

COMMENTS ON THE SOURCE OF LEAD EXPOSURE IN
CONNECTION WITH THE REPAIR OF A GASOLINE STORAGE
TANK OF CONTINENTAL OIL COMPANY, AT ALTESIA, NEW
MEXICO

The clinical information on these cases of lead poisoning was such as to indicate at the outset that the exposure had been very severe. (The man who died worked for less than a day before he became acutely ill. Apparently his illness developed steadily in severity until his death. This could only have occurred as the result of gross contact of the skin with tetraethyl lead, or as the result of the inhalation of high concentrations of tetraethyl lead vapor in the air.)^{*} The latter, no doubt, represented the true situation. Additional information on the men indicated that they had been exposed somewhat to triethyl lead compounds. This, however, need not have been severe, and under the conditions that are known to have existed, it could not have been a significant factor in the induction of cases of poisoning.

The severity of the lead exposure has been confirmed by the analytical data obtained on the urine and blood of several of the exposed men. These data are attached hereto, without additional comment.

The source of the exposure is evident from the analytical results on the sludge, the scale, and the cloth that was placed over the only opening in the tank during a period of aeration. These also are attached.

The organic lead content of the sludge was high, - much

in days preceding the day referred to here, on the order of 5 minutes, but on the other about 3 hours. The time of onset of illness is not so remarkable as a matter of the information, but the exposure, no doubt, was quite severe.

larger proportion of the organic lead in the sludge was tetraethyl lead. Whether this was there as tetraethyl lead prior to the prolonged steaming of the tank cannot be ascertained, but there are at least two possibilities. This tank was a blending tank at one time. (a) It may have had Ethyl Fluid introduced into it in such a manner that the latter settled to the bottom of the tank and then later seeped through into the space beneath the tank. (b) Or there may have been a considerable amount of organic lead salts in the sludge, and these may have been converted in part to tetraethyl lead by the steaming process. In any case tetraethyl lead was there and this was vaporized into the air by the steam and partly removed from the tank and partly deposited on the walls of the tank by condensation. In no other way is it possible to explain the presence of tetraethyl lead in appreciable concentration in the sample of scale removed from the walls of this tank, (cf. the tetraethyl lead content of the scale).

The result on the soil sample taken from beneath the tank is of no value in the reconstruction of the conditions within the tank, since the organic lead content was too low to have specific significance.

The significance of the results on the piece of cloth is fairly clear, despite the fact that the character of the lead compound deposited in the fabric was not determined. Probably most of the lead in the air that passed through the cloth failed to be trapped by the cloth. Certainly this was the case if this lead was in the form of vaporized tetraethyl lead. At all events the presence of lead in appreciable concentration in the air escaping from the tank has been demonstrated.

The nature and the actual severity of the lead exposure of

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the workmen cannot be determined with precision. However, it cannot be said that there are any new or hitherto unanticipated factors that need to be taken into account to explain this case. It was merely one of the series of extraordinarily dangerous tanks that has come to our attention. It is precisely this set of conditions that the tank-cleaning regulations are designed to deal with. (The application of these regulations did protect the cleaning personnel in this case.) Our safety personnel must accept the fact that such conditions are destined to occur from time to time, and that gasoline storage tanks in general must be dealt with on the assumption that such conditions may be encountered without warning or foreknowledge thereof.

Despite the proved efficacy of the present regulations, if followed, in warding off danger under the conditions that existed in this tank, this incident may be regarded as an indication of the need for a device that may warn safety engineers of the existence of high concentrations of tetraethyl lead vapor in the air within tanks. Every effort will be made to develop such a device. Certain ideas have been advanced in this direction and will be explored. However, it seems inadvisable at this time to acquaint field safety personnel with this possibility, since to do so might suggest that there is a technical inadequacy in our present procedure, and that no human fault could be blamed for this episode. The facts are to the contrary. This unhappy affair was the direct result of a mistake in judgment, and a failure to follow verbal and written instructions. Our efforts in the development of a technical device of the type referred to, should not be permitted to take the burden of responsibility for sound judgment from the shoulders of safety personnel, but rather to

supplement such judgment by technical data when it is possible to do so.

