

FINAL REPORT ON CASES OF TETRAETHYL LEAD INTOXICATION FROM
TANK CLEANING AT STOURPORT, SEPTEMBER, 1950.

MEDICAL ASPECTS.

CONFIDENTIAL.

An interim report was submitted on the 29th September, 1950. In this report, notification, itinerary, tank history, certain items on tank cleaning, and the medical history of the individuals concerned were given. There were a number of discrepancies in this report, especially in respect of the duration of exposure of some of the individuals concerned. The men involved in the incident have been kept under remote observation, and certain biological samples, and samples of lead-bearing material from the tanks have been analysed.

The medical attendants of the men involved were fully informed of the clinical manifestations of tetraethyl lead poisoning and its treatment, and were given a summary of our clinical findings in each case on the 29th September, 1950. Official notification of these cases of tetraethyl lead poisoning to H.M. Chief Inspector of Factories was consequently not made by us.

The incident was brought to light through Dr. G. Hoarn, Physician, Dudley Road Hospital, Birmingham, who diagnosed correctly a case of tetraethyl lead poisoning that had been admitted to his ward on the 20th September. Representatives of the Associated Ethyl Company Limited visited the A.F.R.D. at Red Stone, near Stourport on the 26th September, to investigate the incident and to act in an advisory capacity.

Tank History.

The tank concerned in the incident is a cylindrical rivetted tank, 102 feet in diameter, 25 feet high, 4000 tons capacity, with a fixed roof, mercury sealed, and has two manholes, each approximately 30 inches in diameter, one at the bottom of the tank, and one placed eccentrically on the roof. The roof of the tank is at approximately ground level. There is a ditch approximately six feet deep, and three feet wide, in concrete, surrounding the tank. From the ditch the embankment surrounding the tank slopes steeply away to the ground level.

It was stated that Tank No. 3 was first put into commission in 1937, and used for base spirit. From 1941 to early 1947 it had contained loaded gasoline, some of which contained 5.5 c.c. T.E.L. per gallon. In late 1947 the tank was filled with water to a depth of approximately 20 feet. It was out of commission until mid-July, 1950, when the water was removed, to about one foot from the bottom. The roof man lid had been removed prior to the pumping operation. The bottom man lid was removed on the 28th August. The ventilation of the tank was that it was open to the atmosphere through the roof man lid.

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CONFIDENTIAL.

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The incident was brought to light through Dr. G. Hearn, Physician, Dudley Road Hospital, Birmingham, who diagnosed correctly a case of tetraethyl lead poisoning that had been admitted to his ward on the 20th September. Representatives of the Associated Ethyl Company Limited visited the A.F.R.D. at Red Stone, near Stourport on the 26th September, to investigate the incident and to act in an advisory capacity.

Tank History.

The tank concerned in the incident is a cylindrical rivetted tank, 102 feet in diameter, 25 feet high, 4000 tons capacity, with a fixed roof, mercury sealed, and has two manholes, each approximately 36 inches in diameter, one at the bottom of the tank, and one placed eccentrically on the roof. The roof of the tank is at approximately ground level. There is a ditch approximately six feet deep, and three feet wide, in concrete, surrounding the tank. From the ditch the embankment surrounding the tank slopes steeply away to the ground level.

It was stated that Tank No. 3 was first put into commission in 1937, and used for base spirit. From 1941 to early 1947 it had contained loaded gasoline, some of which contained 5.5 c.c. T.E.L. per gallon. In late 1947 the tank was filled with water to a depth of approximately 20 feet. It was out of commission until mid-July, 1950, when the water was removed, to about one foot from the bottom. The roof man lid had been removed prior to the pumping operation. The bottom man lid was removed on the 8th August. The ventilation of the tank was that by natural wind through the two man lids. The tank had not previously been cleaned.

There were two other tanks in this location, of similar pattern and history, referred to as Nos. 1 and 2.

Tank Cleaning Contractors.

The contractors for the tank cleaning were Messrs. J. Whelan and Sons, 204, Firsford Street, Birmingham 18.

Tank Cleaning.

The following notes are supplementary and complementary to those in the interim report.

It was noted in the previous report that a smell of organic lead was detectable when the tank was approached on the afternoon of the 26th September. This is the first occasion on which, in our experience, an organic lead odour has been detectable in sludge. It is therefore not surprising that the analysis of the sludge resulted in extraordinarily high figures, far beyond any of those previously analysed in this country. This is partly due to improved methods of analysis, as it is very difficult to analyse sludge samples without some loss of volatile organic lead. This loss has now been very considerably reduced, but it is possible that the results shown below may still be on the low side for organic lead. It will be observed, from a consideration of these, that although the tanks from which the samples were taken were all of the same construction, were put into commission at the same time, and, so far as is known, were used for the storage of similar leaded gasoline, and had a similar period of disuse, there is a considerable variation in the lead contents of the sludge of the three tanks. The analysis has been repeated on several occasions, with similar results in each. This variation in lead content of tank sludge is merely confirmatory to what was previously known, that is to say that sludge is not homogeneous in its lead content, and that it is impossible to predict from the tank construction and history whether or not the material in it contains organic lead in such concentration as to present a hazard to health. The tank concerned in the incident, No. 3, had an intermediate organic lead content compared with the other two. American experience led to the conclusion that exposure of unprotected individuals to the vapour arising from sludge which contained approximately 0.1% organic lead, calculated on the dry weight of sludge, was likely to result in serious illness and death, if the exposure was of as short a period as fifteen minutes. It is surprising, therefore, that some individuals concerned in this incident were not more seriously ill than they were, as the exposure to the vapour from sludge which contained at least 0.16% tetraethyl lead without respiratory protection was at least several hours in the case of [redacted] and [redacted]. It is also noteworthy that the completion of the cleaning of these tanks was carried out by the same contractors, and that it was completed early in December, without mishap, although one tank sludge contained 0.42% volatile organic lead. Constant and skilled supervision was provided for this by the Regent Oil Company. It is fortunate that Tank No. 3 and not Tank No. 1 was the one involved in the intoxication of five individuals.

% Pb due to:	Tank No. 1.	Tank No. 2.	Tank No. 3.
Tetraethyl Lead.	0.420	0.0340	0.162
Triethyl Lead.	0.023	0.0025	0.000

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It was noted in the previous report that a smell of organic lead was detectable when the tank was approached on the afternoon of the 26th September. This is the first occasion on which, in our experience, an organic lead odour has been detectable in sludge. It is therefore not surprising that the analysis of the sludge resulted in extraordinarily high figures, far beyond any of those previously analysed in this country. This is partly due to improved methods of analysis, as it is very difficult to analyse sludge samples without some loss of volatile organic lead. This loss has now been very considerably reduced, but it is possible that the results shown below may still be on the low side for organic lead. It will be observed, from a consideration of these, that although the tanks from which the samples were taken were all of the same construction, were put into commission at the same time, and, so far as is known, were used for the storage of similar leaded gasoline, and had a similar period of disuse, there is a considerable variation in the lead contents of the sludge of the three tanks. The analysis has been repeated on several occasions, with similar results in each. This variation in lead content of tank sludge is merely confirmatory to what was previously known, that is to say that sludge is not homogeneous in its lead content, and that it is impossible to predict from the tank construction and history whether or not the material in it contains organic lead in such concentration as to present a hazard to health. The tank concerned in the incident, No. 3, had an intermediate organic lead content compared with the other two. American experience led to the conclusion that exposure of unprotected individuals to the vapour arising from sludge which contained approximately 0.1% organic lead, calculated on the dry weight of sludge, was likely to result in serious illness and death, if the exposure was of as short a period as fifteen minutes. It is surprising, therefore, that some individuals concerned in this incident were not more seriously ill than they were, as the exposure to the vapour from sludge which contained at least 0.16% tetraethyl lead without respiratory protection was at least several hours in the case of [REDACTED] and [REDACTED]. It is also noteworthy that the completion of the cleaning of these tanks was carried out by the same contractors, and that it was completed early in December, without mishap, although one tank sludge contained 0.42% volatile organic lead. Constant and skilled supervision was provided for this by the Regent Oil Company. It is fortunate that Tank No. 3 and not Tank No. 1 was the one involved in the intoxication of five individuals.

