

Review of
A Study of 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) Exposures in Paritutu, New Zealand

**A Report to the Ministry of Health
by the Institute of Environmental Science and Research Limited (ESR)**

February 2005

and

**the critique by John Leonard of Gary Rea Associates
September 12, 2006**

Prepared by

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1. Introduction:

1.1 The ESR investigation

In October 2001 the Ministry of Health (MoH) contracted the Institute of Environmental Science & Research (ESR) to investigate non-occupational exposure to dioxins among residents of Paritutu, a suburb of New Plymouth. The investigation into suspected exposure to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) related to a point source of production of the herbicide 2,4,5-T, namely the Ivon-Watkins Dow [IWD] plant, currently operating as Dow AgroSciences. Subsequent to community consultation, environmental soil dioxin testing and ethics committee approval, the blood of 52 selected residents was analysed for polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs).

The report of the study was dated February 2005. The most relevant finding was that “Participants residing in the area for more than 15 years between 1962-1987 exhibited marked elevations in TCDD (14.6 pg/g lipid, on average) compared to expected background levels (2.4 pg/g lipid)”.

1.2 The John Leonard critique

The John Leonard report was conducted for TV3. John Leonard presented his instructions (presumably from TV3) as follows:

1. You have asked me to examine the statistical data recorded in the “Study of 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) Exposures in Paritutu New Zealand” and to comment on the results assuming the data in the data sets is not correct.
2. You have also asked that I consider the statistical data and form an opinion as to the peak body burdens of TCDD.

Mr. Leonard concludes his report with recommendations for further research. He states that “there is concern that the data available, being the basis for these reports, may not be correctly treated or that different interpretations and analyses are possible”, and “it would be desirable that the data should be examined by a biostatistician to independently assess the data and draw appropriate conclusions”.

1.3 This review

I was contacted by Dr. Fiona Thomson-Carter General Manager of Environmental Health at ESR, New Zealand, on October 25 2006 and asked if I would conduct an independent “appraisal of the John Leonard report and whether it affects the findings and conclusions of our report”.

2. The focus of this review

The most important information given in the ESR report is the current dioxin concentrations in the blood samples given by residents in Paritutu. This review therefore focuses on the blood concentration findings.

An important public health issue concerning TCDD exposure to residents in Paritutu is whether or not the ESR investigation provides data which accurately reflect the community exposure. In particular, a key question is whether or not population exposures might be higher than given in the ESR document. Mr. Leonard was asked to “form an opinion as to the peak body burdens of TCDD”. My objective will be to assess the ESR report concerning peak body burdens, along with the comments of Mr. Leonard.

TCDD is a remarkable chemical substance because it persists in the body for many years. This means that current measurements of TCDD in blood can be used to assess past exposures occurring many years ago. There are two components to consider. The first is the current concentrations of TCDD in blood samples. As a second step, it is possible to back calculate what past concentrations may have been many years ago based on knowledge of the persistence of TCDD in humans. I will first consider the information on the current blood concentrations, and then comment on the back calculations.

I decided not to go through and comment on each point made by Mr. Leonard one by one because (1) Although some points are of interest and include minor corrections, I did not identify any points he made which raised substantive issues that would affect the overall interpretation of the ESR report, and (2) Mr. Leonard himself did not claim that any of the points he presented raised substantive issues that would alter the interpretation of the ESR study.

3. The ESR study size

The ESR study was specifically designed to try to identify the most highly exposed persons and then to invite them to give blood samples for testing. Altogether 52 persons participated, 24 in a first round selected because they were predicted to be “most likely to show elevated concentrations of TCDD” from exposures which included early years when TCDD concentrations were highest (1962-87). A second round of testing was conducted with 28 participants selected to evaluate more recent exposure in the period 1972-86.

For the objective of determining those with the highest TCDD concentrations, the sample sizes are quite large. There is an important distinction between conducting a study to determine the highest exposures, with a study designed to determine the distribution of concentrations in the total population. When participants are selected carefully, all that is needed to determine the highest concentrations are some of the people with the highest concentrations.

An example of a small sample size informative study is one we conducted of the serum TCDD levels of New Zealand pesticide applicators published in the Journal of the National Cancer Institute (Smith AH et al, 1992). Of 548 men employed as professional pesticide applicators in New Zealand from 1979 through 1982, nine were selected who had sprayed 2,4,5-T the longest,

for a range of 83-372 months. The nine were chosen because they had sprayed for the greatest length of time, and therefore were expected to have the highest blood concentrations of TCDD. A clear difference was found in TCDD concentrations among the sprayers compared to a selected comparison group. Three of the sprayers who had sprayed the longest had concentrations of TCDD which were above 100 pg/g, between 100 and 140 pg/g (these are actual concentrations not back calculated to higher concentrations when the exposures occurred). This information allowed us to characterize the highest exposure to applicators in New Zealand which was the objective of the study. Thus a study involving a sample size of just 9 among the exposed applicators was highly informative and was published in a leading scientific journal.