Signed:

Robert A. Kehoe
Robert A. Kehoe, M. D.,
Medical Director

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TANK REPAIRING ACCIDENT - CONTINENTAL OIL COMPANYARTISIA, NEW MEXICO

This tank was cleaned by [REDACTED] as contractor for the Continental Oil Company on November 27, 1944 - November 29, 1944, and observed by Mr. Lenington, Ethyl Corporation safety representative. According to the management and Mr. Lenington all safety precautions were observed in the cleaning operations, including complete changes of clothing, air-line masks, gloves and boots. Baths were taken by all workmen at noon and in the evening. Four men entered the tank in the cleaning operations and apparently the entire procedure was regular and according to safety regulations. As evidence of this is the fact that only one of the men who helped with the tank cleaning developed any signs of illness, and that these occurred in connection with the repair work in which he assisted.

The sludge was put in a pit located about twelve feet from the manhole, but as the work progressed, it was found necessary to dig a long trench to hold the sludge as the fluid portion did not drain readily into the ground due to the type of soil. This sludge remained uncovered for two days and subsequently a question arose as to the possibility that vapors from this source had entered the tank, thereby providing the exposure experienced by the repair men. This, obviously, is a most unlikely explanation of the latter exposure. The sludge was not covered immediately because of shortage of help.

The tank was steamed on the nights of November 29 and 30, and December 2 and during the day and night of December 3. Wet steam

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was used as dry steam was not available. This fact accounted for the presence of about 5-60 gallons of aqueous condensate in the tank in pools at various low spots over the bottom when it was being made ready for concrete. This water was drained through a hole made in the bottom of the tank at the edge, as there was no water draw-off.

The tank remained as above until December 9, five days after the last steaming, when the concrete bottom was poured. There was some question as to whether a new steel bottom was to be installed or a layer of concrete poured over the leaky bottom with the idea of putting a metal bottom over the concrete later. This, by the way, would create a situation that would make it impossible to clean the bottom. Mr. Lenington informed the superintendent that if welding or other hot work was to be done on the bottom, it would have to be sand blasted and a side sheet removed. This was considered too expensive an undertaking. The superintendent stated that Mr. Lenington approved the pouring of the concrete without special precautions after the thorough steaming and testing for vapors, and declared it safe from that standpoint.

Mr. Lenington left for another tank cleaning and later in the week went to Dallas to help Mr. Jeppe with the army school being conducted there at the time. He was finishing there and on his way back to Amarillo when the report on the trouble at Artesia was received. No other safety representative of the Corporation was present. Mr. Lenington, by the way, told me he had discussed this particular tank and the pouring of the concrete on Thursday, I believe, at Dallas, with Mr. Ball who, so Lenington reports, said he could see nothing wrong with the procedure.

The Continental Oil Company finally decided to employ

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concrete on the bottom, and Mr. [REDACTED] was given the contract. Five days had elapsed since the steaming, but the refinery safety man made three different tests on the tank and reported it gas free for open working and safe from the viewpoint of explosive mixtures.

The contractor had a total of (13) men working for him. This number includes six Mexicans. At some time during the day all of these men with the exception of one were in the tank. Some, however, were inside only momentarily, helping shift the trough or doing other work for a short time. The group of Mexicans spent their time in and out - at times shovelling gravel and operating the concrete mixer.

The actual working arrangement consisted of a small motor generator outside the tank for current for the light, and a small concrete mixer set up on blocks at the manhole, with a trough about six feet in length extending through the manhole into the tank. The concrete was dumped into the trough and moved along into the tank from the outside and then distributed on the inside as the bottom was laid. Mr. [REDACTED], who became violently ill and succumbed, was the worker who followed the edge of the concrete, pushing, pulling and levelling it about the bottom and, as I understand, worked very hard. Others in the tank moved about to and from the manhole.