% Pb due to:	Tank No. 1.	Tank No. 2.	Tank No. 3.
Tetraethyl Lead.	0.420	0.0340	0.162
Triethyl Lead.	0.023	0.0045	0.039
Diethyl Lead Halides.	0.017	0.0031	0.023
Diethyl Lead. (OH) ₂ & CO ₂ .	0.005	0.0070	0.009
Total Organic Pb.	0.465	0.0486	0.233
Inorganic Pb.	2.680	1.5750	2.240
Water from sludge Pb in P.p.m.			
Organic.	Nil.	0.27	2.82
Inorganic.	0.7	0.23	5.03

The concentration of organic lead in sludge water in tank No. 3, i.e. 2.82%, is, in our opinion, about saturation point under the conditions existing at that time.

Medical History of Individuals.

The five individuals concerned in this incident were the two sons of the contractors, Messrs. [redacted] Whelan and Sons, [redacted] and [redacted], and the employees [redacted], [redacted] and [redacted]. The contractor, [redacted], while presenting no symptoms or signs of intoxication, is included in the case histories to illustrate one point.

[redacted]

Aged 34, married, three children. Engineer.

This man is considered first, as he had been longest on the job of cleaning three tanks at Stourport. He had been previously engaged in cleaning tanks at Red Mile, in Nottingham, in August, 1950, in which the safety precautions were not observed. He did not suffer any ill-effects from this misdeed. He took over the job of cleaning No. 3 Tank at Stourport from his brother, [redacted] on the 13th September, 1950. He was examined first on the 26th September, and again on the 1st December. He was of the opinion that his brother had given in too easily, and on the last examination still thought it was possible to work off the symptoms. When he first took over from his brother, he wore protective clothing, sometimes over his ordinary street clothing, and a positive pressure full face air line mask most of the time when in the tank, but took it off when it became cumbersome. On the afternoon of the first day he was in the tank, the 13th September, he developed abdominal discomfort and pain, and was sleepless that night. The following day, his vision, normally defective became worse, and he saw double at times. He felt weak, and tired easily. His appetite became poor. He felt nauseated all the time, but was unable to vomit. He tried to force himself to eat. A dull frontal headache developed, and he noticed that he had become pale. Diarrhoea ensued, and became severe. On the 15th September, all the symptoms became worse, and about this time "telephone bells" seemed to be ringing continuously in his ears. On Saturday, 16th September, he remained in bed. A very severe pain had developed in the "pit of his stomach," and he spent most of the day tossing about the bed with pain. He was perspiring very freely about this time. The diarrhoea continued in a severe form. He took some hot milk that evening, and shortly after the severe abdominal pain eased, leaving a soreness, but the perspiration increased. His gums were sore, and he had a very bad taste

[redacted]

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Medical History of Individuals.

The five individuals concerned in this incident were the two sons of the contractors, Messrs. [redacted] and Sons, [redacted] and [redacted] O., and the employees [redacted] and [redacted]. The contractor, [redacted], while presenting no symptoms or signs of intoxication, is included in the case histories to illustrate one point.

[redacted]
[redacted]
Age 34, married, three children. Engineer.

This man is considered first, as he had been longest on the job of cleaning three tanks at Stourport. He had been previously engaged in cleaning tanks at Red Mile, in Nottingham, in August, 1950, in which the safety precautions were not observed. He did not suffer any ill-effects from this misadventure. He took over the job of cleaning No. 3 Tank at Stourport from his brother, M.J. Whelan, on the 13th September, 1950. He was examined first on the 26th September, and again on the 1st December. He was of the opinion that his brother had given in too easily, and on the last examination still thought it was possible to work off the symptoms. When he first took over from his brother, he wore protective clothing, sometimes over his ordinary street clothing, and a positive pressure full face air line mask most of the time when in the tank, but took it off when it became cumbersome. On the afternoon of the first day he was in the tank, the 13th September, he developed abdominal discomfort and pain, and was sleepless that night. The following day, his vision, normally defective became worse, and he saw double at times. He felt weak, and tired easily. His appetite became poor. He felt nauseated all the time, but was unable to vomit. He tried to force himself to eat. A dull frontal headache developed, and he noticed that he had become pale. Diarrhoea ensued, and became severe. On the 15th September, all the symptoms became worse, and about this time "telephone bells" seemed to be ringing continuously in his ears. On Saturday, 16th September, he remained in bed. A very severe pain had developed in the "pit of his stomach," and he spent most of the day tossing about the bed with pain. He was perspiring very freely about this time. The diarrhoea continued in a severe form. He took some hot milk that evening, and shortly after the severe abdominal pain eased, leaving a soreness, but the perspiration increased. His gums were sore, and he had a very bad taste in his mouth. Severe muscular twitchings, which he could not control, were present at this time, and he had some itching of the skin, particularly on the face and hands. He forced himself to return to work on the Monday, but with the other men, Coates and Cascoigne, found work outside the tank, and when materials from the tank were handled, full safety measures were observed. On the 25th and 26th September, he entered the tank again. He did not admit any terrifying dreams, but stated on the 1st December that he had not slept since he started tank cleaning on 13th September.

On examination on the 26th September, after he had come out of the tank, and had bathed and changed, he was noted to be pale, haggard, and had some twitching of his facial muscles, especially around the mouth.

Blood pressure 110/70. Temperature 97.2 Pulse rate 60. Stippled cells - nil. Blood film - normal. Apart from exaggerated superficial and deep reflexes, and a slight, but not coarse, tremor of the hands, no abnormality was found. The urine was free from albumen and sugar, the haemoglobin (Sahli) 100%. (100 = 14.8 grammes.)

Subsequent to this examination, he remained at work, but kept away from tank cleaning for two weeks, after which he returned to supervise other employees who had recommenced the cleaning. He told the Regent Oil Company supervisor that he was perfectly all right, but as a result of persistent leading questions, he finally admitted to me on the 1st December that he had not been symptom-free, and, moreover, had had some further exposure from time to time, although mostly in the open. On this occasion, he was still pale, visibly thinner, and still had a marked loss of appetite. The bad taste in the mouth was persistent, and he was constantly eating or chewing mints to counteract it. He was still sleeping badly, and was very irritable. The frontal headache had persisted, the gums were still sore, and he still had severe involuntary twitchings and felt persistently cold. There had been loss of libido since the onset. He did not admit to feeling tired, but one learned subsequently that when the tank cleaning finished on about the 14th December, he immediately went to bed for a week's rest.

The medical attendant of this man had been informed by us of his condition on the 29th September, and he had been given phenobarbitone, which he took intermittently from the 29th September. Apart from this, and a copious intake of fluid, he had no other treatment.

On the 1st December, there were no abnormal clinical findings. Blood pressure 110/70. Temperature 97.6. Pulse rate 60. E.C.G. normal. Blood films, 105 stippled cells per million R.B.C., haemoglobin 105% (Sahli). The lead concentrations in urine and blood are given below.

