NSW HEALTH

Supplementary report from the expert panel considering the blood dioxin levels for Sydney Harbour fishermen and their family members.

3 August 2006

The NSW Health Department contacted the 44 Sydney Harbour fishermen with current commercial licences, at the time the commercial fishing ban in Sydney harbour was imposed, and their immediate families to discuss blood dioxin testing. A total of 124 individuals registered to attend a clinic (22 fishermen and 102 family members). Following informed consent a total of 95 (20 fishermen and 75 relatives) provided blood samples for blood dioxin testing.

The expert panel was re-convened to address point 2 of the Terms of Reference for the panel as listed below:

Sydney Harbour fishermen and families blood dioxin tests expert panel

Terms of Reference:

1. To review the results of the four blood dioxin tests completed to date[1] and advise on:

   a. The likely source of the dioxin and dioxin-like chemicals

   b. The comparison between these results and Australian and international blood dioxin levels for:
      i. The general population
      ii. High fish-eating communities
      iii. Industrial workers
      iv. Accident exposed populations

   c. The degree of clinical significance that can be attributed to these blood dioxin levels

   d. The advice that should be provided to these fishermen/family members on the basis of these blood dioxin levels, including the necessity for repeat testing.

2. To comment on blood dioxin test results from Sydney Harbour fishermen and their families in line with the issues raised in point 1.

[1] These four tests were conducted in early April by the Australian Broadcasting Corporation and released in a report entitled "Investigation on polychlorinated dibenzodioxins and furans (PCDDs/PCDFs) and WHO – PCBs in Human blood – Client Australian Broadcasting Corporation -Sydney Australia. Olaf Papke & Nina Lohmann, Hamburg, April 11th 2006"

The following experts are members of the expert panel:

Professor Bernard Stewart
Professor and Head
Cancer Control Program
South Eastern Sydney and Illawarra Area Health Service

Dr Gerard Neville
Senior Medical Officer
Environmental Health Unit
Queensland Health

Dr Caroline Gaus
Research Fellow
National Research Centre for Environmental Toxicology
University of Queensland

A/Prof Jochen Mueller (unavailable for teleconference)
Principal Research Fellow
National Research Centre for Environmental Toxicology
University of Queensland

Summary data was provided to the expert panel on 6th July 2006. A teleconference was held on Monday 10th July, to consider the matters raised in the Terms of Reference. Professor Stewart, Dr Gaus and Dr Neville participated in the teleconference. A/Prof Jochen Mueller was in Europe at the time and unable to participate in the teleconference.

The summary of discussions that took place at the teleconference follows and constitutes the supplementary report of the panel addressing point 2 of the Terms of Reference.

ERGO Forschungsgesellschaft mbH conducted the tests (Geierstrasse 1, D-22305 Hamburg, Tel: +49 40 69 70 96; Olaf Päpke, Managing Director; Nina Lohmann, Project Manager). The following tables summarise the results provided to the expert panel members for consideration

Table 1: 2,3,7,8-TCDD (pg/g lipid), by age group

Age group (years)	No.	Min	25th	50th	75th	Max	Mean	Aust SEU point estimate[2]*
<16	15	n.d. (3)$^{\alpha}$	2.5	3.9	6.3	19.0	5.1	n.d. (0.8)$^{\alpha}$
16 – 30	11	0.9	2.2	4.1	18.7	100.4	17.8	0.1
31 – 45	34	0.8	3.2	9.3	19.0	40.8	12.0	0.6
46 – 60	21	1.4	8.7	26.1	41.6	56.4	25.0	1.1
≥61	14	2.7	52.4	92.6	154.7	310.0	109.5	1.9
All ages	**95**	**n.d. (3)$^{\alpha}$**	**3.7**	**10.3**	**31.7**	**310.0**	**28.8**	**0.7**

***Average (lower bound) concentrations of four sample pools (two for each gender) for each age group.**
$^{\alpha}$ n.d. = not detected (limit of detection)