By noon good progress had been made after approximately four hours of work in the tank. Mr. [REDACTED] felt weak and unsteady, but continued to work the remainder of the day. He complained to Mr. [REDACTED] at noon, "he wasn't feeling too good." Mr. [REDACTED] another workman, became somewhat ill at noon and during the afternoon worked outside of the tank. The other men worked as usual throughout the afternoon in and out of the tank. By evening 80% of

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the tank bottom had been installed. From what I could learn no skin contact was made with any portion of the inside of the tank. As the work progressed more and more of it was done on top of the concrete with the exception of Mr. [REDACTED] who worked on the tank floor part of the time. After finishing work in the evening the men went to their homes, some living twenty miles away in the town of Hagerman, New Mexico. The Mexicans lived nearby Artesia and in the surrounding country.

TANK DATA

Tank was blending tank #15

This tank is a small round top tank of 10,000-bbl. capacity approximately sixty feet in diameter. There is a manhole opening near the bottom 25 inches in diameter and a vent on the roof 4 inches in diameter and a gauge hatch approximately 6 inches in diameter. On the tank directly opposite from the manhole there were two openings about 6 inches from the floor - one 4-inch and the other a 6-inch opening. These were the gasoline line openings and the lines were disconnected and blanked off. There was no manhole opening in the roof.

The above were the only openings for ventilation into the tank and no side sheet was removed during the pouring of the concrete which was approximately 80% completed, leaving about 4 cubic yards still to be poured to complete the job. Through one of the small gasoline line openings at the bottom of the tank a compressed air hose was introduced and it supplied air from the compressor in another part of the refinery and was in operation while the men worked.

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Relative to the bottom the superintendent of the refinery, the contractor and Mr. Lenington all state that it had no large holes or openings in it. The contractor saw a few (three or four) holes the size of a pencil, but it would be rather difficult to see some openings as the underlying soil would be the same color, and there might have been many fine holes. The bottom was springy when walked on which would allow settling when heavy concrete was applied.

It is possible, of course, that there were larger holes than those described, and it is possible that sludge was present in considerable quantity under the tank on the ground. The character of the soil, as mentioned elsewhere, was such that it was not readily penetrated by the sludge and therefore the absence of wetness around the edges of the tank, on the outside, does not prove that there was not a considerable quantity of material under the tank. There was, in fact, a spot of wetness, about six by twelve inches on one side of the tank.

As to spiking of this tank in the past there is no history. It is an old tank, in service a number of years and additional lead may have been introduced directly into the tank at sometime or other. The superintendent said it had never been done to his knowledge. However, in recent years, there have been three superintendents in charge of this refinery.

Re: Possible Source of Lead

There was some question at the outset as to lead being the causative factor in these cases because of the rapidity of the onset of symptoms. However, as the illness progressed, it was apparent that it was lead intoxication and an attempt was made to

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find the source of lead.

The bottom of the tank was four-fifths covered and could not be seen but Mr. Gillespie, the refinery superintendent, Mr. [REDACTED], the contractor, and Mr. Lenington said there were no large holes in the bottom. Mr. [REDACTED] said he saw three or four small holes about the size of a lead pencil; Mr. Gillespie said it would hold a water bottom of four to six inches for a couple of months but since the soil allows poor absorption and drainage as observed in the sludge pit, it would be possible for fluid to pocket beneath the bottom. Around the edge of the tank in only one place was there any significant wetting of the soil from the leaky bottom. However, the interval of five days between the hot steaming and the concreting could allow vaporization of the contents below the bottom. On the other hand, one might expect some gasoline vapor to be in the tank also but it tested gas free or within safe limits before work was begun. This could be explained by the water bottom which the superintendent said was always kept in the tank because of the leaky bottom so gasoline may have been kept out of the area under the tank sufficiently to give one this picture.

The bottom in this tank was springy when walked on and the heavy concrete on the bottom may have been a factor in pushing up any trapped below through the holes remaining in the floor ahead of the concrete.

In light of the fact that some of the men in the tank complained of irritated eyes and "running noses," I tried to find a source of dry triethyl salts. This would mainly have to come from the sides, since the bottom was wet or damp. From previous findings on sides of tanks I questioned this, but thought the air blowing from the hose into the tank may possibly have set up circular

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motion loosening up some dust from the sides to account for the above symptoms.