Date.	Urine.					Blood.		
	Vol. of Sample. (mls.)	Mg. Pb.		S.G. at 20°C.	Standardised. Mg./litre. 1.014.	Wt. gr.	Mg. Pb. Sample.	Mg. Pb. 100 grs.
		Sample.	Per litre.					
26. 9.50.	115	.093	.851	1.027	.443			
27. 9.50.	275	.126	.458	1.022	.292			
12.10.50.	45	.036	.800	1.019	.589			
13.10.50.	91	.042	.462	1.014	.462			
10.11.50.	370	.062	.168	1.009	.261			
1.12.50.	185	.051	.276	1.009	.430	21.41	0.021	0.098

Comment.

It will be seen that in this and subsequent cases described,

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Company supervisor that he was perfectly all right, but as a result of persistent leading questions, he finally admitted to me on the 1st December that he had not been symptom-free, and, moreover, had had some further exposure from time to time, although mostly in the open. On this occasion, he was still pale, visibly thinner, and still had a marked loss of appetite. The bad taste in the mouth was persistent, and he was constantly eating or chewing mints to counteract it. He was still sleeping badly, and was very irritable. The frontal headache had persisted, the gums were still sore, and he still had severe involuntary twitchings and felt persistently cold. There had been loss of libido since the onset. He did not admit to feeling tired, but one learned subsequently that when the tank cleaning finished on about the 14th December, he immediately went to bed for a week's rest.

The medical attendant of this man had been informed by us of his condition on the 29th September, and he had been given phenobarbitone, which he took intermittently from the 29th September. Apart from this, and a copious intake of fluid, he had no other treatment.

On the 1st December, there were no abnormal clinical findings. Blood pressure 110/70. Temperature 97.6. Pulse rate 66. E.C.G. normal. Blood films, 105 stippled cells per million R.B.C., haemoglobin 105 (Sahli). The lead concentrations in urine and blood are given below.

Date.	Urine.					Blood.		
	Vol. of Sample. (mls.)	Mg. Pb.		S.G. at 20°C.	Standardised. Mg./litre. 1.014.	wt. gm.	Mg. Pb. Sample.	Mg. Pb. 100 gm.
		Sample.	Per litre.					
26. 9.50.	115	.093	.351	1.027	.443			
27. 9.50.	275	.125	.453	1.022	.292			
12.10.50.	45	.036	.300	1.019	.539			
13.10.50.	91	.042	.462	1.014	.482			
10.11.50.	370	.062	.163	1.009	.401			
1.12.50.	185	.051	.276	1.009	.430	21.41	0.021	0.093

Comment.

It will be seen that in this and subsequent cases described, diagnosis was made on clinical grounds, and confirmed by the finding of a persistent increase in the excretion of lead in the urine, and in some cases an increased lead content in the blood. It may also be seen that the diagnosis was made on the general clinical picture presented, and not on any particular symptom or finding. It will be seen that the blood pressure, temperature, pulse rate and stippled cell counts were of no value in these cases.

In this particular case, it would have been possible for the individual, and in fact at one stage it was possible for him, to mislead the layman as to the true condition of his health. This man was deliberately

evasive for his own ends, but his knowledge of the condition was not sufficient to prevent a diagnosis being made on purely clinical grounds.

It is not possible to gauge the actual time this man was exposed to the toxic vapours, but in all it was at least several hours. A certain similarity between his symptoms and reactions to tetraethyl lead and those of his sibling, [REDACTED] may be seen, but at no stage was encephalopathy encountered. If anything, his exposure was not so intense, but more prolonged, and was repeated before he was symptom-free, and before the urinary excretion of lead was consistently within normal limits. The severity of the alimentary symptoms is noteworthy. The excessive perspiration has been occasionally encountered in similar cases in the past, but has not always been present. The itching of the skin was described by Kehoe in the original non-fatal cases reported by him. It has not been prominent in reports of cases of intoxication since.

In this and in the subsequent cases, every possible precaution was taken to prevent contamination of the specimens of biological material obtained for analysis, and we feel that the samples reported upon were not contaminated, as samples taken from blenders in similar conditions, and at the same time, gave normal findings. The lead excretion in the case of this man, [REDACTED] will be observed to be very variable, and the first four samples, taken between the 25th September and 13th October inclusive were at a level rarely encountered, and indeed the higher ones are usually associated with a much more severe illness than presented by this individual. It will be seen, from consideration of the lead excretion figures of this individual, and of the other men in this series, that excretion of lead in urine is a very indifferent guide as to the severity of the clinical manifestations. One of the others had a lower rate of lead excretion, and yet had more severe symptoms. It is desirable also to point out that even at the lower rates of excretion, such as on the 10th November and the 1st December, this man presented the symptoms of tetraethyl lead poisoning. We have previously expressed the opinion that no great weight should be given to the result of a single sample of urine, and that the result of a series is desirable before any opinion is given. There is ample confirmatory evidence of this statement in the analytical results recorded in this report. Further consideration of the "lowest common denominator" of safety in lead excretion in urine will be given later in this report.

[REDACTED]

Aged 38. Married. One child. Engineer.

The history of this man has been partly obtained from observers.

He had been engaged on tank cleaning at Red Mile in Nottingham, and did not take any precautions. He did not suffer any apparent detriment to health as a result. He had apparently been present on the site at Stourport in the week prior to which the actual tank cleaning operation commenced, and probably between the 6th and 8th September. The tank cleaning proper was commenced with B. Cart on the afternoon of the 11th September. It is possible that he started off wearing a respirator, but quickly discarded it, as the sight glasses steamed up. The carburettor jet in the pump became blocked, and it was replaced by the one in the air-line compressor. He did not bother to bath or change his undergarments at the end of the working period on the 11th September.

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similarity between his symptoms and those of his sibling, [redacted] may be seen, but at no stage was encephalopathy encountered. If anything, his exposure was not so intense, but more prolonged, and was reported before he was symptom-free, and before the urinary excretion of lead was consistently within normal limits. The severity of the alimentary symptoms is noteworthy. The excessive perspiration has been occasionally encountered in similar cases in the past, but has not always been present. The itching of the skin was described by Kehoe in the original non-fatal cases reported by him. It has not been prominent in reports of cases of intoxication since.

In this and in the subsequent cases, every possible precaution was taken to prevent contamination of the specimens of biological material obtained for analysis, and we feel that the samples reported upon were not contaminated, as samples taken from blenders in similar conditions, and at the same time, gave normal findings. The lead excretion in the case of this man, [redacted] will be observed to be very variable, and the first four samples, taken between the 26th September and 13th October inclusive were at a level rarely encountered, and indeed the higher ones are usually associated with a much more severe illness than presented by this individual. It will be seen, from consideration of the lead excretion figures of this individual, and of the other men in this series, that excretion of lead in urine is a very indifferent guide as to the severity of the clinical manifestations. One of the others had a lower rate of lead excretion, and yet had more severe symptoms. It is desirable also to point out that even at the lower rates of excretion, such as on the 10th November and the 1st December, this man presented the symptoms of tetraethyl lead poisoning. We have previously expressed the opinion that no great weight should be given to the result of a single sample of urine, and that the result of a series is desirable before any opinion is given. There is ample confirmatory evidence of this statement in the analytical results recorded in this report. Further consideration of the "lowest common denominator" of safety in lead excretion in urine will be given later in this report.

[redacted]
Aged 33. Married. One child. Engineer.

The history of this man has been partly obtained from observers.

He had been engaged on tank cleaning at Red Mile in Nottingham, and did not take any precautions. He did not suffer any apparent detriment to health as a result. He had apparently been present on the site at Stourport in the week prior to which the actual tank cleaning operation commenced, and probably between the 6th and 8th September. The tank cleaning proper was commenced with [redacted] on the afternoon of the 11th September. It is possible that he started off wearing a respirator, but quickly discarded it, as the sight glasses steamed up. The carburettor jet in the pump became blocked, and it was replaced by the one in the air-line compressor. He did not bother to bath or change his undergarments at the end of the working period on the 11th September. He stated that he noticed a heavy smell in the tank when he entered, and although it was nauseating, he carried on working.

