



EUROPEAN REGIONAL PROGRAMME ON CHEMICAL SAFETY

Control of
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Quality Control Studies
on PCBs, PCDDs and PCDFs in Human Milk
Umeå, Sweden 1987



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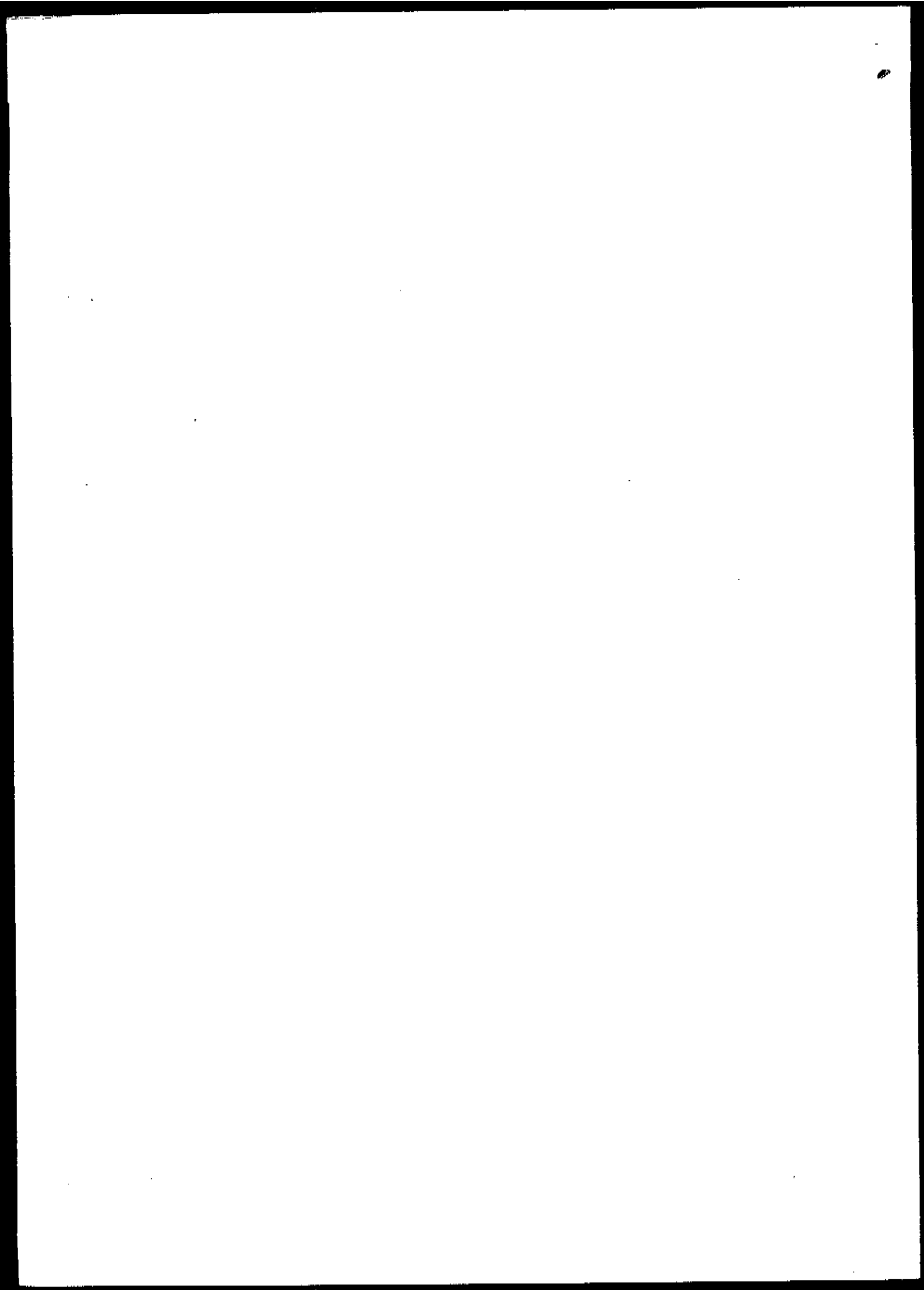
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QUALITY CONTROL STUDIES ON LEVELS OF PCBs, PCDDs AND PCDFs IN HUMAN MILK

Report on a WHO Consultation
Umeå, Sweden, 27-28 August 1987

English only

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1. Introduction

Within the project of the WHO Regional Office for Europe (WHO/EURO) on PCBs, dioxins and related compounds, a series of planning meetings, consultations and working groups have been organized jointly with other institutions and organizations in order to give advice and develop guidelines to minimize and control occupational and accidental exposure to these chemicals as well as to control and reduce their emissions into the environment. Furthermore numerous joint activities have been implemented within the project to evaluate and assess the possible health risks in infants associated with exposure to those chemicals through human milk.

A guideline document to prevent and control accidental exposure to PCBs, PCDDs and PCDFs is being issued by WHO/EURO in autumn 1987. The emissions of these chemicals from municipal sewage sludge and solid waste incinerators were discussed in depth by a working group held in Naples in March 1986. This was followed by an international seminar on emissions of trace organics from municipal solid waste incinerators, organized jointly by WHO/EURO and the International Solid Waste Association (ISWA) in Copenhagen in January 1987. The proceedings of this seminar have been published in the Journal of Waste Management and Research in September 1987.

Following the recommendations of the planning meeting on risk assessment in infants associated with exposure to PCBs, dioxins and related compounds held in Copenhagen in March 1986, a working group was organized in collaboration with the Regional Government of Venice in Abano Terme, Italy, in February 1987. The meeting based its discussion and evaluation on the most recently available research data on toxicity and health effects of these chemicals as well as on their exposure sources and levels, including exposure through human milk. It concluded among others that, based on the available exposure data, the intakes of PCBs, PCDDs and PCDFs during the nursing period are estimated to correspond to less than 5% of the lifetime intake. Primary preventive measures were recommended as the most effective way to eliminate emissions of these chemicals into the environment and thus to reduce exposure of the population. Breastfeeding should be encouraged and promoted on the basis of its well-proven benefits to the developing infant despite the presence of these chemicals in breast-milk at present exposure levels. Furthermore the meeting recommended that the studies should continue to produce more exposure and health effect data to improve risk assessment in infants, including analytical studies on levels in human milk and epidemiological studies on health effects in infants. In order to ensure the reliability and comparability of the results from the analytical studies, the meeting regarded it necessary to organize an interlaboratory quality control study between the participating laboratories.

Based on the above and other similar recommendations from earlier WHO/EURO meetings within this project, WHO/EURO started planning the analytical field studies and interlaboratory quality control study. A planning meeting was held in Lillestroem, Norway, in October 1986 to design the study protocol to be followed during the field studies in the participating countries. It also identified the coordinating institutions in each country. The protocol was then circulated to all countries with known or potential interest to seek their possible participation in the studies. In addition, the Lillestroem meeting confirmed the necessity of carrying out an

interlaboratory quality control study coordinated by WHO/EURO between the laboratories which would perform the milk analyses from the field studies, in order to ensure the reliability of the analytical results. Fifteen participating laboratories were identified and the laboratory headed by Professor C. Rappe at the University of Umeå, Sweden, was selected to coordinate the practical aspects of this study.

The present consultation was organized by WHO/EURO in order to evaluate and discuss the results of the above quality control study. It was hosted by the University of Umeå and financial support was received from the Swedish Government. The meeting was opened on behalf of the University by the Rector, Professor L. Beckman. Dr E. Yrjänheikki addressed the meeting on behalf of WHO/EURO. Professor C. Rappe was elected to chair the meeting and Dr J. Carlé to act as rapporteur. Twelve temporary advisers from the participating laboratories and two observers attended the meeting (Annex 1).

2. Scope and purpose

The present consultation discussed and evaluated the results of the WHO-coordinated quality control study based on a summary prepared by WHO/EURO. The results of the Nordic quality control study were also discussed. The applied analytical methodologies in the participating laboratories were evaluated thoroughly and necessary improvements were discussed. Necessary further activities to ensure the reliability and comparability of the results in future studies were also discussed. The meeting reviewed the present situation in the ongoing analytical field studies and discussed the needs for analytical services for certain of the participating countries, as well as other practical aspects concerned with storage and transport of the collected milk samples. The main output of the meeting was a summary of results from the participating laboratories and recommendations for further steps to ensure the validity of the analytical results of the field studies.

3. Results of the Nordic quality control study

The above study was sponsored by the Nordic Council of Ministers with participation of laboratories from Denmark, Finland, Norway and Sweden. Aliquots of the pooled milk sample were also sent to the collaborating laboratory in Switzerland and their results were included in the final report. The study was coordinated by the laboratory headed by Professor C. Rappe at the University of Umeå, Sweden, and was completed by February 1987. To be able to compare the results from the participating laboratories, aliquots of a pooled milk sample were distributed together with a mixture of ¹³C-labelled PCDD/PCDF congeners with given concentrations. The laboratories were asked to calculate recoveries of these labelled standards and the levels of the native compounds in the milk sample based on the given concentrations of labelled standards. All identified congeners of PCDD/PCDF present in human breast-milk were determined and included in the study report.

The summary presented by Dr J. Carlé showed that the results from two of the participating laboratories, which had been able to detect and report most of the PCDD/PCDF congeners present in human breast-milk, were in good agreement. However, the three remaining laboratories had various kinds of problems with their results, especially when analysing the low concentrations of 2,3,7,8-tetra CDD. Furthermore quite a number of the PCDD/PCDF congeners were not analysed/detected by these three laboratories.

A summary of this study has been prepared by the Nordic Council of Ministers and copies are available upon request from: Professor Bo Jansson, The National Environmental Protection Board, Special Analytical Laboratory, Box 1302, S-171 25 Solna, Sweden.

4. The WHO interlaboratory quality control study

4.1 Participating laboratories

According to the study protocol designed by the WHO planning meeting in Lillestroem in October 1986, the WHO interlaboratory quality control study was coordinated, and the practical aspects organized, by the laboratory headed by Professor C. Rappe at the University of Umeå, Sweden.

Two separate pools of human milk were collected by the coordinator and distributed together with the necessary standards to the participating laboratories for analysis. Altogether 15 laboratories were approached. PCDD and PCDF results were received from 12 laboratories and PCB results from six laboratories.

4.2 Reporting of results

The meeting agreed to accept the results from those laboratories which had reported them before the present meeting in Umeå. An exception was made in the case of one laboratory in view of their incomplete reporting, and the meeting agreed not to include their results in the summary. Taking this into account, the PCDD/PCDF results from 11 laboratories and PCB results from six laboratories were evaluated by the meeting and included in the summary.

Corrections in the reported results were accepted from three laboratories. They were accepted only because they were due to communication problems and typing errors in the summary. No corrections or additions were accepted due to results being obtained by analyses performed after reporting the results to WHO/EURO.