The ESR study was of similar design with selection of those likely to have the highest blood concentrations of TCDD, but it involved 52 participants versus 9 in the above 2,4,5-T applicator study. The sample size was more than adequate. Mr. Leonard is not correct in his statements implying that the sample sizes were too small (Executive Summary 2.1).

The ESR report presented confidence intervals for the average TCDD blood concentrations in various groups and sub-groups. It is appropriate to do so, but they should not be a focus of the interpretation of the findings. Indeed, the confidence intervals can be misinterpreted and the range of values is more informative, particular the highest concentrations. In the ESR report the overall range of blood concentrations was given as 0.85 to 33.3 pg/g. The important number here is 33.3 pg/g. In a study designed to include those with the highest potential exposure, the peak concentration was 33.3 pg/g. In Appendix O where all the measurements are given, the next highest concentrations were 25.4 and 23.5 pg/g. All the remaining TCDD blood concentrations were below 15 pg/g. These concentrations are the ones to focus on, in particular the highest current blood concentrations among the participants.

4. Did the ESR study select participants with the highest TCDD exposure?

This topic was not raised by Mr. Leonard, but I will address it since I believe it is relevant to the goal of identifying those with the highest body burdens of dioxin in Paritutu.

Section 3.4 of the ESR report states that: “the highest residential TCDD soil concentration predicted ... was 106 pg/g, with a total of 37 addresses predicted to be above 40 pg/g. The highest modeled soil concentration at a residence for which we were able to obtain a serum sample in this study was 42.9 pg/g soil”.

This information raises a sampling question since there were 37 residences predicted to have a soil concentration of more than 40 pg/g, but only one such household participated. Based on Figure 7, the highest blood concentration of 33.3 pg/g was for a resident of this household. Apart from this one individual, it can be seen in Figure 7 that the observed blood results bear little relationship to the levels predicted.

The concern this information raises is that some residents in the community may have higher blood concentrations than those who participated. The pool from which participants were selected was those who responded to advertisements and it is unfortunate that there were not more respondents from the potentially high exposure residences. Even if they had responded,

they would have to have been resident in the dwelling for many years during the period 1962-87 to have experienced the peak exposures. However the possibility remains that there are similar or higher blood concentrations among others in the community than the highest three detected in the study (33.3, 25.4 and 23.5 pg/g).

5. Back calculation of past dioxin concentrations

The half-life of TCDD in humans is roughly ten years. This means that about half of the dioxin in the body at one point in time will still be there ten years later. However there is uncertainty in the half-life and the ESR report uses two values, 7.1 years and 11 years which have been used by other investigators.

The objective of back calculation is to identify the likely concentration of TCDD in the body when the exposures ceased or were much reduced. During the exposure period, the blood concentrations gradually rise. When exposure stops, they gradually fall. One should not back calculate to point in time before the exposure stopped since this will exaggerate past body burdens. Based on the exposure scenario, it is reasonable to back calculate to 1987 as done by ESR. Back calculation in the ESR report for the individual with the highest current blood TCDD concentration (33.3 pg/g) gave estimates of 225 pg/g (7.1 year half-life) and 98 pg/g (11 year half-life). These concentrations can be used to place in perspective the highest exposure found in this study with those found in other population studies (see later section).

6. Pathways of dioxin exposure

The ESR report noted that “Consumption of home-grown produce of a specific nature appeared to contribute significantly to elevations in serum TCDD. This included leafy vegetables, apples, pears, and any food with a surface exposed to the atmosphere that is then consumed. There was no indication of a significant contribution to exposure from root vegetables, protected fruits (citrus, feijoas, etc), poultry or eggs, or kai moana (seafood)”. The implication is that contamination by air was involved, rather than from the soil. If so this is reassuring since contamination by air has stopped. Mr. Leonard discusses various minor points about exposure by food, but does not raise any substantive issues so I will not review them here.

The analysis of food pathways of exposure would be greatly influenced by those with the highest blood concentrations. It may be helpful to look at the food sources and potential pathways for those with the three highest blood concentrations (33.3, 25.4 and 23.5 pg/g) on their own to see if any particular pattern stands out.