The first symptom he noticed was abdominal discomfort, which progressed to pain, and was quickly followed by intense and persistent diarrhoea, which necessitated his leaving the tank for considerable periods.

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In the exact words of an observer, "He had the diarrhoea so bad that he was stuck to the seat." He vomited a few times, and was unable to eat. He slept badly that night. The following day he entered the tank again, but felt so ill at midday that he stopped work on tank cleaning, and has not returned to it since, nor does he seem to have any desire to return to this type of work. On this day, the 12th September, in addition to the symptoms described above, and which had become more severe, he had a dull pain behind his ears, "pins and needles" in the face and hands, which had persisted until our last examination on the 1st December. He became very irritable and confused. Giddiness was severe, especially on movement, and it also had persisted to the date of the last examination. He remained off work after Wednesday, 13th September, and spent most of his time in bed. The diarrhoea persisted, and continued to be severe. While waiting at his doctor's surgery on the 18th September, he had a violent "shivering and shaking" attack, and was admitted to hospital the same evening, where he remained for four weeks.

On admission to hospital, he was confused, and was provisionally diagnosed as psychosis of unknown origin. Apart from a few lucid intervals, he remains amnesic for a period of two weeks of his stay in hospital. On admission, Blood pressure 140/60. Temperature 98. Pulse rate 80. On admission, he was found to be markedly mentally disorientated, excited, restless, anxious and apprehensive. There was a marked tremor of the hands, tongue and face. He was given 5 c.c. of paraldehyde intramuscularly, and other mild barbiturates by mouth, with no effect. He had really very little intensive treatment in hospital. He kept all the patients in the ward awake for a few nights, and would have been referred to a mental hospital had not his condition been subject to very marked day-to-day variations. Shortly after admission, he shouted out, "I have got tetraethyl lead poisoning. I am dying. Four other men have died." The following day he said, "You had better get the other four men in here, as your treatment is making me better." Later, apparently, he got out of bed, and ran up and down the ward without his pyjama trousers on. He also threw food over a nurse, and made attempts to throw water over the ward sister. On another occasion, he made a dash for the ward corridor, shouting that he was going to stop the children crying outside.

When seen on the 1st December, he had a recollection of these aberrations of behaviour, and tried to justify his actions by saying that he "had to stop those nurses running up and down all the time," and that the children were crying in an adjacent children's ward.

When his father visited him on the 24th September, he told him to go away, then to lift the bed, and when his pillows were consequently adjusted, he was very abusive, and repeated his desire to have the entire bed lifted. His father was very distressed at his condition, and felt that his son was insane. He was, moreover, confirmed in this belief when the ward sister enquired of him whether or not there was mental trouble in the family.

When examined on the 27th September, Michael Whelan was fairly lucid, but had some defect in memory, especially of recent events. He could not remember [redacted], nor was he at all clear of the chronological order of tank cleaning. He did not understand why he should require to wear respiratory protection when there was a man hole open at the bottom of the tank and another at the top, with the wind blowing through. After all, he had to get the job done if he were going to make any money, and it was more difficult to work with protection. He was endeavouring to study the [redacted] regulations on tank cleaning, which had been sent to him in

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our last examination on the 1st December. He became very irritable and confused. Giddiness was severe, especially on movement, and it also had persisted to the date of the last examination. He remained off work after Wednesday, 13th September, and spent most of his time in bed. The diarrhoea persisted, and continued to be severe. While waiting at his doctor's surgery on the 18th September, he had a violent "shivering and shaking" attack, and was admitted to hospital the same evening, where he remained for four weeks.

On admission to hospital, he was confused, and was provisionally diagnosed as psychosis of unknown origin. Apart from a few lucid intervals, he remains amnesic for a period of two weeks of his stay in hospital. On admission, Blood pressure 140/60. Temperature 98. Pulse rate 80. On admission, he was found to be markedly mentally disorientated, excited, restless, anxious and apprehensive. There was a marked tremor of the hands, tongue and face. He was given 5 c.c. of paraldehyde intramuscularly, and other mild barbiturates by mouth, with no effect. He had really very little intensive treatment in hospital. He kept all the patients in the ward awake for a few nights, and would have been referred to a mental hospital had not his condition been subject to very marked day-to-day variations. Shortly after admission, he shouted out, "I have got tetraethyl lead poisoning. I am dying. Four other men have died." The following day he said, "You had better get the other four men in here, as your treatment is making me better." Later, apparently, he got out of bed, and ran up and down the ward without his pyjama trousers on. He also threw food over a nurse, and made attempts to throw water over the ward sister. On another occasion, he made a dash for the ward corridor, shouting that he was going to stop the children crying outside.

When seen on the 1st December, he had a recollection of these aberrations of behaviour, and tried to justify his actions by saying that he "had to stop these nurses running up and down all the time," and that the children were crying in an adjacent children's ward.

When his father visited him on the 24th September, he told him to go away, then to lift the bed, and when his pillows were consequently adjusted, he was very abusive, and repeated his desire to have the entire bed lifted. His father was very distressed at his condition, and felt that his son was insane. He was, moreover, confirmed in this belief when the ward sister enquired of him whether or not there was mental trouble in the family.

When examined on the 27th September, Michael Whelan was fairly lucid, but had some defect in memory, especially of recent events. He could not remember Cart's name, nor was he at all clear of the chronological order of tank cleaning. He did not understand why he should require to wear respiratory protection when there was a man hole open at the bottom of the tank and another at the top, with the wind blowing through. After all, he had to get the job done if he were going to make any money, and it was more difficult to work with protection. He was endeavouring to study the Company's regulations, on tank cleaning, which had been sent to him in hospital.

Hospital Investigations.

20.9.50. Haemoglobin 104%. W.B.C. 4,200. D.S.R. 1.
Reticulocytes 1%. No stippled cells.

X-ray chest. "Calcified focus in the right lower zone, no sign of active disease."

23.9.50. C.S.F. 3 cells. Protein 20 mgm. W.R. neg. Lange, neg.

KE 0021376

On the 1st December, he was re-examined by me. He looked well, although thinner than when previously seen. He complained of intermittent nausea, abnormal taste which was not defined, dull pain in the head, and "pins and needles" in the fingers and face. He was sleeping better, but still had unpleasant dreams about twice a week. He felt giddy occasionally. His chief complaints were irritability and inability to concentrate. He had a slight cough, for which no cause was found. On examination, blood pressure was 120/80, temperature 97.8, pulse rate 70. There was a positive Chvostek sign on the left side of the face, and the deep reflexes were exaggerated. There were no abnormal signs otherwise. The haemoglobin (Shli) was 90%. Stippled cells 160 per million. E.C.G. normal. The lead excretion in urine and blood is shown below.

Date and Time.	Urine.					Blood.		
	Vol. of Sample. (mls.)	Mg. Pb.		S.G. at 20°.	Standardised. Mg./litre 1.014.	wt. gm.	Mg. Pb.	
		Sample.	Litre.				Sample.	100 gm.
4.10.50. 1330	330	0.076	0.230	1.011	.293			
4.10.50. 1730	360	0.034	0.233	1.009	.363			
4.10.50. 2150	395	0.103	0.276	1.011	.351			
5.10.50. 0330	347	0.148	0.426	1.014	.426			
5.10.50. 1400	390	0.062	0.188	1.006	.439			
5.10.50. 1445	400	0.062	0.155	1.003	.722			
5.10.50. 1530	340	0.046	0.135	1.003	.632			
26.10.50.	340	0.132	0.423	1.020	.288			
31.10.50.	114	0.013	0.158	1.007	.316			
15.11.50.	247	0.079	0.320	1.023	.195			
1.12.50.	383	0.034	0.090	1.009	.127	3.46	.009	.106

Comment.