4.3 Summary of results

The list of the 11 participating laboratories whose PCDD/PCDF results were included in the summary, together with the names of responsible persons, is presented in alphabetical order of country in Annex 2. Annex 3 lists the laboratories which provided PCB results. The results were summarized by WHO/EURO and presented at the meeting by Dr E. Yrjänheikki. Annexes 4 and 5 summarize the means and ranges of PCDD/PCDF results in pools 1 and 2 respectively, presented by ppt on fat basis. Annexes 6 and 7 present the respective results in pq/g on whole milk basis. Annex 8 shows the PCB results in µg/g calculated on fat basis, and Annex 9 on whole milk basis.

Both the PCDD/PCDF and the PCB results were in good agreement between the laboratories. It was decided to use a good statistical method, for example that proposed by the Association of Official Analytical Chemists (AOAC) to further treat the data from this study for use in a subsequent scientific report. The outliers within the results from the individual laboratories should be eliminated only on the basis of such statistics and the final mean calculations should be based on these data. In the final scientific report both the whole milk and fat basis results should be reported. It was proposed that the statistical calculations should be applied only to the results on a whole milk basis.

The detection limit applied for individual methods was defined as signal/noise >3:1. For the mean value calculations half of the detection limit should be used in the cases where ND (not detected) was reported.

Since the figures of 1,2,3,7,8,9-hexa CDF and 1,2,3,4,7,8,9-hepta CDF were in most of the results under the detection limit, it was decided to delete these data from the final scientific report.

The differences in the response factors between the ^{12}C - and ^{13}C -labelled congeners were considerable, especially in relation to PCDDs. This would have to be taken into consideration when interpreting older results but due to the design of the present study this problem has no practical relevance. It was agreed that the distributed ^{12}C -labelled standards were in accordance with the laboratory standards used. The problem of ^{13}C -labelled congeners, especially PCDDs, has to be solved before future studies.

4.4 Applied methodologies

In principle the applied methodologies for analysing PCDDs and PCDFs were similar, with only slight differences in applied chemicals and in ratios of cleaning solvent mixtures used. The fat content was in most cases determined by addition of sodium oxalate followed by solvent extraction, using a procedure similar to the AOAC method for pesticide residues in milk.

Clean-up of milk samples for PCDD/PCDF analyses was performed by liquid chromatography with carbon, silica gel, alumina columns and various liquids, with slight differences between laboratories, the majority referring to Smith *et al* in *Analytical Chemistry* (1984). The final quantification was made by high performance gas chromatography/mass spectrometry instrumentation with either quadrupole systems or high resolution magnetic instruments. All applied methodologies were considered acceptable and can be used in future analyses of human milk samples.

The whole procedure is very complex and time-consuming and it was therefore considered important to improve and develop new and more time-saving clean-up techniques for milk analyses. Improvements are also needed in analyses of fat content in view of the rather large variations in the results. This is particularly important because the analytical data on fat basis is used to calculate the daily intakes in infants.

All participating laboratories used in principle the same methodology for PCB analyses including GC-separation of isomers and electron capture detection technique for quantification of results. This methodology can be improved by developing routine analyses including more isomer-specific quantification. Which of the isomers should be identified and quantified depend on their importance from the toxicological point of view and on what levels are found in milk.

4.5 Future activities in the WHO quality control study

Because of the differences in the response factors between ^{12}C - and ^{13}C -labelled standards, it was agreed that the study coordinator, Professor C. Rappe, will forward new ^{13}C -labelled standards to all participating laboratories in a few months.

It was considered necessary to organize a second round of the quality control study to take place in late 1988, again coordinated by WHO/EURO. All interested laboratories are invited to participate. Professor Rappe will coordinate the practical aspects and the pooled milk samples are to be distributed tentatively in September 1988. A similar study will in principle be repeated every second year from 1988 onwards.

PCB analysis will also be included in future quality control studies.

Brominated dioxins and furans have not so far been indicated as being a problem in human breast-milk, so they will not be included in the further studies. Polychlorinated terphenyls (PCTs) and polychlorinated naphthalenes (PCNs) have been identified in human milk samples. Whether or not these chemicals will be included in future quality control studies will depend on their interest from a toxicological point of view.

4.6 Modification of design of the WHO quality control study

In future interlaboratory studies the design applied in the present study will be followed in principle. The following changes were agreed upon:

- The coordinating laboratory will not participate if spiked or diluted samples are analysed.
- Pooled milk samples with PCDD/F levels different from each other will be used.
- Spiking levels of ^{13}C -labelled isomers of 0.5 ppt and 3.0 ppt on 150 ml samples will be used instead of the 0.1 and 1.0 ppt levels used in the present studies.
- The coordinating laboratory is responsible for the delivery of adequate standards which have been controlled and analysed before distribution (normally the ^{13}C -standards need correction).
- Syringe-spikes should be added to the extract by the participating laboratory if the recoveries are to be reported.
- For analytical and toxicological reasons, analysis of additional PCB isomers should be considered when performing further control studies.
- Time is needed after submission of the results to WHO/EURO in order to make possible corrections before the results of the other laboratories are forwarded to all laboratories (e.g. 1 month). After this deadline, no corrections or additions will be permitted.
- Results should be reported on both fat and whole milk basis. The fat content should also be reported.
- It should not be mandatory to report the recovery figures.
- It is not necessary to forward the chromatograms to the coordinating laboratory, but this information should be available on request.

4.7 Publication of results of the present WHO quality control study

The results of the present quality control study will be presented at the "Dioxin 87" symposium in Las Vegas in October 1987 by Professor Rappe. In the presentation the participating laboratories will be identified by name and persons responsible. However, the relation between results and laboratories will not be presented.

A paper based on the presentation at the Las Vegas meeting will be published in Chemosphere. This will be prepared by WHO/EURO together with Professor Rappe. It will be circulated in advance to the participants of the present meeting. The authors will be WHO/EURO and Professor Rappe.

The report of the study will also be submitted to Analytical Chemistry. The draft will be prepared by WHO/EURO, Dr Carlé and Professor Rappe. All the participating laboratories will be authors. The first draft will be circulated to the authors by the end of 1987. In addition to the above publication, the results of the study, together with the results of the ongoing analytical field studies in the participating countries, will appear as a document in the Environmental Health Series of WHO/EURO.

5. Overview of present situation in analytical field studies in participating countries

5.1 Austria

Collection of milk samples from 20 mothers from an urban area and 36 mothers from a rural area is being carried out by Dr F. Haschke of the Vienna University Children's Clinic. Questionnaires from mothers are available. PCBs will be analysed by their own laboratory but analytical service is needed for PCDDs/PCDFs. Samples will be pooled and, following preliminary discussions, sent to Professor Rappe for PCDD/PCDF analysis. Results will be available by November 1987.

5.2 Belgium

Altogether 116 individual samples have been collected from the northern part of Belgium by Dr H. Beernaert of the Institute of Hygiene and Epidemiology, Brussels. Questionnaires from donors are available. The concentrations of PCBs and organochlorinated pesticides will be determined by their own laboratory. Analytical service for PCDD/PCDF determinations is needed.

5.3 Canada

Over 400 individual milk samples have been collected from five different geographic areas of Canada. All samples will be analysed for PCBs by Dr J. Mes of Health and Welfare Canada. About 100 samples have been selected for PCDD/PCDF analysis. They will be analysed partly on individual and partly on pool bases. Possible high exposure groups will be identified and analysed separately. Analysis of both PCBs and PCDDs/PCDFs has been started by Dr Ryan and is estimated to be completed by late 1988. However some new data will already be available on these studies by the end of 1987. Questionnaires from mothers are available.

5.4 Denmark

Individual samples from 10 mothers and a pool containing 43 samples have been collected. PCDDs/PCDFs, PCBs and chlorinated pesticides will be analysed by Dr J. Carlé of the National Agency for Environmental Protection by the end of September 1987. Questionnaires from mothers are available.

5.5 Finland

Individual samples from 96 mothers from Helsinki and 98 from Kuopio have been collected by Dr T. Vartiainen of the National Public Health Institute. About 35 primiparae were identified in both these groups. The samples will be pooled and analyses carried out by Dr A. Hesso of the Institute of Occupational Health by the end of October 1987. Questionnaires were completed and will be analysed.

5.6 Germany, Federal Republic of

Nearly 300 individual milk samples have so far been analysed from mothers resident in the Federal Republic of Germany. Thirty individual milk samples have been collected from mothers with supposedly different exposure levels by Dr W. Mathar of the Federal Health Office. Questionnaires were completed. Samples will be analysed soon and the results presented at the Las Vegas meeting in October 1987.

About 200 individual samples will be analysed by the end of November 1987 by Dr P. Fürst of the Federal State Control Laboratory for Food and Environmental Chemistry of Northrhine-Westphalia. Questionnaires from most of the mothers are available.

About 20 additional individual samples have also been analysed by Dr M. Ende of the Laboratory for Food Control of the State of Lower Saxony in Oldenburg.

5.7 Israel

Milk samples are currently being collected by Ms E. Akstein of the Ministry of Health. PCBs will probably be analysed by a local laboratory but analytical service is needed for PCDDs/PCDFs. The first results should be available by January 1988.

5.8 Italy

At present three laboratories in Milan, Rome and Ispra are implementing local quality control studies by using the same pools as in the present WHO study. Collection of milk samples for the field studies in the Florence and Pavia regions has been started during the summer of 1987 and analyses of some of these samples will be carried out by the end of 1987 as a preliminary exercise. All Italian laboratories will take part in the second round of the WHO quality control study in late 1988. Analysis of the collected milk samples can be started after completion of this second round.

5.9 Netherlands

About 300 individual samples will be collected by Dr R. Wegman of the National Institute of Public Health and Environmental Hygiene, by the end of

1987 and analysed for PCBs in the early part of 1988. The results will be compared with data from 1983. These 300 samples will be pooled for PCDD/PCDF analyses. Each pool will consist of 10 individual samples from lactating mothers collected at health care centres, thus forming 30 pools from different cities throughout the country. The results will be available by September/October 1988.

About 30 individual samples have been collected by Dr K. Olie of the University of Amsterdam and will be analysed by the end of October 1987. Questionnaires are available.

5.10 New Zealand

Collection of pooled milk samples has been completed by Dr D. Hannah of the Department of Scientific and Industrial Research. The analyses of PCBs and PCDD/PCDFs will be completed by the end of 1987.

5.11 Norway

Individual samples from 30 mothers have been collected and questionnaires are available. Analyses will be completed and data available by November 1987.

5.12 Poland

Collection of milk samples will be started in April 1988. PCBs can be analysed by a local laboratory but for PCDDs/PCDFs analytical service is necessary.

5.13 Sweden

Individual samples from 30 mothers have been collected from three different areas in Sweden. Questionnaires from mothers are available. Ten further samples will be collected from a fourth area. Samples will be analysed by Professor Rappe of the University of Umeå and results will be available by the end of October 1987.

5.14 United Kingdom

It has been agreed that the Department of Health and Social Security will obtain human milk samples according to the WHO study protocol for analysis by Dr J. Startin of the Ministry of Agriculture, Fisheries and Food. Arrangements for milk collection have suffered some delays due to difficulties concerning ethical considerations and practical arrangements. It is still intended to participate in the studies but samples are unlikely to be available for analysis before the deadline agreed at the Lillestrom meeting.