Table 2: PCDD/Fs TEQ (pg/g lipid), by age group

Age group (years)	No.	Min	25th	50th	75th	Max	Mean	Aust SEU point estimate[2]*
<16	15	0.8	3.2	7.1	15.5	24.9	9.7	2.0
16 – 30	11	3.2	5.2	7.8	25.4	121.5	24.5	3.2
31 – 45	34	3.6	7.8	14.9	28.7	57.2	18.9	5.2
46 – 60	21	4.4	19.0	38.1	55.4	68.7	38.3	7.4
≥61	14	6.6	66.4	118.4	196.5	369.1	135.3	12.4
All ages	**95**	**0.8**	**7.1**	**18.2**	**44.5**	**369.1**	**39.5**	**6.0**

*** Average (lower bound) concentrations of four sample pools (two for each gender) for each age group.**

Table 3: Dioxin-like PCBs TEQ (pg/g lipid), by age group

Age group (years)	No.	Min	25th	50th	75th	Max	Mean	Aust SEU point estimate[2]*
<16	15	0.4	0.6	1.9	3.7	6.2	2.3	2.4
16 – 30	11	0.6	1.1	3.6	7.3	32.7	6.9	3.0
31 – 45	34	1.0	3.9	6.3	9.5	29.0	7.6	5.2
46 – 60	21	0.7	10.6	20.9	27.9	55.0	22.0	6.5
≥61	14	5.2	37.4	66.3	80.7	112.7	62.3	8.4
All ages	**95**	**0.4**	**3.6**	**7.3**	**21.9**	**112.7**	**17.9**	**5.1**

*** Average (lower bound) concentrations of four sample pools (two for each gender) for each age group.**

[2] Australian South East Urban Population that includes Sydney, Canberra, Newcastle and Wollongong from *Dioxins in the Australian population: Levels in Blood, National Dioxins Program Technical Report No 9 2004*

Table 4: PCDDs, PCDFs and dioxin-like PCBs TEQ (pg/g lipid), by age group

Age group (years)	No.	Min	25th	50th	75th	Max	Mean	Aust SEU point estimate[2]*
<16	15	2.9	4.4	9.2	18.1	27.3	12.1	4.5
16 – 30	11	3.8	6.6	12.0	32.7	154.2	31.4	6.2
31 – 45	34	5.0	11.1	23.3	38.3	78.9	26.5	10.1
46 – 60	21	5.1	28.8	56.6	86.9	119.5	60.2	14.0
≥61	14	11.8	116.3	175.3	270.1	472.8	197.7	20.1
All ages	**95**	**2.9**	**11.7**	**26.4**	**73.9**	**472.8**	**57.5**	**11.0**

*** Average (lower bound) concentrations of four sample pools (two for each gender) for each age group.**

Table 5: 2,3,7,8-TCDD (pg/g lipid), by sex

Sex	No.	Min	25th	50th	75th	Max	Mean	Aust SEU point estimate[2]#
Male	52	0.9	4.7	11.4	41.5	310.0	32.2	**0.6**
Female	43	n.d. (3)α	2.5	9.2	26.1	252.9	24.8	**0.9**

 # Average of the two pooled results for each age group
α n.d. = not detected (limit of detection)

Table 6: PCDDs / PCDFs TEQ (pg/g lipid), by sex

Sex	No.	Min	25th	50th	75th	Max	Mean	Aust SEU point estimate[2]#
Male	52	3.2	11.4	21.7	56.3	369.1	44.2	**5.5**
Female	43	0.8	6.0	15.2	38.1	296.4	33.9	**6.0**

 # Average of the two pooled results for each age group

Table 7: Dioxin-like PCBs TEQ (pg/g lipid), by sex

Sex	No.	Min	25th	50th	75th	Max	Mean	Aust SE point estimate[2]#
Male	52	0.4	3.7	8.0	22.2	103.8	19.6	**4.3**
Female	43	0.4	2.9	5.3	20.9	112.7	15.9	**5.9**

 # Average of the two pooled results for each age group

Table 8: PCDDs, PCDFs and dioxin-like PCBs TEQ (pg/g lipid), by sex

Sex	No.	Min	25th	50th	75th	Max	Mean	Aust SE point estimate[2]#
Male	52	3.8	16.9	28.2	78.7	472.8	63.8	**9.9**
Female	43	2.9	8.4	21.2	55.4	409.1	49.8	**12.3**