This man had probably had the most intense exposure of the five men involved. He definitely had developed frank symptoms of lead encephalopathy, but even when he was actually ill, the lead excretion in his urine in early October was at a level not usually associated with any marked symptoms, although on two subsequent occasions, namely the 5th and 26th October, lead excretion in urine was at a very high level. On the 1st December, 80 days after removal from exposure, it will be noted that this man still had symptoms, and although the excretion of lead in urine was within normal limits, his blood lead content was approximately double what is here accepted as the maximum under normal conditions. A little consideration will indicate how important it is that samples of urine and blood should be taken at the same time. One sample of urine taken in the case of this man might lead one to conclude that the symptoms were being feigned, but the abnormal quantity of lead found in the blood, although only one sample was taken, is sufficient confirmatory evidence, in view of the past history, to make his story acceptable.

Two other points of note in this case are that the diagnosis of tetraethyl lead poisoning was not made until the attention of the hospital medical authorities was drawn to it, no regard having been paid to his statement that he was suffering from lead poisoning, and the very severe diarrhoea from which he suffered in the initial stages. In this case also, the blood pressure, pulse rate and temperature readings were not of any great assistance in assessing the case.

KE 0021377

Aged 41. Married. Four children. Pipe-fitter.

This man was examined in hospital on the 27th September, 1950. His condition had been properly diagnosed by the physician in charge. Through him the incident was brought to the attention of the Company, and his subsequent co-operation made the records of this case reasonably complete. This man had probably approximately the same exposure as [redacted] possibly a little less, but certainly he was exposed to a concentration of lead vapour from the sludge with a lead content in excess of 0.1% of organic lead, based on the dry weight, without respiratory protection, for several hours. Part of the history given by him when first seen in hospital was subsequently found to be incorrect. From what one could learn, he had been engaged in tank cleaning at the location in Nottingham with the Whelans, and had not suffered any ill-effects from non-observance of the essential precautions. He did not wear respiratory protection at any time in the tank cleaning at Stourport. It is probable that he was present there, and was in and out of the tank, with Michael Whelan between the 6th and 8th September, and he entered the tank with Michael Whelan on the afternoon of the 11th September. He was slightly indignant at the "suggestion" of the advisability of wearing a respirator and other protection, and he stated that respirators always steamed up, and made him feel uncomfortable. He admitted that the odour in the tank made him feel sick and giddy after a short time. He has no recollection of how he felt on the 11th September, but the following day he felt very weak at midday, had no inclination for food, slept badly that night, but had no dreams as far as he could remember. Vomiting and diarrhoea ensued about this time. He saw his own doctor, who told him he had "nerves", and gave him sleeping tablets. He had a feeling of stiffness in his legs, and occasionally severe pain. His vision became blurred, and a frontal headache developed. Later, he had numbness and tingling in the hands and feet. A dry cough, which is still present, developed, and was associated with pain across the shoulders. He returned to work about the 18th, but the smell of the petrol caused nausea and vomiting. He developed severe abdominal pain, and was admitted to hospital on the 20th September for this. Dysuria (difficulty in passing urine) was marked at this time, and morphia was required for its relief. At this time, he also had violent "starts and twitchings", and his hands were very "shaky." In hospital, he passed blood in his urine.

On examination on the 27th September, he looked pale, was very depressed, and slightly disorientated. Blood pressure 130/90. Temperature 97.8. Pulse rate 82. He complained of difficulty in passing water. His memory for recent events was poor. There were no abnormal findings in examination.

Hospital Investigations.

21. 9.50. 1. Haemoglobin 116%, red blood cells 5,360,000, white blood cells 10,500. Normal differential count.

2. Cerebro-spinal fluid - clear colourless fluid. Cells less than 1/ cu.mm. Protein - 30 mgms.%. Lead content - nil.

23.9.50. Blood Urea - 30 mgms. %.

KE 0021378

Through his co-operation made the records of this case reasonably complete. This man had probably approximately the same exposure as possibly a little less, but certainly he was exposed to a concentration of lead vapour from the sludge with a lead content in excess of 0.1% of organic lead, based on the dry weight, without respiratory protection, for several hours. Part of the history given by him when first seen in hospital was subsequently found to be incorrect. From what one could learn, he had been engaged in tank cleaning at the location in Nottingham with the Whelans, and had not suffered any ill-effects from non-observance of the essential precautions. He did not wear respiratory protection at any time in the tank cleaning at Stourport. It is probable that he was present there, and was in and out of the tank, with Michael Whelan between the 6th and 8th September, and he entered the tank with Michael Whelan on the afternoon of the 11th September. He was slightly indignant at the "suggestion" of the advisability of wearing a respirator and other protection, and he stated that respirators always steamed up, and made him feel uncomfortable. He admitted that the odour in the tank made him feel sick and giddy after a short time. He has no recollection of how he felt on the 11th September, but the following day he felt very weak at midday, had no inclination for food, slept badly that night, but had no dreams as far as he could remember. Vomiting and diarrhoea ensued about this time. He saw his own doctor, who told him he had "nerves", and gave him sleeping tablets. He had a feeling of stiffness in his legs, and occasionally severe pain. His vision became blurred, and a frontal headache developed. Later, he had numbness and tingling in the hands and feet. A dry cough, which is still present, developed, and was associated with pain across the shoulders. He returned to work about the 12th, but the smell of the petrol caused nausea and vomiting. He developed severe abdominal pain, and was admitted to hospital on the 20th September for this. Dysuria (difficulty in passing urine) was marked at this time, and morphia was required for its relief. At this time, he also had violent "starts and twitchings", and his hands were very "shaky." In hospital, he passed blood in his urine.

On examination on the 27th September, he looked pale, was very depressed, and slightly disorientated. Blood pressure 130/90. Temperature 97.8. Pulse rate 82. He complained of difficulty in passing water. His memory for recent events was poor. There were no abnormal findings in examination.

Hospital Investigations.

21. 9.50. 1. Haemoglobin 116%, red blood cells 5,360,000, white blood cells 10,500. Normal differential count.
2. Cerebro-spinal fluid - clear colourless fluid. Cells less than 1/ cu.mm. Protein - 30 mgms.%. Lead content - nil.
- 23.9.50. Blood Urea - 30 mgms. %.
- 26.9.50. Urine - N.A.D.
- 27.9.50. 1. Urine - red blood cells and occasional hyaline casts.
2. Blood Urea - 33 mgms. %.
3. Urea clearance - 120% of normal.
- 7.11.50. Haemoglobin 97%, red blood cells 4.9 million.
- B.P. 140/70. Urine - normal.

K F 0021379

No cause for the haematuria (blood in urine) was found, and apparently his renal function is normal.

When re-examined on the 1st December, he was still confused on what had occurred. He complained of poor appetite, slight nausea, frontal headache, decreased visual acuity, pains across his back and shoulders, and a cough. He had lost one and a half stones in weight in hospital, but had regained one stone. He was sleeping better, but not normally. He tired easily, although he had not returned to work. He admitted that he had had pneumonia a few years ago. The X-ray of this man, seen in hospital, and not recorded in the findings, did not show any evidence of disease. He looked paler and thinner than when seen in hospital. Blood pressure 140/80, Temperature 97.8, Pulse rate 76. Haemoglobin 97% (Sahli). No stippled cells. E.C.G. normal. No abnormal signs were detected on examination. The concentration of lead in urine, faeces and blood is shown below.