5.15 United States of America

The Centers for Disease Control (CDC), Atlanta, has an ongoing scientific study to determine the correlation on levels of PCDDs/PCDFs between adipose tissue and serum. Another study recently completed aimed to determine the half-life of 2,3,7,8-tetra CDD using selected Vietnam veterans as the study population. The preliminary results indicate a half-life of about 7.1 years. CDC has no plans to start human milk analyses in future. New analytical data from USA on levels of PCDDs/PCDFs in human milk will be available by the end of 1987 from the studies coordinated by Dr A. Schecter.

5.16 Yugoslavia

Collection of milk samples has been completed from two geographical areas by Dr E. Reiner of the Institute for Medical Research and Occupational Health. PCBs will be analysed at the Institute's laboratory. Samples will be pooled and sent for PCDD/PCDF analyses by October 1987. Tentative agreement has been reached to use Professor Rappe's laboratory for these analyses.

Based on the above overview of the present situation in the analytical field studies, most of the new data will be available by the end of 1987. For this reason the meeting proposed postponement of the next meeting to evaluate these results until the second half of January 1988 (tentatively 28-29 January in Copenhagen).

6. Present situation in other countries

6.1 Hungary

Although official confirmation has not yet been received from the Government concerning participation of Hungary in the study, information was received from Dr Hesso, Helsinki, that two pools of human milk have been collected by Dr A. Czeizel of the National Institute of Hygiene, Budapest. PCB analyses will be carried out by their own laboratory and samples for PCDD/PCDF analyses will be sent to Dr Hesso. Results will be available by the end of 1987.

6.2 Switzerland

At present there are no plans to start collecting samples. Dr H. Buser of the Swiss Federal Research Station, Wädenswil, will convey the interest of WHO/EURO in Swiss participation in the second round of the WHO quality control study to the authorities in Switzerland.

7. Analytical service

All participating countries can perform the analyses of PCBs in milk samples in their local laboratories. However, certain countries do not have laboratory facilities capable of performing PCDD/PCDF analyses as discussed in section 5. above. The laboratories which participated and qualified in the present WHO quality control study, confirmed their willingness to give analytical service to other countries. It was left up to each country to discuss and agree on the details with the laboratory of their choice. WHO/EURO will approach the countries which need this service and give them the above information.

8. Transport and storage of milk samples

In certain cases it is known that problematic vial sealing has caused severe contamination of the milk samples. In order to avoid these problems the instructions, which were discussed thoroughly during the Lillestroem meeting and included in the report, should be followed very carefully. The present meeting also discussed the problems concerning storage of deep-frozen milk samples and concluded that no noticeable changes have been found in the contents of samples kept frozen for a period of several months. When sending the samples by air it is advisable to mark the package carefully as described in the Lillestroem report (p. 17) and also to add the flight number in addition to the airwaybill number.

9. Conclusions and recommendations

9.1 Based on the discussion and evaluation of the results from the participating laboratories on levels of PCBs, PCDDs and PCDFs in human milk, the meeting concluded that, as far as the general levels are concerned, there is good agreement between results from all laboratories. Agreement is less good for individual isomers. On this basis these laboratories are qualified to perform the analysis of human milk samples collected during the ongoing WHO-coordinated field studies as well as in other relevant exercises in future.

9.2 The analytical methodologies, including purification, separation and quantification, applied by the participating laboratories were in principle considered acceptable and can be used for further analyses of milk samples.

9.3 It is recommended that the analyses of PCBs, PCDDs and PCDFs in human milk should only be performed by those laboratories whose methodology has qualified by participating in the present WHO quality control study or another similar study.

9.4 The meeting regarded it very important to organize interlaboratory quality control studies to ensure the reliability and comparability of the results and recommended that similar studies to be coordinated by WHO/EURO should be organized every second year from 1988 onwards, the next round to commence in late 1988.

9.5 It is recommended that WHO/EURO approach all known and potentially interested laboratories to ascertain their willingness to participate in the above second round of the quality control study.

9.6 It is recommended that future quality control studies include both PCBs and PCDDs/PCDFs.

9.7 In future quality control studies it is recommended that the results are calculated on both fat basis and whole milk basis.

9.8 It is recommended to develop methodologies to quantify more individual isomers of PCBs in human milk. Which isomers should be identified depend on their presence in human milk and toxicity to humans. A proposal should therefore be made by experts in toxicology.

9.9 If new studies on levels of other chemicals in human milk are planned (e.g. PCTs, PCNs), it is recommended that relevant interlaboratory quality control studies between laboratories should be carried out before starting the actual field studies.

9.10 The procedure used at present for analysis of PCDDs and PCDFs is regarded as being very complex with possibilities of error and contamination, as well as being very time-consuming and expensive. It is therefore recommended that more simple and time-saving methods, especially for the clean-up procedure, should be developed.

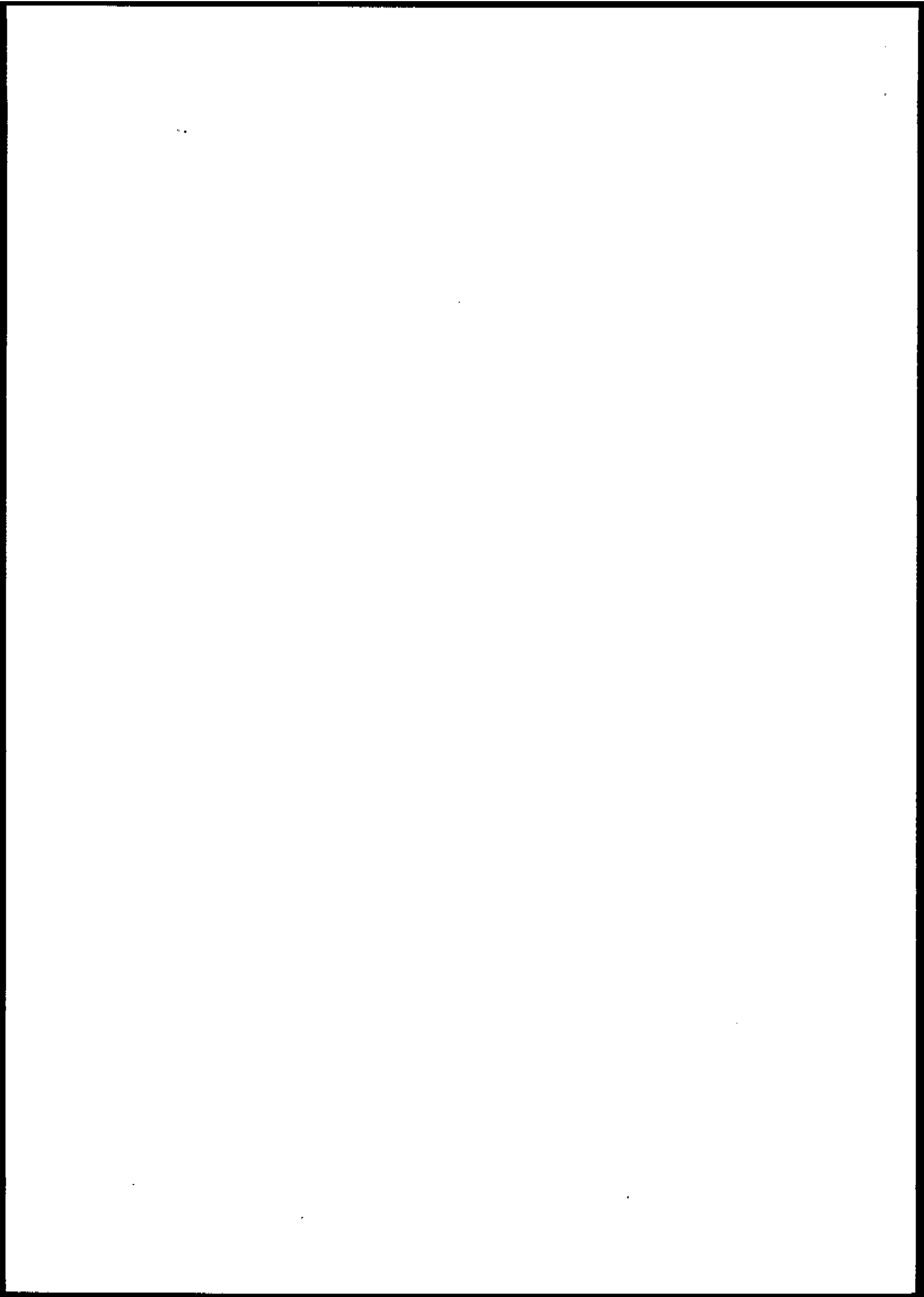
9.11 Improvements are also recommended for analyses of fat content in human milk since intake calculations in infants are based on these data.

9.12 When sending and storing milk samples it is recommended to follow very carefully the instructions given in the report of the Lillestroem meeting.

9.13 It is recommended that the results of the present interlaboratory quality control study be presented at the international congress "Dioxin 87" in Las Vegas in October 1987 and subsequently submitted to an analytical journal (Analytical Chemistry).

9.14 The report of this meeting should be circulated by WHO/EURO to the laboratories and institutions participating in the ongoing human milk field studies and to all other institutions/organizations with a known interest in such studies.

9.15 The activities planned within the WHO/EURO project on PCBs, PCDDs and PCDFs should be continued in order to prevent the emission of these chemicals into the environment and to produce more analytical, toxicological and health-effect data for improvement of risk assessment of health effects in infants associated with contamination of human milk.



