith to state that in an extended research to discover a commercially feasible material to be added to gasoline in small quantity in order that the efficiency of the internal combustion engine could be increased and the motor fuel supply of the future conserved, tetraethyl lead was found to be the most practical and commercial material for such purposes.

At the time of this discovery it was realized that this material in the concentrated form possessed poisonous characteristics but there was no reason to believe that in this respect it differed materially from the toxicity of other and ordinary lead compounds. However, later experimental work disclosed the existence of toxic characteristics different from those usually associated with the lead industry. Immediately our predecessor, and later we, sought and obtained the advice of scientific men of high repute and authorities on lead poisoning. Their advice was followed; the only public hazard then thought possible, but not likely to occur, was from the exhaust gases from automobiles in which Ethyl Gasoline, mixed in the proportion of 1 part of tetraethyl lead to 1300 parts of gasoline, was used. Tests made over a long period of time indicated that there was no danger from this source.

Later we requested the Bureau of Mines and Columbia University to conduct experiments to ascertain if there were any hazards from the inhalation of vapor or skin application of Ethyl Gasoline. We have not received reports of their findings, but understand they will be submitted to you during the Conference.

We respectfully submit, in the order in which you have requested the data in your letter, the following.

1- MANUFACTURE OF TETRAETHYL LEAD

Tetraethyl lead is now manufactured only by E. I. du Pont de Nemours & Company, under patented processes. Briefly, the steps in its manufacture are as follows:

A lead-sodium alloy is prepared at high temperature by the admixture of metallic lead and metallic sodium. This alloy, in the form of large cakes, is ground up and introduced into an autoclave together with an ethyl halide and maintained under pressure at a proper temperature for such a period of time as to bring about the formation

of tetraethyl lead. The reaction mixture is passed into stills from which tetraethyl lead is distilled off and collected into storage tanks from which it is piped into drums for shipment. The residue from the distillation is piped out of the plant to the place of disposal. All of these operations are carried out in unit systems which, under ideal conditions, are completely gas-tight.

HAZARDS IN MANUFACTURE

The hazards encountered in the above processes are as follows:

- 1- The inhalation of dust in the sodium-lead alloy.
This has been completely negated by the installation of enclosed grinding apparatus with dust tight connection between the bottom of the mill and the receiver.
- 2- Inhalation of fumes from the molten alloy.
This has been prevented by the use of properly arranged retorts and ventilation.
- 3- Inhalation of vapor of tetraethyl lead.
This has been entirely eliminated by an improved method of filling the autoclaves; by new connections between the autoclaves and the stills and by enclosing the autoclaves with separately ventilated booms to care for accidental leaks.
- 4- Inhalation of the vapor of the ethyl halide.
This hazard is circumvented in the same manner as that of tetraethyl lead vapor.
- 5- Skin contact with tetraethyl lead.
This has been almost entirely eliminated under the routine operation of the plant by reason of the development of a properly closed system. Accidental spills are promptly washed up with a solution of chlorinated sodium which effectively renders the tetraethyl lead inert.

Tetraethyl lead as thus manufactured, is a water-clear, heavy liquid, slightly volatile at ordinary temperatures. It is insoluble in water, but miscible in all proportions with fat and fat solvents. These properties explain the above mentioned hazards. In determining the magnitude of these hazards experimental work has been done to determine accurately the physiological properties and the toxicity of the compound.

HAZARDS ENCOUNTERED IN THE MANUFACTURE OF TETRAETHYL LEAD

The manufacture of tetraethyl lead was begun by the E. I. du Pont de Nemours & Company. It was subsequently undertaken by the Standard Oil Company (New Jersey) at their Bayway Plant. In the two plants unforeseen accidents incident to the development of the new industry and to changes from laboratory to production scale of manufacture led to the appearance of poisonings, with twelve fatalities. In the du Pont plant first one and then another protective measure was developed on the recognition of a hazard; with the result that

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it is now possible to effectively guard against them. (Exact data as to the occurrence of poisoning is not contained in the records in this office; we understand the du Pont Company has been invited to your Conference.) In the Perry plant of the Standard Oil Company (New Jersey) the manufacture of tetraethyl lead was begun by a method which was thought to be simpler and attended with less hazard than that previously in use. A sudden development of acute poisoning, with five fatalities, incident to the development of this new method, resulted in the immediate abandonment of the plant and the discontinuance of the manufacture of tetraethyl lead therein. The seventy one men exposed were placed in a hospital for observation. Most of these men showed no important symptoms and all but the fatal cases made uneventful recoveries. Since that time the manufacture of tetraethyl lead has been carried out solely in the du Pont plant.