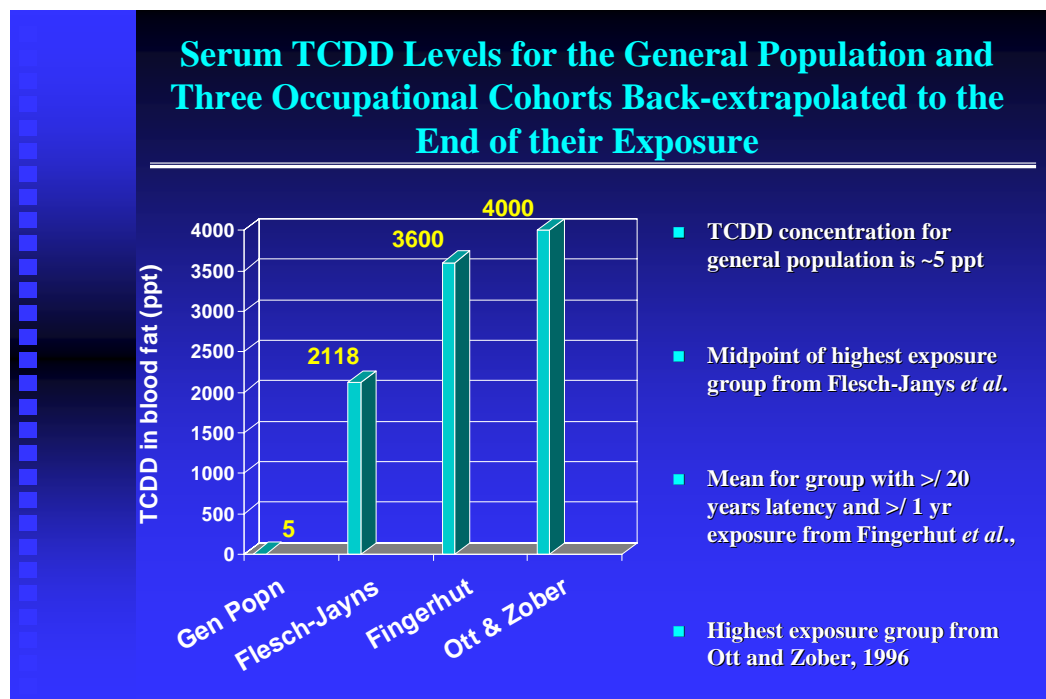
7. Other points raised by Mr. Leonard

Mr. Leonard has raised many other minor points not addressed above. As noted in section 2 above, I decided not to go through and comment on each point one by one because (1) Although some points are of interest and include minor corrections, I did not identify any points he made which raised substantive issues that would affect the overall interpretation of the ESR report, and (2) Mr. Leonard himself did not claim that any of the points he presented raised substantive issues that alter the interpretation of this study.

8. Placing Paritutu dioxin exposure in perspective

Before the ESR project was conducted, I had not expected that it would find much evidence of exposure in residents without occupational exposure in the IWD plant itself. Finding three participants with concentrations above 20 pg/g, and with back calculations suggesting they may have in the past had blood concentrations in excess of 100 pg/g (perhaps as high as 225 pg/g for one individual) was surprising. It is now clear that the operation of this plant resulted in widespread environmental exposure with some individuals experiencing quite marked increased in blood dioxin concentrations.

There is a need to place these exposures in perspective. Although these concentrations are considerably above those of the general population in New Zealand, they are very much lower than blood concentrations found in workplace exposures in the past. The Figure below presents back calculated blood concentrations for three worker studies where concentrations are back-calculated to a 2000-4000 pg/g range (Fingerhut, MA et al, 1991, Flesch-Janys, D et al 1995, Ott, MG, Zober, A. 1996). General population concentrations are generally less than 5 pg/g (leftmost bar). The highest back calculated concentration for Paritutu was 225 pg/g. This concentration is about ten times lower than the lowest concentration in these three occupational studies. It is noteworthy that even at these very high worker blood concentrations it has been difficult to determine if there are increased long term mortality risks for the workers. I believe there are, including some increase in cancer mortality, but it required combining information from each cohort study to reach that conclusion (IARC, 1997).



9. Concluding remarks

A precautionary approach should be adopted concerning dioxin and dioxin-like compounds with an on-going goal of reduction in population body burdens of TCDD. This has been taking place in New Zealand. It is clearly evident that some Paritutu residents had additional exposure well above the average in the general population. The ESR study provides excellent and valuable information concerning this, although it has a limitation in that there were quite a number of residences with potentially high exposure without participants coming forward from them. It is indeed regrettable that the Paritutu community had these exposures, but it can only cause them greater harm if they are unduly alarmed by misguided political and media attention to their past exposure. There is no treatment, and their blood concentrations will continue to gradually decrease. The blood concentrations for the large majority of participants in this study were quite commonly found in the general population just 20 or so years ago.

References:

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