LIST OF PARTICIPANTS

TEMPORARY ADVISERS

Dr J. Carlé (Rapporteur)
Head of Laboratory
National Agency for Environmental
Protection
Department of Analytical Chemistry
Moerkhoej Bygade 26
DK-2860 Soeborg
Denmark

Dr S. Facchetti
Head of Radiochemistry Division
CEC Joint Research Centre
Ispra Establishment
210210 Ispra (Varese)
Italy

Dr P. Fürst
Chemisches Landesuntersuchungsamt
Nordrhein-Westfalen
Sperlichstr. 19
D-4400 Münster
Federal Republic of Germany

Dr A. Hesso
Institute of Occupational Health
Haartmaninkatu 1
SF-00290 Helsinki 29
Finland

Mr A. de Jong
Head, Division of Molecule
Spectroscopy
National Institute of Public Health
and Environmental Hygiene
P.O. Box 1
3720 BA Bilthoven
Netherlands

Dr W. Mathar
Wissenschaftlicher Oberrat
Bundesgesundheitsamt
Postfach 330013
Berlin (West)

Dr L.L. Needham
Chief, Toxicology Branch
Division of Environmental Health
Center for Environmental Health
Centers for Disease Control
1600 Clifton Road
Atlanta, GA 30333
USA

Dr M. Oehme
Norwegian Institute for Air Research
Elvegaten 52
Postboks 130
N-2001 Lillestrom
Norway

Dr K. Olie
Laboratory of Environmental and
Toxicological Chemistry
University of Amsterdam
Nieuwe Achtergracht 166
1018 WV Amsterdam
Netherlands

Professor C. Rappe (Chairman)
Department of Organic Chemistry
University of Umeå
S-901 87 Umeå
Sweden

Dr J.J. Ryan
Food Research Division
Health and Welfare Canada
Health Protection Branch
Tunney's Pasture
Ottawa, Ontario K1A 0L2
Canada

Dr J.R. Startin
Organic Contaminants Dept
Ministry of Agriculture, Fisheries
and Food
Food Science Laboratory
Haldin House
Queen Street
Norwich NR2 4SX
United Kingdom

OBSERVERS

Dr H.R. Buser
Eidgenössische Forschungsanstalt für
Obst, Wein und Gärtenbau
Section for Plant Protection
CH-8820 Wädenswil
Switzerland

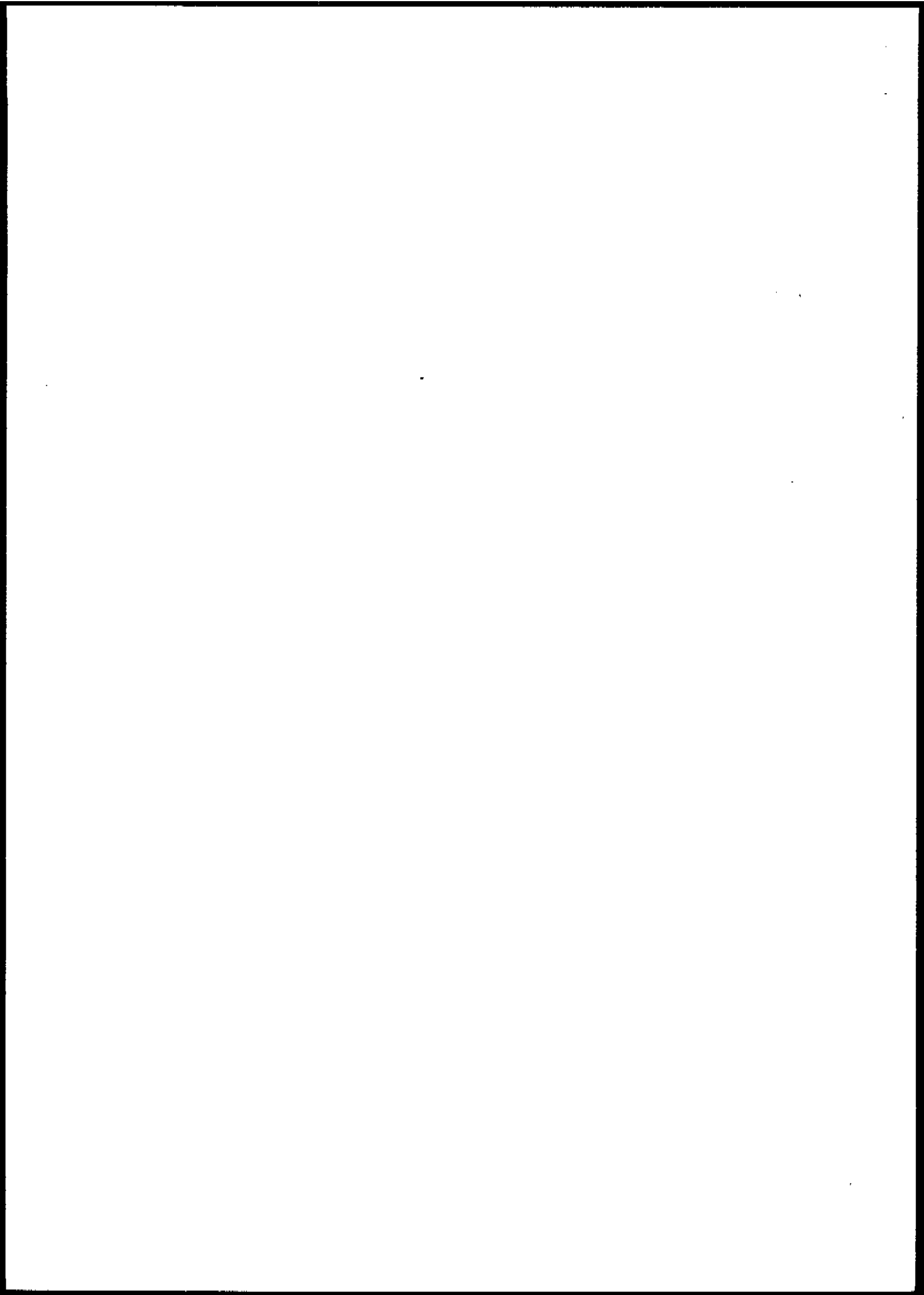
Dr G. Lindström
Department of Organic Chemistry
University of Umeå
S-901 87 Umeå
Sweden

WORLD HEALTH ORGANIZATION

Regional Office for Europe

Dr E. Yrjänheikki
Consultant for Special Toxicological Studies

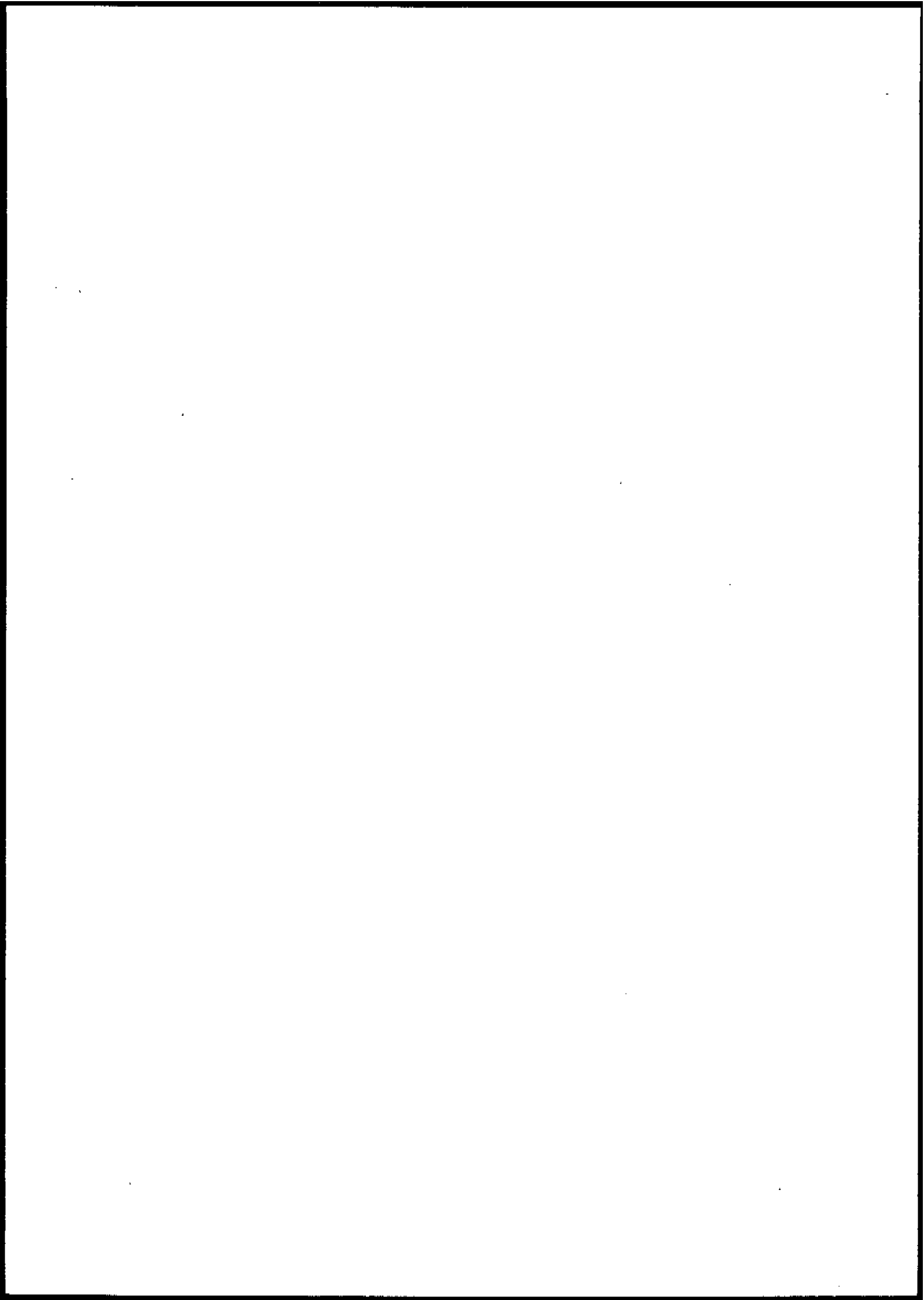
Support staff: Ms P.A. Christensen
Senior Secretary, Toxicology and Occupational Health



LIST OF LABORATORIES WHICH REPORTED PCDD/PCDF RESULTS¹

<u>Country</u>	<u>Contact Person</u>	<u>Institution</u>
Canada	Dr J.J. Ryan	Food Research Division Health and Welfare Canada Ottawa
Finland	Dr A. Hesso	Institute of Occupational Health Helsinki
Germany, Federal Republic of	Dr P. Fürst	Chemisches Landesuntersuchungs- amt Nordrhein-Westfalen Münster
	Dr W. Mathar	Max von Pettenkofer-Institut Federal Health Office Berlin (West)
Netherlands	Dr K. Olie	Laboratory of Environmental and Toxicological Chemistry University of Amsterdam
	Dr R.C. Wegman	Department of Industrial Contaminants Laboratory of Organic Chemistry National Institute of Public Health and Environmental Hygiene, Bilthoven
Norway	Dr M. Oehme	Norwegian Institute for Air Research, Lillestroem
Sweden	Professor C. Rappe	Department of Organic Chemistry University of Umeå
United Kingdom	Dr J.R. Startin	Ministry of Agriculture, Fisheries and Food Food Science Laboratory, Norwich
United States of America	Dr L.L. Needham	Center for Environmental Health Centers for Disease Control Atlanta
	Dr R.D. Stephens	Hazardous Material Laboratory Department of Health Services Berkeley