 # Average of the two pooled results for each age group

Summary of expert panel discussion on blood dioxin tests for Sydney Harbour fishermen and families

Teleconference held on 10th July 2006

1(a) The likely source of the dioxin and dioxin-like chemicals

Notwithstanding the limitations associated with attempting to identify PCDD/F and PCB sources from profiles that have undergone alteration due to bioaccumulation and biomagnification, on the balance of probabilities it is highly likely that dioxin and dioxin-like chemicals from Sydney Harbour seafood are the major contributors to the blood dioxin levels demonstrated in the 95 cases being reviewed. Evidence to support this includes:

- Sydney Harbour fishermen and their families were likely to be regular consumers of seafood from Sydney Harbour, at levels above that now recommended by the NSW Food Authority assessment.
- The particular dioxin 2,3,7,8-TCDD, which is known to be significantly represented in samples of seafood from Sydney Harbour, was also the predominant PCDD (in TEQ levels) found in the blood samples from the 95 cases
- Past occupational exposure is unlikely to have significantly contributed to 2,3,7,8–TCDD levels as most fishers reported having been in the fishing industry for majority of their working life. No individual reported being currently employed in an industry where exposure to 2,3,7,8-TCDD is likely.

1(b) The comparison between these results and known Australian and international blood dioxin levels

General Comments

- The 95 samples from the Sydney Harbour fishers and their families can be considered to be representative of Sydney Harbour fishers and their families.
- The 95 results demonstrate considerable variation across the five age groups, with generally increasing dioxin levels with increasing age.
- Those in the greater than 60 years age group had considerably higher blood dioxin levels than those in other age groups.
- Most data on blood dioxin levels from elsewhere is reported in terms of mean results and does not provide information on the range of individual levels. It is therefore inherently difficult to compare an individual's level with these mean population level measures. Information about the distribution of individual readings that make up the population needs to be considered when attempting to compare an individual's level with a mean value of a population. Should an individual reading be notably different from a mean value this does not necessarily imply that the individual's level is outside the "normal" range of values within the population.

1(b)(i) General population dioxin level data

- Direct comparison of the 95 levels of mean blood total dioxins (PCDD/Fs and dioxin-like PCBs TEQ, pg/g lipid) from the fishermen and their families with those reported in the Australian National Dioxin Program[1] by age group shows that:
    - In the < 16 years age group, the mean total PCDD/Fs & dioxin-like PCBs (12.1 pg/g TEQ) was 2.7 times the Australian southeast urban (SEU) region mean of 4.5 pg/g.
    - In the 16 - 30 age group, the mean total PCDD/Fs & dioxin-like PCBs TEQ (31.4 pg/g) was 5 times the SEU mean of 6.2 pg/g
    - In the 31- 45 age group, the mean total PCDD/Fs & dioxin-like PCBs TEQ (26.5 pg/g) was 2.6 times the SEU mean of 10.1 pg/g.

- In the 46 - 60 age group, the mean total PCDD/Fs & dioxin-like PCBs TEQ (60.2 pg/g), was 4.3 times the SEU mean of 14.0 pg/g.
- In the > 61 age group, the mean total PCDD/Fs & dioxin-like PCBs TEQ (197.7 pg/g) was 9.8 times higher than the SEU mean of 20.1 pg/g.

Based on these data it is likely that the levels for each age group are higher compared to the majority of other individuals of corresponding age from the southeast urban Australian community