2- BLENDING OF ETHYL FLUID

Tetraethyl lead is shipped in carefully tested, sealed drums to the plant of the Ethyl Gasoline Corporation at Dayton, Ohio. Here it is unloaded into storage tanks or stored in the original drums. The unloading is carried out by an automatic pump and piping system after which the drums are carefully cleaned and returned to the manufacturer. The tetraethyl lead is pumped out of the storage tanks and mixed with the proper amount of ethylene dibromide and a non-toxic red dye. This operation is carried out in a closed system under very great downward ventilation, under conditions which present no danger of spillage and which allow of no manual manipulation. The drums are carefully tested for leaks and labelled in such a way that their contents may not be mistaken. They are then shipped to stations provided by the various Oil Companies in which, under the same precautions, the mixture with gasoline is made. Various mixtures are made, the most concentrated of which consists of one part of tetraethyl lead to 1300 parts of gasoline.

HAZARDS EXISTING IN BLENDING AND DISTRIBUTION OF TETRAETHYL LEAD

The hazards existing in these processes consist of the inhalation of vapor and absorption through the skin of tetraethyl lead as well as ethylene dibromide. There is a further slight risk encountered in the inhalation of dust of decomposition products of tetraethyl lead found in old returned drums.

EXPERIENCE IN BLENDING AND DISTRIBUTING

As in the case of the manufacture of tetraethyl lead the processes of blending were accompanied originally by a considerable exposure to the previously mentioned hazards. As a result of this there have been a considerable number of workmen poisoned and very early in the process there were two fatalities, since which time none have occurred. The application of experimentally determined facts plus the acquisition of experience has made possible the development of automatic machinery, methods of ventilation, and enforcement of rules for handling these toxic substances in such a way that poisoning in the blending plant has become insignificant. There were forty two cases of poisoning in the six months prior to August, 1924. Since that time there have been seventeen cases, all of which showed very slight symptoms. There was one other, which

may have been a severe case; cerebral symptoms, similar to those of tetraethyl lead intoxication appeared in the course of an influenza-like infection. The diagnosis was, therefore, a matter of doubt. Recovery occurred. Careful medical examinations of all employees at regular intervals, both in the blending and manufacturing plants, has made possible the recognition of such early signs of intoxication as to permit of prevention of any serious degree of poisoning.

Little or no difficulty has been experienced by the stations at which the admixture with gasoline is carried out. Here, too, precautionary measures made possible by the experience of the manufacturing and blending plants have been put into effect in such a way as to obviate the dangers of inhalation and contact. Here, too, medical observation has been constantly kept of all employees who are under exposure.

3- DISTRIBUTION OF ETHYL GASOLINE

The only form in which tetraethyl lead reaches a garage, a filling station or a private consumer is in some one of its dilutions in gasoline, the most concentrated of which consists of one part of tetraethyl lead in 1300 parts of gasoline. This condition is accomplished by mixing the gasoline at the large blending plants controlled by the various Oil Companies and by conveying the thus prepared gasoline in tank wagons to filling stations and garages.

HEALTH HAZARDS IN HANDLING AND USE OF ETHYL GASOLINE

The possible hazards to the public, to the garage mechanic and to the filling station employee are as follows:

- 1- Exposure to exhaust gas containing the finely divided dust of lead in the form of lead bromide and a small amount of lead oxide.
- 2- Exposure to skin contact with gasoline containing tetraethyl lead and lead dibromide.
- 3- Exposure to vapor from gasoline containing tetraethyl lead and ethylene dibromide.
- 4- Exposure to lead deposits in motors and exhausts.
- 5- Exposure to dust due to the decomposition of such tetraethyl lead as is contained in spilled gasoline.

EXPERIENCES IN DISTRIBUTION OF ETHYL GASOLINE

Whatever hazard, if any, actually exists in the above factors has not been controlled. Ethyl Gasoline has been (until recently when its sale was suspended) dispensed from more than 10,000 filling stations, some of those over a period of two years; a large proportion over one year. It has been used in thousands of cars which have been cared for by many mechanics, and the owners of the cars themselves.