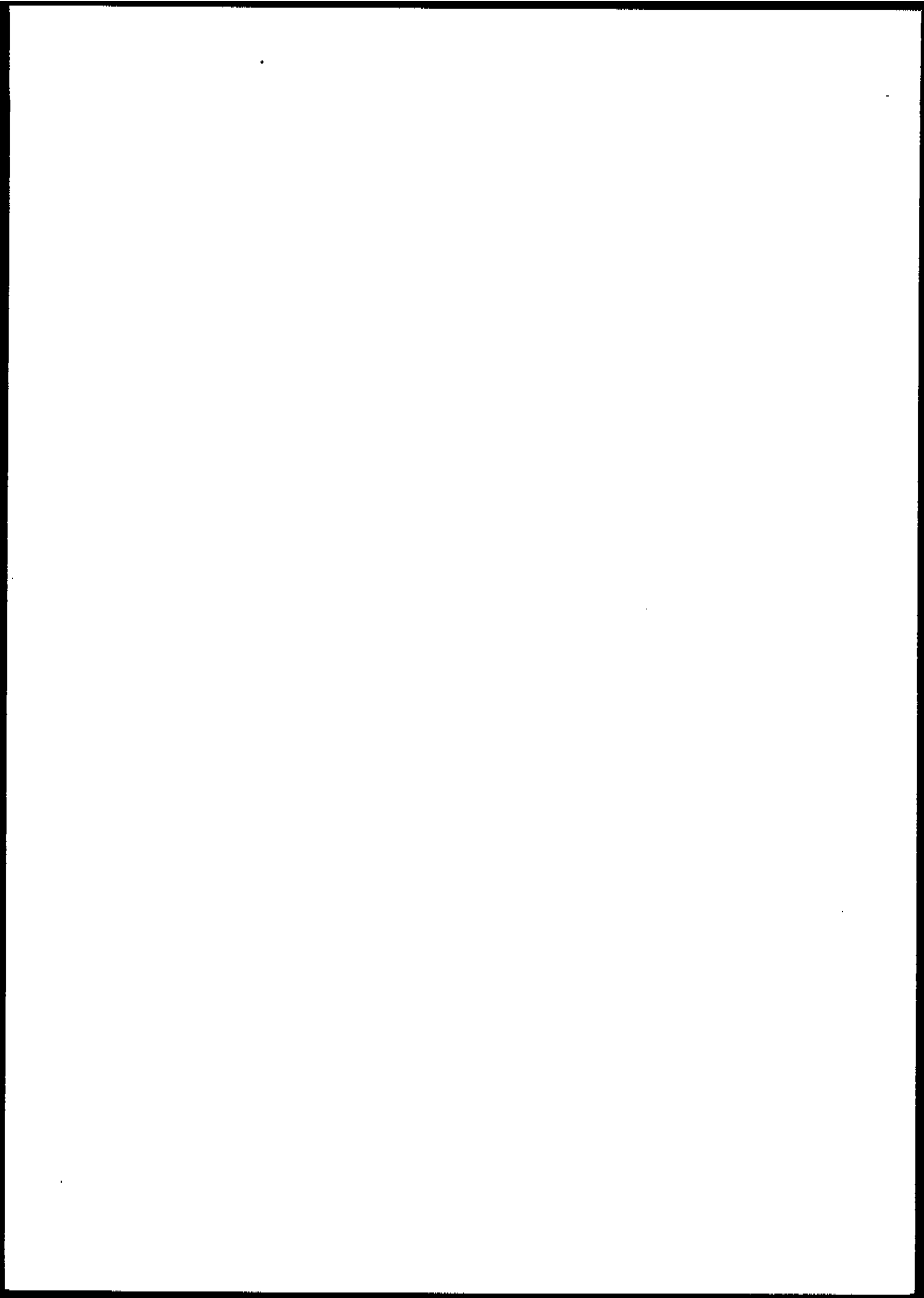
¹ see Annex 10 for full addresses



LIST OF LABORATORIES WHICH REPORTED PCB RESULTS¹

<u>Country</u>	<u>Contact Person</u>	<u>Institution</u>
Canada	Dr J.J. Ryan	Food Research Division Health and Welfare Canada Ottawa
Finland	Dr A. Hesso	Institute of Occupational Health, Helsinki
Germany, Federal Republic of	Dr P. Fürst	Chemisches Landesuntersuchungsamt Nordrhein-Westfalen, Münster
	Dr W. Mathar	Max von Pettenkofer-Institut Federal Health Office Berlin (West)
Netherlands	Dr R.C. Wegman	Department of Industrial Contaminants Laboratory of Organic Chemistry National Institute of Public Health and Environmental Hygiene, Bilthoven
United States of America	Dr L.L. Needham	Center for Environmental Health Centers for Disease Control Atlanta

¹ see Annex 10 for full addresses



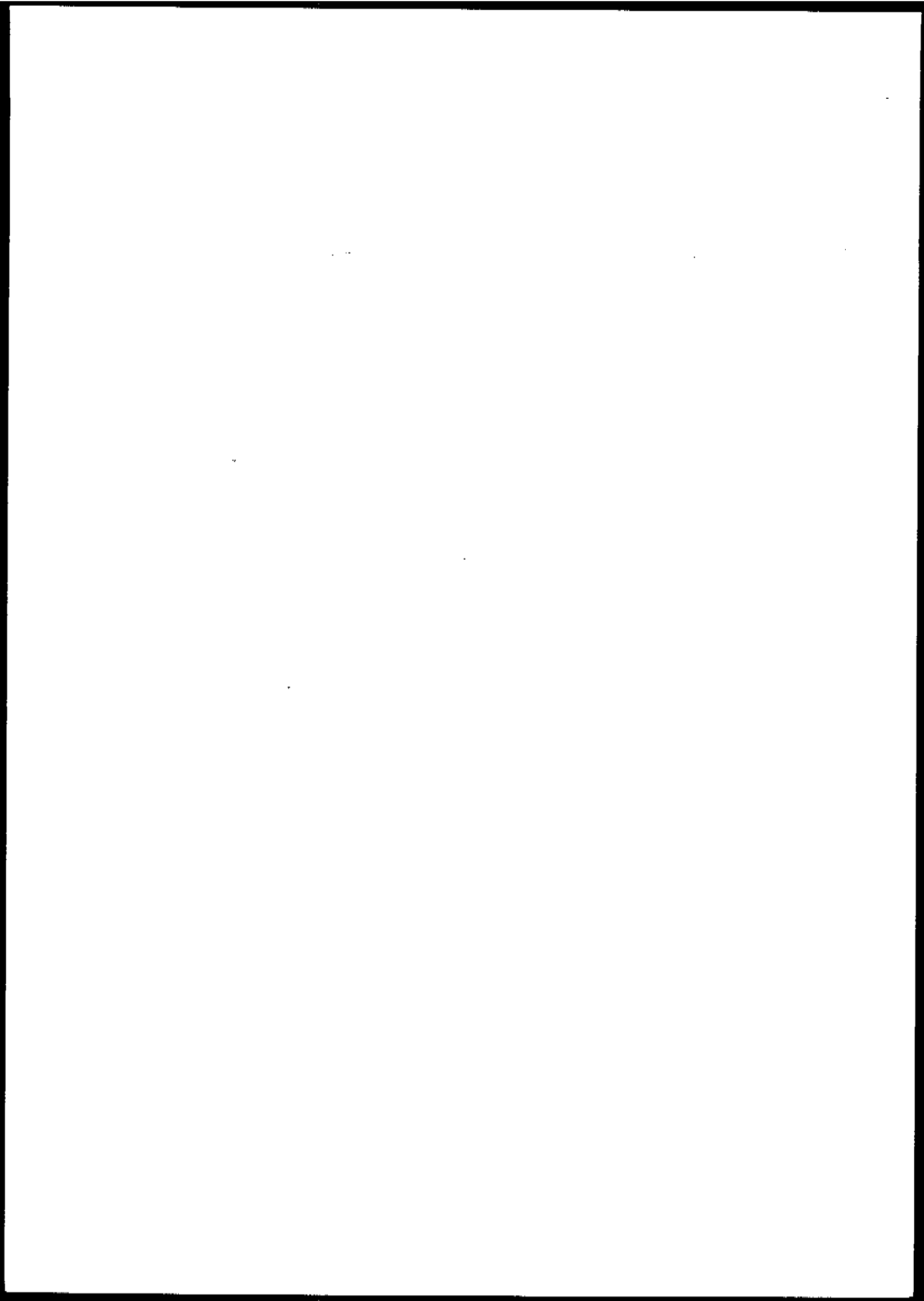
DIOXINS AND FURANS IN HUMAN MILK
POOL 1 (ppt on fat basis)

Laboratory	1	2	3	4	5	6	7	8	9	10	11	Mean	Range
<u>Congeners</u>													
<u>Dioxins</u>													
2,3,7,8 tetra	3.3	2.2	3.1	4.6	4.6	4.5	4.0	5.1	10.6	3.2	NA	4.5	2.2-10.6
1,2,3,7,8 penta	9.1	4.4	1.2	8.1	8.7	10.1	7.9	9.4	10.2	5.9	8.0	7.5	1.2-10.2
1,2,3,4,7,8 hexa	3.6	2.3	<3.0	3.3	2.7	3.9	6.8	4.4	3.2	0.8	3.6	3.3	0.8-6.8
1,2,3,6,7,8 hexa	24	20	23	29	32	38	21	35	40	22	25	28	20-40
1,2,3,7,8,9 hexa	9.5	4.4	8.0	7.3	6.3	1.5	8.0	8.5	6.5	5.7	4.9	6.4	1.5-9.5
1,2,3,4,6,7,8 hepta	65	37	36	57	67	49	41	76	66	54	190*	55	36-76
octa	194	142	144	228	290	58	499	286	281	191	722*	231	58-499
<u>Furans</u>													
2,3,7,8 tetra	3.4	1.5	0.9	4.7	3.6	5.1	32*	3.7	13.7	2.5	9.9	4.9	0.9-13.7
1,2,3,7,8 penta	0.8	0.4	0.3	<2.0	1.1	0.6	2.5	0.9	5.1*	<1.0	<1.8	0.9	0.3-2.5
2,3,4,7,8 penta	23	13	7.4	28	23	22	24	25	25	16	27	21	7.4-27
1,2,3,4,7,8 hexa	3.5	2.8	<3.0	5.4	5.2	3.6	5.4	5.3	5.0	2.7	7.0	4.3	2.7-7.0
1,2,3,6,7,8 hexa	2.4	2.5	<2.0	3.7	3.5	2.9	3.4	4.1	5.5	2.3	4.3	3.2	<2.0-5.5
2,3,4,6,7,8 hexa	2.1	0.8	<1.0	1.9	2.1	<1.5	2.4	1.9	2.6	1.0	<0.4	1.5	<0.4-2.7
1,2,3,4,6,7,8 hepta	5.5	3.6	9.9	7.1	6.9	9.7	32*	8.2	14.0	6.2	37*	7.9	3.6-14.0
octa	1.3	<5.0	1.6	1.9	<3.0	13.6*	<3.0	1.9	5.6	<3.0	76*	1.9	1.3-5.6
Fat content %	2.6	2.7	2.5	2.0	2.2	2.5	2.8	2.0	2.6	2.8	2.3	2.4	2.0-2.8