In checking into the air line blowing into the tank it was turned on with the valve half opened as no one seemed to know where it was set during the work in the tank. In a short time air was moving out of the manhole, and from the outside, vapor could be seen coming out of the vents on top---possibly from the moisture from the concrete. A piece of cloth was obtained at the store and fastened over the manhole and allowed to remain there three and a half hours with the air valve half open. This was removed and folded to keep the exposed part together and placed immediately in a paper bag for analysis. A control piece of the same cloth was kept. This would only disclose some lead vapor in the tank, but when done most of the floor was covered.

A sample of the sludge from the tank was obtained from the sludge pit, and a sample of scale from the side wall of the tank.

L. J. Schradin

January 25, 1945

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Samples of urine and blood received from men involved in cementing bottom in tank for the Continental Oil Company, (Dr. Schrader) Artesia, New Mexico.

Name	Urine			Blood				
	Analysis Number	Volume ml.	Mg. Pb/L.	Analysis Number	Spectrophotometric Weight Grams	Mg. Pb/100 G.	Weight Grams	Dilution Mg. Pb/100 G.
[REDACTED]	44A-6949	90	0.80	44A-6950	7.8	0.125	13.2	0.12
[REDACTED]	44A-6947	100	0.80	44A-6948			15.6	0.055
[REDACTED]	44A-6945*	100	0.13	44A-6946	12.9	0.065	14.8	0.070

* Specific Gravity not taken, but urine was colorless indicating dilution.

Samples Collected: 12-14-44
 Samples Received: 12-18-44
 Samples Reported: 12-20-44

Analysis of 5 Pumps of Sludge and Coal Samples from Tank #5
Continental Oil Refining Company, Alameda, New Mexico

Analysis Number	Description	Grams (Dried)	Per Cent Organic Pb	Per Cent Inorganic Pb	Remarks
44A-6973	Soil beneath tank	8.5	0.06	0.25	Appears to be clay; a but a smoky-like odor
44A-6973	Sludge taken from sludge pit	6.5	1.31	1.39	Blackish material with fine, large amount of solvent in alcohol-ethyl impregnated with oil; not be removed by solvent
44A-7101	Coals taken from side walls	6.0	0.17	3.09	

Note 1

Analyses of samples 44A-6973 and 44A-7101 were repeated in order to determine the amount of V.E.L. present in lead portion.

44A-6973 - Total lead in ethyl extract (10 g. at 10%) = 51.8 mg.
 Lead in ethyl extract following treatment with 20% NaOH = 37.5 mg. = 73% V.E.L.
 44A-7101 - Total lead in ethyl extract (10 g. at 10%) = 2.09 mg.
 Lead in ethyl extract following treatment with 20% NaOH = 1.46 mg. = 70% V.E.L.

* The preliminary alcohol treatment was eliminated in this case.

Note 2

A sample of cloth which had been placed over manhole was also submitted for analysis. The cloth had been 2-1/2 hours with a stream of compressed air being supplied to the tank.

Lead in control piece = 0.017 mg. per sq. ft.
 Lead in test cloth after exposure = 0.45 mg. per sq. ft.

Samples received: December
 Samples reported: January

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Samples received: December 18 and 23, 1944
 Samples reported: January 9, 1945

-0.012 mg. per sq. ft.
 -0.040 mg. per sq. ft.

ed over sample was also submitted for analysis. The cloth had been in position for
 ed air being supplied to the tank.

ment was obtained in this case.

of following treatment with 50% NH₄OH = 1.45 mg. - 1.1% I.L.T.
 of extract (to 2.00 mg.)
 of following treatment with 50% NH₄OH = 37.5 mg. - 75% I.L.T.
 of extract (to 5.00 mg.)

not were reported in order to determine the amount of I.L.T. present in the organic

Grams (Dried)	Per Cent Organic Pb	Per Cent Inorganic Pb	Remarks
2.3	0.06	0.25	Appears to be clay; no odor of gasoline, but a sweet-like odor.
6.5	1.31	1.35	Blackish material with strong odor of gaso- line. Large amount of oily material dis- solved in alcohol-xylene. Sludge appeared impregnated with oily material which could not be removed by suction.
6.0	0.17	3.09	