- There is considerable variation in mean estimates of PCDD/F and/or dioxin-like PCB TEQs levels among international data. In general, mean levels in many other parts of the world are approximately 2 to 10 times higher than levels determined for the general Australian population[3].
- A German study[4] undertaken in the mid 1990's of 15 adults (age 24 – 58 years) found PCDD/F TEQ levels from 11.7 pg/g to 31.9 pg/g NATO/ CCMS TEQ (mean 18.4 pg/g, median 18.3 pg/g). The 2,3,7,8–TCDDlevels for these 15 German adults were from 1.3 pg/g to 4.9 pg/g (mean 2.4 pg/g, median 2.2 pg/g) This can be compared to the Sydney Harbour fishers and families of similar age range (n=55, age 24 – 58 years) with 2,3,7,8–TCDD levels of 0.76 pg/g to 100.4 pg/g (mean 18.2 pg/g, median 10.3 pg/g) and PCDD/F TEQ levels of 3.6 pg/g to 121.5 pg/g (mean 27.2 pg/g, median 17.3 pg/g) although it should be highlighted that PCDD/F TEQ factors used for the German data are slightly different to those recommended by WHO.
- The findings from the Sydney Harbour group were similar compared to reports from some populations with higher general seafood consumptions, such as Finland (average 50.4 pg/g TEQ lipid; n=18, collected in 1993)[5]
- In the mid 90's, 286 German children aged <12 years were tested for PCDD/F TEQ with average levels of 10 pg/g lipid[6], which is similar to the mean PCDD/F level of 9.7 pg/g lipid in the less than 16 years age group. However, levels of dioxin have decreased several fold over the last 30 years in developed countries.
- Some recent U.S. data[7] is particularly informative as it reports individual level data for 1081 individuals and provides an indication of the variation in PCDD/F & dioxin-like PCB TEQ levels both as a whole group and when stratified by age and gender. The raw data demonstrated a range of values of 8 – 208 pg/g lipid for participants, with an inter-quartile range of 17.7 pg/g (25%) to 35.0 pg/g (75%). The 95% percentile for all participants was 69.3 pg/g lipid. In general, the estimated mean levels of various age and gender groups is higher than that of the general population in Australia with the overall mean being estimated at 30.4 pg/g or approximately three times the Australian estimated mean level. This US data does not provide levels in children.
    - The PCDD/F & dioxin-like PCB TEQ levels for the Sydney Harbour fishermen and families had a range of values from 3.8 pg/g to 472.8 pg/g (excluding the less than 16 years age group), with a 95% percentile of 246.6 pg/g for the males, and 278.3 pg/g for females.

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[3] Figures 3-5 & 6: Human Health Risk Assessment of Dioxins in Australia, National Dioxins Program Technical Report No 12, 2004

[4] Wuthe et al. First data on background levels of non-ortho and mono-ortho PCBs in blood of residents from Southern Germany. *Chemosphere* 32:567-574, 1996.

[5] Kontsas, H, Rosenberg,C, Torneaus, J, Mutanen, P & Jappinen, P *1998* .Exposure of workers to 2,3,7,8-substituted polychlorinated dibenzo-p-dioxin (PCDD) and 46 dibenzofuran (PCDF) compounds in sawmills previously using chlorophenol-containing antistain agents., *Archives of Environmental Health, vol. 53(2), pp. 99-109.*

[6] Wuthe et al. First data on background levels of non-ortho and mono-ortho PCBs in blood of residents from Southern Germany. *Chemosphere* 32:567-574, 1996.

[7] Evaluation of PCDD/F and Dioxin-like PCB Serum Concentration Data from the 2001-2002 National Health and Nutrition Examination Survey of United States Citizens. LL Ferriby, JJ Knutsen, M Harris et al (in press) note: this research was sponsored by Dow Chemicals.

- The 30-44 year, 45-59 year and 60+ year age groups can be directly compared between the two data sets;
    - For the 30-44 year age group the US group had a median value of 21.1 (range 10.4-117.2) PCDD/Fs & dioxin-like PCBs TEQ pg/g compared to 23.3 (range 5.0 – 78.9) for the Sydney Harbour group.
    - For the 45-59 year age group the US group had a median values of 27.7 (range 10.3-208.1) PCDD/Fs & dioxin-like PCBs TEQ pg/g compared to 56.6 (range 5.1-119.5) for the Sydney Harbour group.
    - For the 60+ year age group the US group had a median value of 43.7 (range 10.4-164.0) PCDD/Fs & dioxin-like PCBs TEQ TEQ pg/g compared to 175.3 (range 11.8 – 472.8) for the Sydney Harbour group.

- There were no appropriate age group levels reported that could be used as comparison for the less than 16 years group (no individuals under 20 years of age participated in the US study).