NA = Not analysed

* = results not included in mean calculations

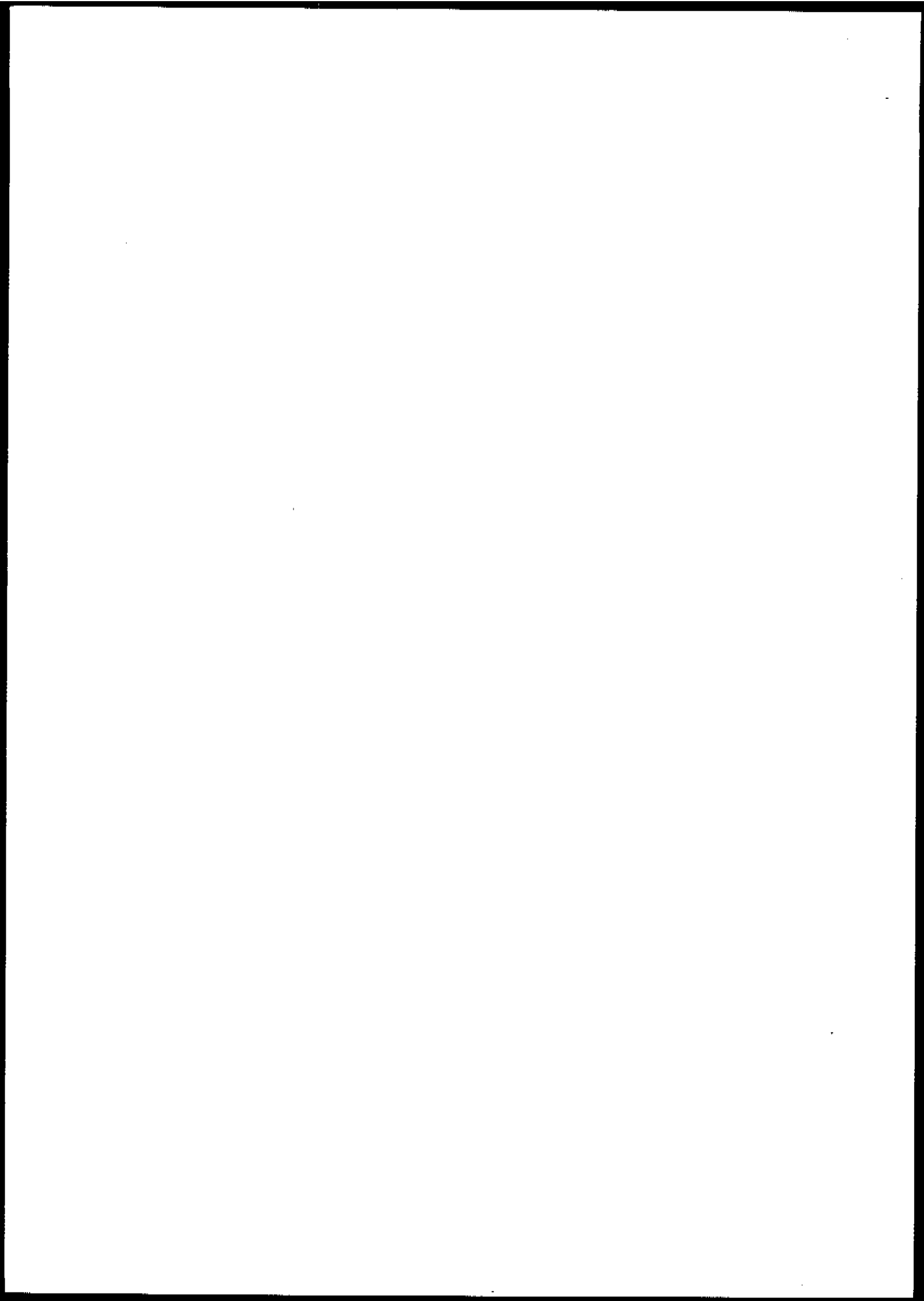
< = informed detection limit; half of this value used in mean calculations



DIOXINS AND FURANS IN HUMAN MILK
POOL 2 (ppt on fat basis)

Laboratory	1	2	3	4	5	6	7	8	9	10	11	Mean	Range
Congeners													
Dioxins													
2,3,7,8 tetra	3.3	2.2	NA	4.8	4.1	4.9	2.9	3.7	7.8	3.1	NA	4.1	2.2-7.8
1,2,3,7,8 penta	8.0	4.2	1.3	9.3	7.6	8.7	6.6	7.5	11.0	8.5	8.1	7.3	1.3-11
1,2,3,4,7,8 hexa	3.9	1.7	<3.0	4.4	2.2	3.8	3.5	2.9	1.2	4.3	2.9	2.9	1.2-4.4
1,2,3,6,7,8 hexa	23	17	15	33	35	43	20	32	43	28	32	29	17-43
1,2,3,7,8,9 hexa	8.6	3.5	5.0	8.1	4.7	1.9	5.1	7.1	4.7	3.2	7.6	5.4	1.9-8.6
1,2,3,4,6,7,8 hepta	55	33	33	59	63	44	28	59	49	38	390*	46	28-63
octa	173	128	123	306	255	59	411	232	214	188	610	245	59-610
Furans													
2,3,7,8 tetra	3.0	1.5	0.7	5.2	3.2	4.0	35*	3.1	4.4	2.8	7.5	3.5	0.7-7.5
1,2,3,7,8 penta	0.7	0.2	0.7	<2.0	1.3	0.7	2.4	0.8	1.1	0.8	<2.0	1.1	0.2-2.4
2,3,4,7,8 penta	24	12	11.7	34	26	22	22	23	19	17	30	20	11.7-34
1,2,3,4,7,8 hexa	4.3	3.3	<3.0	8.8	7.9	4.4	6.1	6.0	4.3	5.0	8.7	5.5	<3.0-8.8
1,2,3,6,7,8 hexa	2.7	2.7	<2.0	5.7	4.5	2.8	4.1	4.4	4.8	3.3	5.6	3.8	<2.0-5.7
2,3,4,6,7,8 hexa	2.4	1.2	<1.0	2.7	2.5	<1.5	3.7	1.8	0.8	1.6	<0.2	1.6	<0.2-3.7
1,2,3,4,6,7,8 hepta	5.5	4.5	2.1	9.1	8.9	9.1	25*	8.3	9.4	7.7	15	7.1	2.1-15
octa	1.0	<5.0	0.6	1.7	<3.0	9.3*	<3.0	1.5	2.2	1.2	38*	1.4	0.6-2.2
Fat content %	2.5	2.6	2.5	1.5	2.1	2.6	2.6	2.2	2.6	2.5	2.2	2.3	1.5-2.6

NA = Not analysed
* = results not included in mean calculations
< = informed detection limit; half of this value used in mean calculations

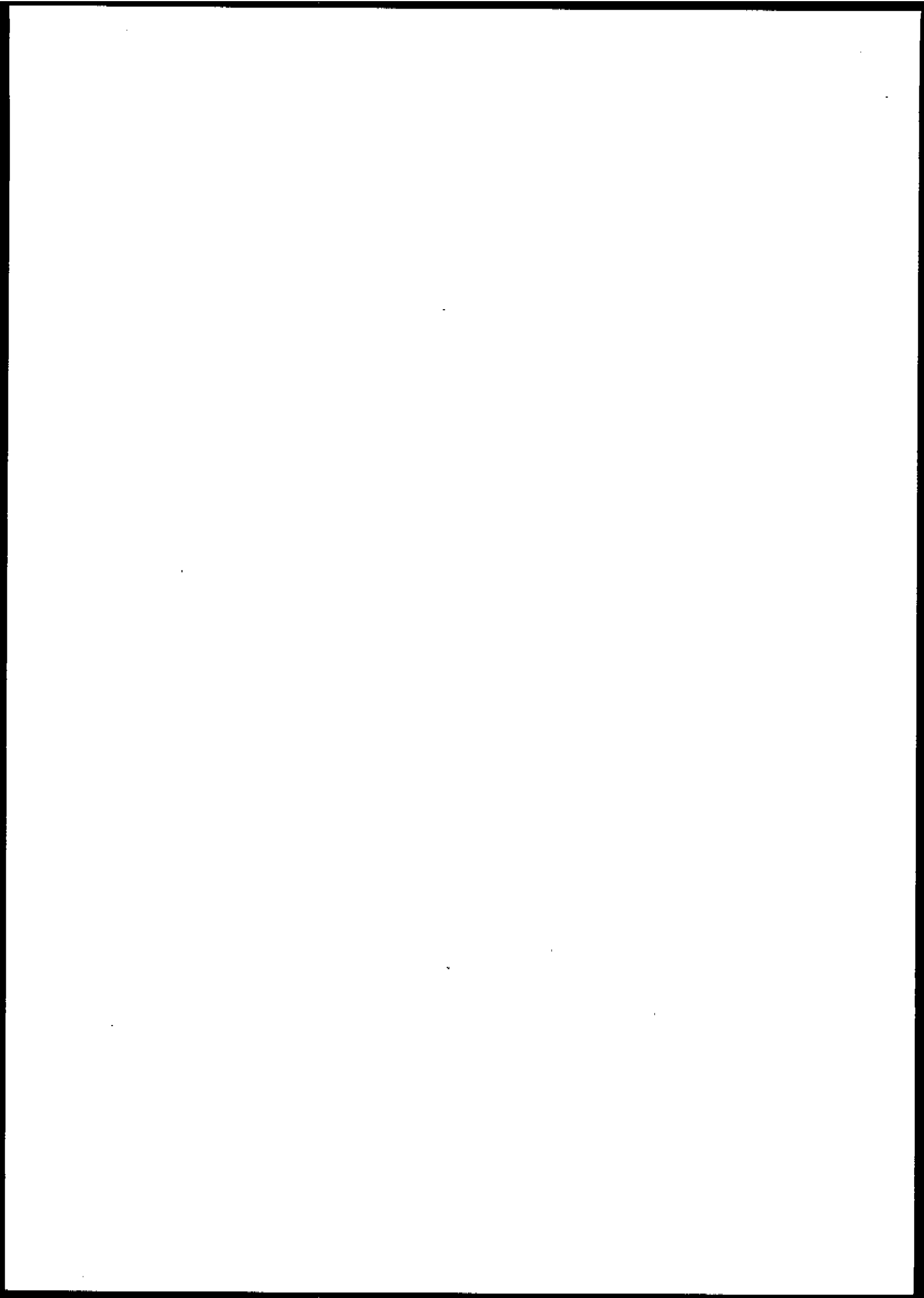


DIOXINS AND FURANS IN HUMAN MILK
POOL 1 (pg/g on whole milk basis)