	Urine.					Blood.		
	Vol. of Sample. (mls.)	Mg. Pb. Sample.	Litre.	S.G. at 20°.	Standardised. Mg./litre.	wt. gm.	Mg. Pb. Sample.	100 gm.
27. 9.50. 2115	176	0.260	1.48	1.013	1.590	8.13	0.0063	0.0775
27. 9.50. 2240	276	0.230	0.833	1.008	1.456			
27. 9.50. 2350	350	0.170	0.486	1.004	1.700			
27/28.9.50.	216	0.330	1.759	1.014	1.759			
27/28.9.50.	223	0.450	1.973	1.016	1.730			
27/28.9.50.	408	0.210	0.514	1.004	1.795			
27/28.9.50.	330	0.150	0.454	1.002	3.180			
27/28.9.50.	350	0.170	0.486	1.005	1.360			
27/28.9.50.	375	0.240	0.641	1.004	2.240			
27/28.9.50.	270	0.180	0.666	1.005	1.860			
28. 9.50. 0435	299	0.300	1.000	1.010	1.400			
1.10.50.								
23.10.50.1017	292	0.037	0.127	1.004	0.443			
23.10.50. 1143	305	0.023	0.075	1.002	0.526			
23.10.50. 1253	350	0.034	0.097	1.003	0.453			
23.10.50. 1700	318	0.042	0.132	1.003	0.696			
23.10.50. 1715	325	0.091	0.270	1.009	0.436			
23.10.50. 2245	375	0.079	0.211	1.006	0.493			
24.10.50. 0630	265	0.085	0.321	1.013	0.345			
16.11.50.	233	0.047	0.202	1.013	0.217	19.74	0.017	0.026
1.12.50.	170	0.020	0.118	1.013	0.127			

Faeces.

Date.	Ash. Wt. gm.	Mg. Pb. Sample.	Mg. Pb. 1 gm. ash.
28. 9.50.	0.34	0.230	0.675
1.10.50.	1.81	0.680	0.375

KE 0021380

... was sleeping better, but not normally. He tired easily, although he had not returned to work. He admitted that he had had pneumonia a few years ago. The X-ray of this man, seen in hospital, and not recorded in the findings, did not show any evidence of disease. He looked paler and thinner than when seen in hospital. Blood pressure 140/80, Temperature 97.8, Pulse rate 76. Haemoglobin 97% (Sahli). No stippled cells. E.C.G. normal. No abnormal signs were detected on examination. The concentration of lead in urine, faeces and blood is shown below.

	Urine.					Blood.		
	Vol. of Sample. (mls.)	Mg. Pb.		S.G. at 20°.	Standardised. Mg./litre.	wt. gm.	Mg. Pb.	
		Sample.	Litre.				Sample.	100 gm.
27. 9.50. 2115	176	0.260	1.48	1.013	1.590			
27. 9.50. 2240	276	0.230	0.833	1.008	1.456			
27. 9.50. 2400	350	0.170	0.486	1.004	1.700			
27/28.9.50.	216	0.330	1.759	1.014	1.759			
27/28.9.50.	228	0.450	1.973	1.016	1.730			
27/28.9.50.	408	0.210	0.514	1.004	1.795			
27/28.9.50.	330	0.150	0.454	1.002	3.180			
27/28.9.50.	350	0.170	0.486	1.005	1.360			
27/28.9.50.	375	0.240	0.641	1.004	2.240			
27/28.9.50.	270	0.180	0.666	1.005	1.860			
28. 9.50. 0435	299	0.300	1.000	1.010	1.400	8.13	0.0063	0.0775
1.10.50.								
23.10.50.1017	292	0.037	0.127	1.004	0.443			
23.10.50. 1143	305	0.023	0.075	1.002	0.526			
23.10.50. 1253	350	0.034	0.097	1.003	0.153			
23.10.50. 1700	318	0.042	0.132	1.003	0.696			
23.10.50. 1715	325	0.091	0.270	1.009	0.436			
23.10.50. 2245	375	0.079	0.211	1.006	0.493			
24.10.50. 0630	265	0.085	0.321	1.013	0.345			
16.11.50.	233	0.047	0.202	1.013	0.217			
1.12.50.	170	0.020	0.118	1.013	0.127	19.74	0.017	0.026

Faeces.

Date.	Ash. Wt. gm.	Mg. Pb. Sample.	Mg. Pb. 1 gm. ash.
28. 9.50.	0.34	0.230	0.675
1.10.50.	1.81	0.680	0.375

Comment.

This man, who had an intense exposure, and whose concentration of lead in urine was at times at a very high level, in fact some of the higher concentrations have only very rarely been encountered, by R. Kehoe, did not at any time exhibit symptoms of frank lead encephalopathy. One symptom in this case which requires note is the presence of blood in the urine. A similar condition was described by Inder Singh in tank cleaning in India in 1945. The cause of this is obscure, and it certainly does not seem to have left any permanent disability. It should be noted also that the symptom for which this man was admitted to hospital was severe abdominal pain.

KE 0021381

again an uncommon part of the clinical picture of tetraethyl lead poisoning. It will be noticed in this case also that the blood lead was in excess of normal on the 1st December, while the concentration in urine was well within the maximum of the normal range determined here.

[REDACTED]

Aged 31. Married. No Children. Pipe fitter.

The history given by this man, although very lucid, was found subsequently to have discrepancies. He was apparently a recent employee of J. Whelan and Sons, but had been engaged on the tank cleaning at Nottingham in mid August, although he had not had a great deal of exposure there. He joined [REDACTED] and [REDACTED] on the 11th September, and was in and out of the tank. He did not have respiratory protection, although he wore protective clothing of sorts over his ordinary working clothes.

This man stated that he felt well on the Monday and Tuesday, the 11th and 12th September, but on Wednesday, 13th September, he felt giddy, and had cold "spells", especially in the shoulders. He was sleepless, and had bad dreams. Although he did not admit vomiting to me, two independent observers stated that they had seen him outside the tank lying on the bank, retching and vomiting on one or other of these days. He was also retching and vomiting in the tank on Wednesday, and this condition was the subject of some mirth to [REDACTED] who had started the job on that day. On the 13th also he had "a taste like a penny in his mouth." On the 14th he did not go to Stourport. His symptoms remained the same. His sleeplessness became more severe. On the 15th he went to see his own doctor, who, he said, told him that he was "a bundle of nerves" and that there was nothing wrong with him. He stayed away from work on the 16th and 17th, the symptoms remaining more or less the same at this time. He vomited on the afternoon of the 17th, following retching throughout the day. He had a very vivid dream that evening, but not particularly terrifying. In the few short intervals of sleep that he had, he apparently shouted out. He returned to work at Stourport on the 18th, although he had been unable to eat his breakfast that morning. He worked away from the tank, shovelling earth on the pit that had been excavated for sludge. The smell from this caused nausea, and he returned home. On the 19th, he worked as a fitter in Birmingham, but felt very weak and tired easily. His arms and legs felt heavy, and he felt cold and aching all over, particularly in the legs and thighs, which were also stiff. He felt and saw twitchings in his muscles at this time. Some of these caused quite violent "starts." He was apparently at Stourport again on the 20th and 21st, but no exposure on these days is known. He suffered from palpitations of the heart at this time, the other symptoms remaining at more or less the same level. He had no appetite at the weekend, 23rd to 24th September, and on the latter day he started to have diarrhoea, which was still present on the 26th September. He went to the cinema on the 23rd, and had difficulty in seeing the picture. He had the feeling all the time that he was very far back in the theatre. He slept badly on the 25th and 26th. His appetite remained poor. On the latter day he stated that he had a violent pain in the front of the "stomach" from the time he got up, and that it was still present. It appeared to be in the muscles, and not internal. Intermittently, he had seen double. He had [REDACTED] his left leg before starting the [REDACTED]

KE 0021382

It will be noticed in this case also that the blood lead was in excess of normal on the 1st December, while the concentration in urine was well within the maximum of the normal range determined here.