1(b)(ii) High fish-eating / fishing communities

- There are no relevant data available from Australian fishers for direct comparison.
- Dioxin levels in some communities with high fish consumption are typically elevated compared to background populations. This is specifically the case in communities resident along the coast of the Baltic Sea. Levels of PCDD/F TEQ in adult males have been reported in the range of 70 – 200 pg/g lipid in high Baltic seafood consumers, and 30 – 140 pg/g lipid in low to moderate Baltic seafood consumers.[8]
- Finnish fishermen (consuming fish from the Baltic, surveyed in 1997) had a mean 2,3,7,8-TCDD level of 25 pg/g (median 19; range 4.9 pg/g – 110 pg/g), and a mean level of PCDDs/Fs of 180 pg/g TEQ (median 170 pg/g; range 51pg/g – 420pg/g, n=26)[9]. The Finnish study showed a clear correlation between blood dioxin levels and frequency of fish meals.
- A study of 40 residents from a community along the St Laurence River in Quebec demonstrated a mean dioxin-like compound blood level of 102 pg/g TEQ.(range 37 to 287 pg/g)[10]. It should be noted that the measurements were performed using the DR-CALUX bioassay.

From this data, we can say that the Sydney Harbour group has similar levels to that found in some other high fish-eating and fishing communities.

1(b)(iii & iv) Industrial workers & accident exposed populations

- In general, blood dioxin levels among people exposed via industrial & accident related scenarios can be substantially higher than those among general populations, or communities eating fish with high 2,3,7,8-TCDD levels.
- The WHO IARC Monograph Volume 69, *Polychlorinated Dibenzo*-para-*dioxins and Polychlorinated Dibenzofurans* 1997 reports the following industrial worker & accident exposed population levels:
    - A study of 9 New Zealand 2,4,5-T herbicide applicator workers has reported a back-calculated mean 2,3,7,8 TCDD level of approximately 300 pg/g lipid.

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[8] Assmuth, T & Jalonen, P. (2005) Risks and management of dioxins and dioxin-like compounds in Baltic Sea fish: An integrated assessment. TemaNord 2005:568

[9] Kiviranta H et al. Polychlorinated dibenzo-p-dioxins, dibenzofurans, and biphenyls in fishermen in Finland. *Environ. Health Persp.* 110, 355 – 361, 2002.

[10] P. Ayotte et al. Biomarker Measurements in a Coastal Fish-Eating Population Environmentally Exposed to Organochlorines. *Environ. Health Persp.* 113, 1318 - 1324, 2005.

- The largest Vietnam veteran study involving veterans spraying “agent orange” was conducted among veterans from the Ranch Hand Operation. In 1987 it measured blood 2,3,7,8 TCDD levels for 888 individuals. A median level of 12.4 pg/g lipid was reported with a range in levels of 0.0 to 617.7 pg/g lipid (back-calculated median level ~ 50 pg/g).
- The most extensive data available for industrial workers is from the United States National Institute for Occupation Safety and Health (NIOSH) study that included 253 workers with an average back-calculated blood 2,3,7,8 TCDD level of approximately 2000 pg/g lipid.
- Residents of Seveso in Italy were contaminated with 2,3,7,8 TCDD as a result of a TCP production reactor accident in 1976. The area affected by the chemical dispersal was divided into Zone A (~750 individuals, soil levels ≤ 580 μg/m^2), B (~5000 individuals, soil levels ≤ 50 μg/m^2) and R (~30,000 individuals, soil levels ~5 μg/m^2) depending on TCDD contamination in soil. All inhabitants from these zones were considered exposed. 2,3,7,8-TCDD levels in blood from 19 Seveso residents collected in the year of exposure have been reported in the range of 828 - 56000 pg/g lipid (12557 pg/g mean, 7420 pg/g median)(Zone A). Another study of 6 individuals from Zone A reported a mean level of 334 pg/g lipid when back-extrapolation to year of exposure was undertaken based upon blood levels measured in 1992/3. This study also reported a back-extrapolated mean level of 111 pg/g for a group of 52 individuals from Zone B.