Laboratory	1	2	3	4	5	6	7	8	9	10	11	Mean	Range
<u>Congeners</u>	:	:	:	:	:	:	:	:	:	:	:	:	:
<u>Dioxins</u>	:	:	:	:	:	:	:	:	:	:	:	:	:
2,3,7,8 tetra	0.086	0.059	0.068	0.092	0.123	0.113	0.112	0.102	0.276	0.090	NA	0.112	0.059-0.276
1,2,3,7,8 penta	0.24	0.12	0.030	0.16	0.19	0.25	0.22	0.19	0.26	0.17	0.18	0.183	0.030-0.26
1,2,3,4,7,8 hexa	0.094	0.062	<0.075	0.066	0.059	0.098	0.190	0.088	0.083	0.022	0.083	0.080	0.022-0.190
1,2,3,6,7,8 hexa	0.62	0.54	0.51	0.58	0.70	0.95	0.59	0.70	1.04	0.62	0.58	0.53	0.51-1.04
1,2,3,7,8,9 hexa	0.25	0.12	0.18	0.15	0.14	0.04	0.22	0.17	0.16	0.16	0.11	0.15	0.04-0.25
1,2,3,4,6,7,8 hepta	1.69	1.00	0.90	1.14	1.47	1.23	1.15	1.52	1.72	1.51	4.37*	1.33	0.90-1.72
octa	5.04	3.83	3.60	4.56	6.38	1.45	13.79	5.72	7.31	5.35	16.60*	5.70	1.45-13.79
<u>Furans</u>	:	:	:	:	:	:	:	:	:	:	:	:	:
2,3,7,8 tetra	0.088	0.041	0.023	0.094	0.079	0.128	0.90*	0.074	0.356	0.070	0.228	0.118	0.023-0.356
1,2,3,7,8 penta	0.021	0.011	0.008	<0.040	0.024	0.015	0.070	0.018	0.13	<0.03	<0.04	0.022	0.008-0.070
2,3,4,7,8 penta	0.60	0.35	0.19	0.56	0.51	0.55	0.67	0.50	0.65	0.45	0.62	0.51	0.19-0.67
1,2,3,4,7,8 hexa	0.091	0.076	<0.075	0.108	0.114	0.090	0.078	0.106	0.130	0.076	0.161	0.097	<0.075-0.161
1,2,3,6,7,8 hexa	0.062	0.068	<0.05	0.074	0.077	0.073	0.095	0.082	0.143	0.064	0.099	0.078	<0.05-0.143
2,3,4,6,7,8 hexa	0.055	0.022	<0.025	0.038	0.046	<0.04	0.067	0.038	0.067	0.028	<0.01	0.040	<0.01-0.067
1,2,3,4,6,7,8 hepta	0.14	0.10	0.25	0.14	0.15	0.24	0.90*	0.16	0.36	0.17	0.85*	0.19	0.10-0.36
octa	0.034	<0.14	0.040	0.038	<0.06	0.34*	<0.08	0.038	0.146	<0.08	1.75*	0.052	0.034-0.146
Fat content %	2.6	2.7	2.5	2.0	2.2	2.5	2.8	2.0	2.6	2.8	2.3	2.4	2.0-2.8

NA = Not analysed

< = informed detection limit; * = results not included in mean calculations



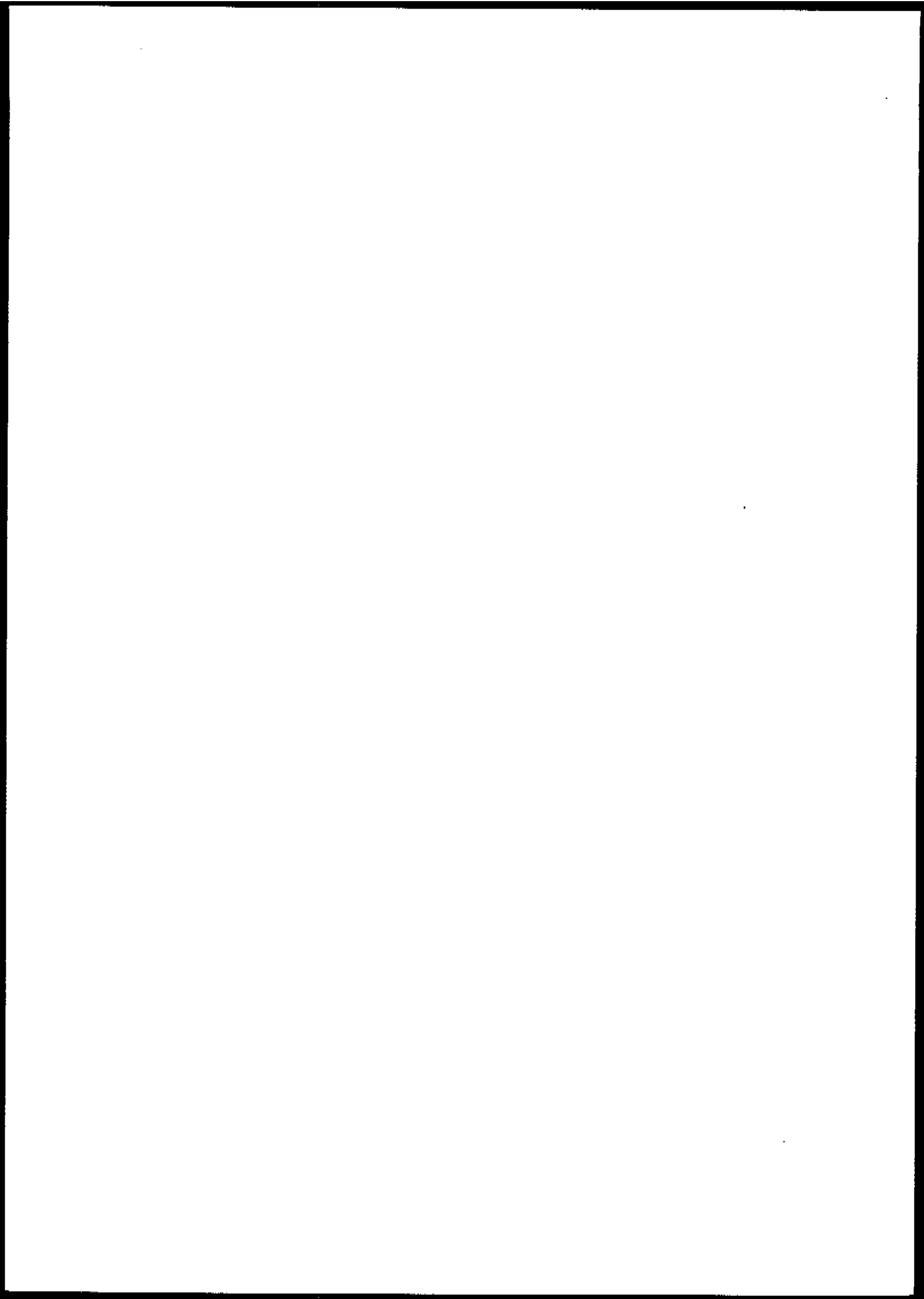
DIOXINS AND FURANS IN HUMAN MILK
POOL 2 (pg/g on whole milk basis)

Laboratory	1	2	3	4	5	6	7	8	9	10	11	Mean	Range
Congeners	:	:	:	:	:	:	:	:	:	:	:	:	:
Dioxins	:	:	:	:	:	:	:	:	:	:	:	:	:
2,3,7,8 tetra	0.083	0.057	NA	0.072	0.086	0.127	0.075	0.081	0.203	0.078	NA	0.096	0.057-0.203
1,2,3,7,8 penta	0.20	0.11	0.03	0.14	0.16	0.23	0.17	0.17	0.29	0.21	0.18	0.17	0.03-0.29
1,2,3,4,7,8 hexa	0.098	0.044	<0.075	0.066	0.046	0.099	0.091	0.064	0.075	0.030	0.095	0.068	0.030-0.099
1,2,3,6,7,8 hexa	0.58	0.44	0.38	0.50	0.73	1.12	0.52	0.70	1.12	0.70	0.70	0.68	0.38-1.12
1,2,3,7,8,9 hexa	0.22	0.09	0.13	0.12	0.10	0.05	0.13	0.16	0.21	0.08	0.17	0.12	0.05-0.22
1,2,3,4,6,7,8 hepta	1.38	0.86	0.83	0.89	1.32	1.14	0.73	1.30	1.27	0.99	8.58*	1.07	0.73-1.38
octa	4.33	3.33	3.08	4.59	5.35	1.53	10.69	5.10	4.92	4.70	13.42	5.55	1.53-13.42
Furans	:	:	:	:	:	:	:	:	:	:	:	:	:
2,3,7,8 tetra	0.075	0.039	0.018	0.078	0.067	0.104	0.91*	0.068	0.14	0.070	0.165	0.080	0.018-0.165
1,2,3,7,8 penta	0.018	0.005	0.018	<0.03	0.027	0.018	0.062	0.018	0.029	0.020	<0.04	0.024	0.005-0.062
2,3,4,7,8 penta	0.60	0.31	0.29	0.51	0.56	0.57	0.57	0.51	0.49	0.43	0.66	0.50	0.29-0.66
1,2,3,4,7,8 hexa	0.108	0.086	<0.075	0.132	0.166	0.114	0.159	0.132	0.112	0.125	0.191	0.124	<0.075-0.191
1,2,3,6,7,8 hexa	0.068	0.070	<0.05	0.086	0.095	0.073	0.107	0.097	0.068	0.083	0.123	0.081	<0.05-0.123
2,3,4,6,7,8 hexa	0.060	0.031	<0.025	0.041	0.052	<0.04	0.096	0.040	0.021	0.040	<0.004	0.038	<0.004-0.096
1,2,3,4,6,7,8 hepta	0.14	0.12	0.05	0.14	0.19	0.24	0.65*	0.18	0.24	0.19	0.33	0.18	0.05-0.33
octa	0.025	<0.13	0.015	0.026	<0.06	0.24*	<0.08	0.033	0.057	0.030	0.84*	0.035	0.015-<0.13
Fat content %	2.5	2.6	2.5	1.5	2.1	2.6	2.6	2.2	2.6	2.5	2.2	2.3	1.5-2.6