[REDACTED]

Aged 31. Married. No Children. Pipe fitter.

The history given by this man, although very lucid, was found subsequently to have discrepancies. He was apparently a recent employee of J. Whelan and Sons, but had been engaged on the tank cleaning at Nottingham in mid August, although he had not had a great deal of exposure there. He joined [REDACTED] and [REDACTED] on the 11th September, and was in and out of the tank. He did not have respiratory protection, although he wore protective clothing of sorts over his ordinary working clothes.

This man stated that he felt well on the Monday and Tuesday, the 11th and 12th September, but on Wednesday, 13th September, he felt giddy, and had cold "spells", especially in the shoulders. He was sleepless, and had bad dreams. Although he did not admit vomiting to me, two independent observers stated that they had seen him outside the tank lying on the bank, retching and vomiting on one or other of these days. He was also retching and vomiting in the tank on Wednesday, and this condition was the subject of some mirth to [REDACTED] who had started the job on that day. On the 13th also he had "a taste like a penny in his mouth." On the 14th he did not go to Stourport. His symptoms remained the same. His sleeplessness became more severe. On the 15th he went to see his own doctor, who, he said, told him that he was "a bundle of nerves" and that there was nothing wrong with him. He stayed away from work on the 16th and 17th, the symptoms remaining more or less the same at this time. He vomited on the afternoon of the 17th, following retching throughout the day. He had a very vivid dream that evening, but not particularly terrifying. In the few short intervals of sleep that he had, he apparently shouted out. He returned to work at Stourport on the 18th, although he had been unable to eat his breakfast that morning. He worked away from the tank, shovelling earth on the pit that had been excavated for sludge. The smell from this caused nausea, and he returned home. On the 19th, he worked as a fitter in Birmingham, but felt very weak and tired easily. His arms and legs felt heavy, and he felt cold and aching all over, particularly in the legs and thighs, which were also stiff. He felt and saw twitchings in his muscles at this time. Some of these caused quite violent "starts." He was apparently at Stourport again on the 20th and 21st, but no exposure on these days is known. He suffered from palpitations of the heart at this time, the other symptoms remaining at more or less the same level. He had no appetite at the weekend, 23rd to 24th September, and on the latter day he started to have diarrhoea, which was still present on the 26th September. He went to the cinema on the 23rd, and had difficulty in seeing the picture. He had the feeling all the time that he was very far back in the theatre. He slept badly on the 25th and 26th. His appetite remained poor. On the latter day he stated that he had a violent pain in the front of the "stomach" from the time he got up, and that it was still present. It appeared to be in the muscles, and not internal. Intermittently, he had seen double. He had had a rash on his left leg before starting the tank cleaning, and he stated that since the sludge got on to it, it had been very irritable, and he had had violent pains in his toes on that side, which caused him to scream out at times with their intensity.

From his own statement, he was apparently very ignorant of the nature of the hazard in tank cleaning, and although he knew that things were not right, he could not make up his mind just what was at fault. He was remaining on the job and with Whelans only until the situation became clarified.

KE 0021383

From his story, little attention had been paid to bathing, and he had retained his soiled work clothes, which he said smelled of the sludge, at his home.

On examination, he was found to be a man of small physique, pale, had an anxious look, and was tense and apprehensive. Blood pressure 120/90. Temperature 97.2. Pulse rate 60. Blood film normal. Stippled cells - nil. Haemoglobin (Sahli) 98%. There was a marked coarse tremor of the left hand, and twitching of the face, especially around the mouth. The tongue was heavily furred and tremulous. A small area of dermatitis was present on the left leg, which appeared to be healing. The central muscles of the abdomen, especially below the navel, were extremely tender, and he winced and squirmed even on light touch. No other physical signs were found. The reflexes were normal.

This man left the employment of the contractor soon afterwards, and had no further experience in tank cleaning. He was stated to be at work elsewhere, and to have made a complete recovery on enquiry on the 1st December, 1950, but this statement has not been confirmed.

Samples of urine obtained from him on two occasions were analysed with the following results.

Date.	Vol. Mls.	Mgs. Pb/sample.	Mg. Pb/litre	S.G. at 20°.	Standardised. Mg/litre 1.014.
26. 9.50.	122	0.126	1.030	1.029	0.500
13.10.50.	42	0.018	0.439	1.022	0.273

Comment.

This man gave a very clear history in chronological order, without prompting, and required very few leading questions, yet some of his story was subsequently found to be incorrect. Again, although the two samples of urine show concentrations of lead at a very high level, no signs of lead encephalopathy were detected, nor, from our present knowledge, did they develop subsequently. As far as can be ascertained, his exposure was not of the same order as that of the two Whelans and Cert. One's impression is that the rash on his leg may have been irritated by the sludge coming into contact with it. The abdominal pain of which he complained on the 26th September did appear to be muscular, and was, in our opinion, very severe. There is nothing else unusual in this story.

KE 0021384

On examination, he was found to be a man of small physique, pale, had an anxious look, and was tense and apprehensive. Blood pressure 120/90. Temperature 97.2. Pulse rate 60. Blood film normal. Stippled cells - nil. Haemoglobin (Schli) 93%. There was a marked coarse tremor of the left hand, and twitching of the face, especially around the mouth. The tongue was heavily furred and tremulous. A small area of dermatitis was present on the left leg, which appeared to be healing. The central muscles of the abdomen, especially below the navel, were extremely tender, and he winced and squirmed even on light touch. No other physical signs were found. The reflexes were normal.

This man left the employment of the contractor soon afterwards, and had no further experience in tank cleaning. He was stated to be at work elsewhere, and to have made a complete recovery on enquiry on the 1st December, 1950, but this statement has not been confirmed.

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Comment.

This man gave a very clear history in chronological order, without prompting, and required very few leading questions, yet some of his story was subsequently found to be incorrect. Again, although the two samples of urine show concentrations of lead at a very high level, no signs of lead encephalopathy were detected, nor, from our present knowledge, did they develop subsequently. As far as can be ascertained, his exposure was not of the same order as that of the two Whelans and Cart. One's impression is that the rash on his leg may have been irritated by the sludge coming into contact with it. The abdominal pain of which he complained on the 26th September did appear to be muscular, and was, in our opinion, very severe. There is nothing else unusual in this story.

Aged 23. Single. Fitter.

This man had only been employed by the contractor for three weeks at the time of the examination. He had not been present at the tank cleaning in Nottingham, and he started tank cleaning at Stourport about the 14th September, when he was mainly engaged in pumping outside the tank. On the 15th, he was inside, after most of the sludge had been removed, mainly scraping up sludge that was adhering to the bottom. He stated that he wore a full face air line respirator. He had protective clothing of sorts. As far as can be ascertained, he wore cotton dungarees, which became soiled during the process of cleaning. According to his statement.

KE 0021385

he drank a lot of beer on the evening of the 15th September, and, contrary to his usual custom after such a detauch, he slept badly that night. On the 17th, he was restless all day, had little inclination for food, and that night did not sleep. On the 18th and 19th he did not go to work. His appetite remained poor, but he slept at night, and had no dreams. On the 20th he returned to Stourport. He does not remember how he felt that day, but he had still little inclination for food. On the 21st, he was not at Stourport, but that night had a dream which he remembers vividly, and in which he had to eat maggots. On the 22nd, he saw double, and that evening he had a dream in which he was in a long, dark tunnel, and as he walked down this tunnel he became smaller and smaller. On the 25th he returned to Stourport on the tank cleaning. This day he felt twitchings in his muscles. He slept better that night than he had done for the past week, and his appetite had slightly improved.