- Comparing 2,3,7,8-TCDD levels among the Sydney fishermen and families to the above 2,3,7,8-TCDD levels the following can be said
    - The 2,3,7,8-TCDD levels (mean 28.8 pg/g) in the 95 people tested are orders of magnitude lower than those recorded in zone A of the Seveso accident.
    - The mean 2.3,7,8-TCDD level for males 16 – 60 years (comparable age groups to industrial workers) of 20 pg/g is lower than the mean level reported for industrial workers and considerably below the mean level for the largest study (NIOSH study).
    - The median 2,3,7,8-TCDD level (10.3 pg/g) for males 16 – 60 years (comparable age groups to herbicide applicators and servicemen) is well below the back-calculated median levels reported for herbicide applicators and below the back-calculated median level reported for Operation Ranch Hand Vietnam veterans.
    - The 2,3,7,8-TCDD levels in the less than 16 years age group or females are not comparable to occupational or veterans cohorts.

1(c) Clinical Significance that can be attributed to individual blood levels recorded

- Technical Report No.12 of the National Dioxin Program has comprehensively summarised the epidemiological evidence relating to human illness and dioxin exposure. The report specifically states in reference to cancer that; “It is difficult to find epidemiological data that have sufficient dose-response information to provide reliable risk estimates in exposed human populations.”

- The International Agency for Research on Cancer has classified 2,3,7,8-TCDD as a group 1 carcinogen.

- 2,3,7,8-TCDD is not a genotoxic carcinogen. There is a consequent implication of a threshold below which health effects are not thought to occur but evidence is insufficient to specify a threshold level in numerical terms.

- Qualitative assessment of risk using population exposure-level data can infer differences in risk. At levels above the presumed threshold where health effects are expected it is reasonable to assume that a community as a whole may be at some increased risk. Although the levels of dioxin in Sydney Harbour fishers and their immediate family

members as a group are above south east urban Australian background levels, it is unknown whether they are also above this threshold.

- Given current scientific knowledge, individual blood dioxin levels should be considered as an indicator of exposure rather than as a clinical indicator to assess an individual's health risk or need for healthcare.

- At the levels found in the 95 individuals, it is not possible to extrapolate population health effects to individual levels to infer adverse health effects.

- At the levels observed among the 95 people tested it cannot be asserted that they will experience adverse health effects.

- Current inability to relate blood dioxin levels to individual prognosis might be further illustrated by the consideration that it is impossible to assert that one individual is at more risk of dioxin-related disease than another based on their blood levels, or to assert that any individual is free of risk based on their blood levels.

- Some health effects such as chloracne have been definitely attributed to dioxin exposure. However these effects have almost exclusively occurred at high levels of exposure and not all individuals exposed at these levels have had health effects. It would not be expected that these effects would be reported in the 95 cases reviewed.

1(d) Advice to 95 individuals already tested including repeat testing

- It would be expected that the levels of dioxin in the 95 people tested will decrease with time provided that they adhere to the current dietary guidance recommended by NSW Health in regard to the consumption of Sydney Harbour seafood.

- When individuals adhere to the recommended guidelines for intake of seafood from Sydney Harbour, it would be expected that the decrease in absolute blood levels would be greater in individuals with higher levels than in those with lower blood levels.

- Regardless of an individual's blood dioxin level, all Sydney Harbour fishers and their families should adhere to the current dietary advice of eating not more than 150g of fish per month or not more than 300g prawns per month from Sydney Harbour (both should not be eaten in the same month). Adults weighing less than 70kg and children should consume proportionately less. This does not limit intake of seafood from other regions.

- The repeating of blood dioxin testing or other clinical examination of any of the 95 individuals tested is not justified to determine risk of disease or to monitor their health. The basis for this includes:
    - that repeat testing will not provide additional information to better inform them of their level of risk;
    - the lack of a typical clinical syndrome related to dioxin exposure;
    - the lack of an appropriate screening test with an ability to influence prognosis.

- Apart from the above dietary advice, the panel is unable to advise of any other appropriate measure that the Sydney Harbour fishers and their families should take to accelerate the reduction in their blood levels.

- Naturally, if any of the cases have any symptoms that are of concern, they should consult their usual medical practitioner for assessment in line with normal medical practice.