On examination on the 26th September, he was of normal appearance. Blood pressure 130/95. Temperature 96.8. Pulse rate 77. Haemoglobin (Sahli) 100%. Blood film normal. No stippled cells found. His pupils were unequal, the left being smaller than the right, but no other abnormal signs were found.

Subsequently, he remained at work away from tank cleaning for a fortnight, but returned to tank cleaning after this time, symptom-free and under skilled supervision. On the 1st December, no symptoms were admitted, and he stated that he felt well. He was of normal appearance. Blood pressure 120/80. Temperature 98.2. Pulse rate 70. Haemoglobin (Sahli) 97%. Blood film - normal. No stippled cells found. The excretion of lead in urine in this man is shown below.

Date.	Vol. (mls.)	Mgm. Pb.		S.G. at 20°.	Standardised. Mg.Pb./litre. 1.014.
		Sample.	Per litre.		
26. 9.50.	320	.063	.212	1.012	0.248
12. 10.50.	27	.010	.339	1.022	0.247
13.10.50.	222	.066	.234	1.020	0.164
10.11.50.	330	.053	.176	1.016	0.154
1.12.50.	46	.013	.293	1.027	0.155

Comment.

Again, the diagnosis had to be made on clinical grounds, but was confirmed later by the analysis of samples of urine. Again blood pressure, temperature and pulse rate, as in the other cases, were of little value. The lead excretions in urine, on the five occasions on which samples were obtained, are seen to be in all cases above normal, in fact on the 1st December, when the individual was symptom-free, the excretion of lead in urine was at a higher level than when the symptoms were present on the 26th September. It is possible that this individual, who had subsequent exposure in tank cleaning, had absorbed further significant amounts of lead, and therefore no comment on the continued excretion of lead at a level higher than normal is warranted.

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Agel 55.

This man associated with the same discre-

On examination
years, end of normal

Date.	Vol. (mls.)	Spec.
		No.
27. 9.50.	255	
12.10.50.	44	
10.11.50.	68	

Comment.

It will be of urine were obtained within normal limits, which is an unusual finding. This is an indication that Nottingham, which came in normal, but which was that the other individual absorbed significant amounts there.

Summary and Conclusions.

Three tanks of similar construction and service, which had contained leaded gasoline, are shown to have contained sludge with great variability in the organic lead content, and the cleaning of one of these, which had a tetraethyl lead content of 0.16%, resulted in the intoxication of five individuals, through non-observance of the regulations governing tank cleaning. One case of encephalopathy developed about one week after the last exposure. Exposure in all cases was at least for several hours. An odour of organic lead was easily detectable in the sludge from the tank concerned.

In the five cases of intoxication, the clinical manifestations were in direct proportion to the intensity and degree of exposure. The lead excretion in the individuals concerned cannot be directly related to the intensity of exposure and clinical manifestations. This may not be clear from the clinical pictures recorded, but our clinical impression is tabulated below.

Name.	Intensity of Exposure.	Clinical Manifestations.	Lead Excretion.
[REDACTED]	1	1	4
[REDACTED]	2	2	1
[REDACTED]	3	3	3
[REDACTED]	4	4	2
[REDACTED]	5	5	5

The residual symptoms cannot be related to the items tabulated above, as two of the individuals concerned had probably subsequent exposure, but at no time at such an intense degree as in the cases of [REDACTED] and [REDACTED].

In the one case in which frank encephalopathy developed, the urinary excretion of lead was a poor indication of the severity of the condition. The individual with the highest lead excretion in urine had most marked symptoms referred to the urinary tract, and not to the central nervous system.

The clinical pictures described are similar to those published in the literature, namely sleep disturbances, loss of appetite, muscular pain and twitchings, diarrhoea, and various abnormal sensations of taste and on the body. Particular in this series are the severity and persistence of abdominal pain and diarrhoea, the intensity of perspiration in one case, and the presence of haematuria in another. The temperature, pulse rate and blood pressure readings were of little value, and were not depressed.

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cleaning. One case of encephalopathy developed after the last exposure. Exposure in all cases was at least for several hours. An odour of organic lead was easily detectable in the sludge from the tank concerned.

In the five cases of intoxication, the clinical manifestations were in direct proportion to the intensity and degree of exposure. The lead excretion in the individuals concerned cannot be directly related to the intensity of exposure and clinical manifestations. This may not be clear from the clinical pictures recorded, but our clinical impression is tabulated below.

Name.	Intensity of Exposure.	Clinical Manifestations.	Lead Excretion.
[REDACTED]	1	1	4
[REDACTED]	2	2	1
[REDACTED]	3	3	3
[REDACTED]	4	4	2
[REDACTED]	5	5	5

The residual symptoms cannot be related to the items tabulated above, as two of the individuals concerned had probably subsequent exposure, but at no time at such an intense degree as in the cases of H.J. Whelan and E. Cart. In the one case in which frank encephalopathy developed, the urinary excretion of lead was a poor indication of the severity of the condition. The individual with the highest lead excretion in urine had most marked symptoms referred to the urinary tract, and not to the central nervous system.

The clinical pictures described are similar to those published in the literature, namely sleep disturbances, loss of appetite, muscular pain and twitchings, diarrhoea, and various abnormal sensations of taste and on the body. Particular in this series are the severity and persistence of abdominal pain and diarrhoea, the intensity of perspiration in one case, and the presence of haematuria in another. The temperature, pulse rate and blood pressure readings were of little value, and were not depressed, as is usually found in tetraethyl lead poisoning. Some symptoms were still present in some cases more than two months after removal from exposure, sleep disturbances, loss of appetite, aberrations of taste, headache and giddiness being the most persistent symptoms. The objective signs were, in all cases, very few or none.

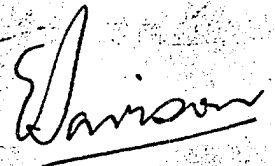
It is noteworthy that none of these cases had intensive treatment. The two hospitalised cases were given a high fluid intake, with very small doses of sedatives.

The lowest common denominator^a for mean lead excretion in the urine, if used as an indicator of the degree of lead absorption, should probably be less than 0.2 mgm. per litre, if symptoms of lead intoxication are to be avoided.

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When competent and independent supervision was provided, tank cleaning on the Stourport site was completed without mishap, although one of the tanks concerned contained more than double the percentage of volatile lead than the tank which gave rise to the intoxication. It should be clear that it is impossible to predict, from the history of tanks which contained leaded gasoline, whether or not the sludge of these is likely to be toxic, as the concentration of organic lead in the sludge of these is very variable, and therefore it is essential that the regulations be observed in all cases, until such times as expert opinion and equipment are available to estimate the degree of hazard. This, in any case, can only apply to small tanks, and, as far as U.K. is concerned, the regulations should be observed for all tanks, and tank cleaning carried out only under competent and independent supervision.

M.R. The concentrations of lead in urine referred to in the above report are the concentrations of milligrammes per litre, and not the standardised figures. A considered normal mean in U.K. is 0.03 mgm. per litre, with concentrations above 0.03 mgm. per litre uncommon, and under normal conditions never in excess of 0.12 mgm. per litre. The mean lead concentration in blood is about 0.027 mgm. per 100 grammes of whole blood, with the upper limit below 0.07 mgm. per 100 grammes. Any concentration above 0.055 mgm. is suspicious.



E. Davison.
Medical Department.
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