NA = Not analysed

* = results not included in mean calculations

< = informed detection limit; half of this value used in mean calculations

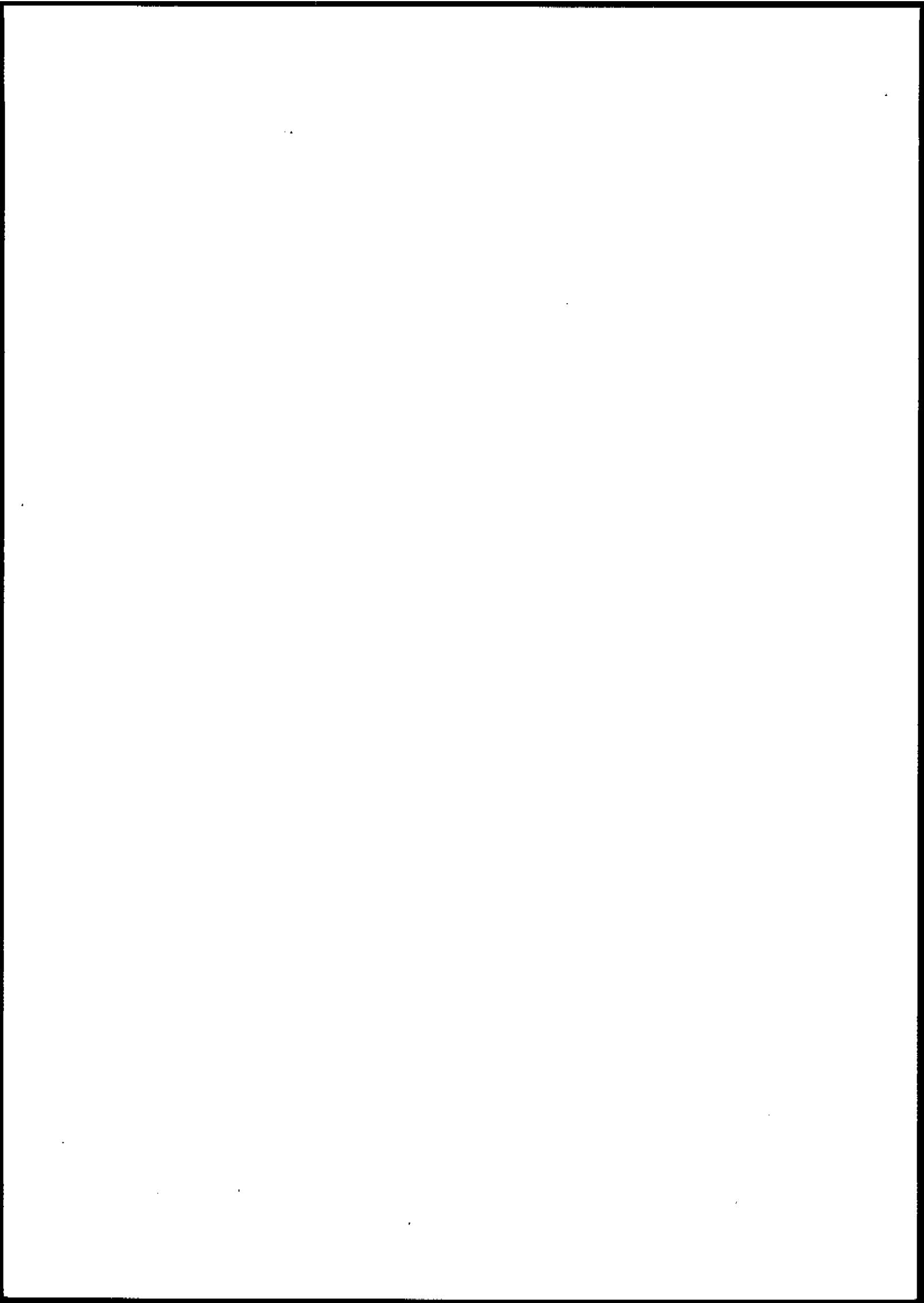


PCBs IN HUMAN MILK

ppm ($\mu\text{g/g}$) on fat basis

Laboratory	1	2	3	4	5	6	Mean	Range
Congeners								
28	<0.02	<0.02	0.029	0.012	0.006	0.01	0.012	0.006-0.029
52	<0.02	<0.02	0.005	0.002	<0.001	0.004	0.003	<0.001-0.005
101	<0.02	<0.02	0.033	0.007	0.001	0.003	0.011	0.001-0.033
138	0.14	0.13	0.16	0.115	0.10	0.15	0.13	0.10-0.16
153	0.14	0.17	0.18	0.182	0.15	0.20	0.17	0.14-0.20
180	0.08	0.09	0.12	0.067	0.07	0.10	0.09	0.07-0.12
Total	0.36	0.39	0.52	0.385	0.32	0.45	0.40	0.32-0.52

< = informed detection limit; half of this value used for mean calculations

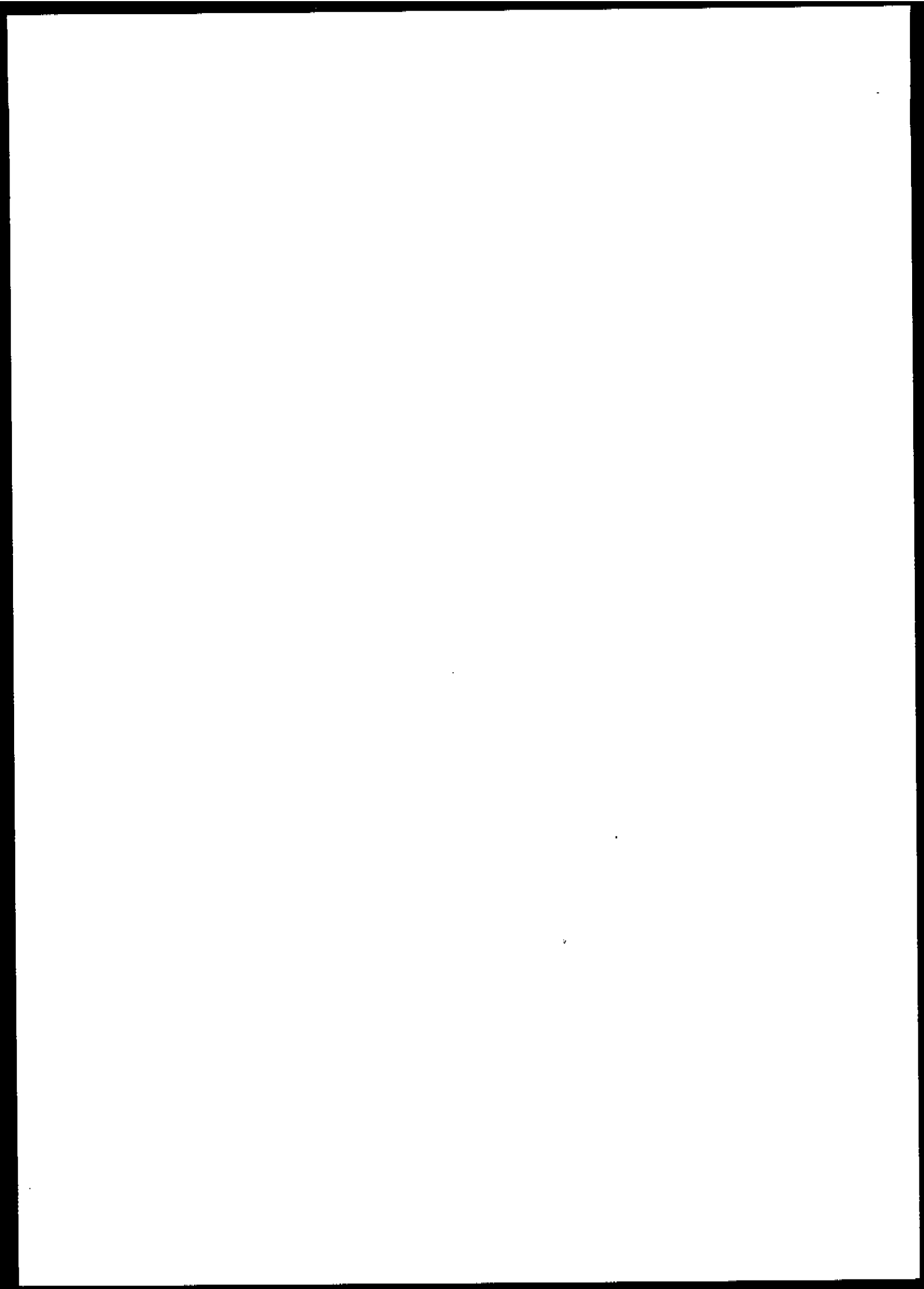


PCBS IN HUMAN MILK

($\mu\text{g/g}$ on whole milk basis)

Laboratory Congeners	1	2	3	4	5	6	Mean	Range
28	<0.0005	<0.0005	0.0006	0.0003	0.0002	0.0002	0.0003	0.0002-0.0006
52	<0.0005	<0.0005	0.0001	0.00005	<0.00004	0.00008	0.00013	<0.00004-<0.0005
101	<0.0005	<0.0005	0.0007	0.0002	0.00004	0.00006	0.00025	0.00004-0.0007
138	0.0035	0.0034	0.0035	0.0030	0.0028	0.0030	0.0032	0.0028-0.0035
153	0.0035	0.0044	0.0040	0.0047	0.0042	0.0040	0.0041	0.0035-0.0047
180	0.0020	0.0023	0.0026	0.0017	0.0020	0.0020	0.0021	0.0017-0.0026
Total	0.009	0.010	0.011	0.010	0.009	0.009	0.0097	0.009-0.011

< = informed detection limit; half of this value used for mean calculations



WHO INTERLABORATORY QUALITY CONTROL STUDY

List of laboratories which expressed interest in participating

<u>Country</u>	<u>Contact Person</u>	<u>Institution</u>
Sweden (coordinating laboratory)	Professor C. Rappe	Department of Organic Chemistry University of Umeå S-901 87 Umeå Sweden Tel: (90) 165266 Telex: 54005 UNIV UME Telefax: (90) 136310
Canada	Dr J.J. Ryan	Food Research Division Health and Welfare Canada Health Protection Branch Tunney's Pasture Ottawa, Ontario K1A 0L2 Canada Tel: (613) 957-0978 Telex: 053-3679 Telefax: (613) 957 1907
Denmark	Dr J.S. Carlé	Head of Laboratory National Agency of Environmental Protection Dept of Analytical Chemistry Moerkhoej Bygade 26 DK-2860 Soeborg Denmark Tel: (01) 697088 Telefax: (01) 698807
Finland	Dr A. Hesso	Institute of Occupational Health Haartmanninkatu 1 SF-00290 Helsinki Finland Tel: (0) 179842 or (0) 4747485 Telex: 121394 TLTX SF Telefax: (0) 414634

<u>Country</u>	<u>Contact Person</u>	<u>Institution</u>
Germany, Federal Republic of	Dr P. Fürst	Chemisches Landesuntersuchungsamt Nordrhein-Westfalen Sperlichstr. 19 D-4400 Münster Federal Republic of Germany Tel: (0251) 7793200 Telex: 892870 rpms Telefax: (0251) 7793250
	Dr W. Mathar	Max von Pettenkofer-Institut Federal Health Office P.O. Box 330013 1000 Berlin 33 Tel: (030) 83082665 or 83080 Telex: 184016 bgesa d Telefax: (030) 83082741
Italy	Dr R. Fanelli	Istituto di Ricerche Farmacologiche "Mario Negri" Via Eritrea 62 20157 Milan Italy
	Dr A. di Domenico	Istituto Superiore di Sanità Viale Regina Elena 299 00161 Rome Italy Tel: (06) 4990 Telex: 610071 ISTSAN I
	Dr S. Facchetti	Commission of the European Communities Joint Research Center Ispra Establishment 210210 Ispra (Varese) Italy Tel: (0332) 789969 Telex: 380042 EUR I, or 380058 EUR I Telefax: (0332) 789001
	Dr M. Berlincioni	Servizio Multinazionale di Prevenzione - USL 10/a Via Ponte Alle Mosse 211 50144 Florence Italy

<u>Country</u>	<u>Contact Person</u>	<u>Institution</u>
Italy (continued)	Dr A. Cavallaro	Presidio Multinazionale de Igiene e Prevenzione - USSL 75/11 Via Juvara 22 20129 Milan Italy

Of the above laboratories the Istituto Superiore di Sanità and the Joint Research Center will act as reference points in Italy.

Netherlands	Dr K. Olie	Laboratory of Environmental and Toxicological Chemistry University of Amsterdam Nieuwe Achtergracht 166 1018 WV Amsterdam Netherlands Tel: (020) 525 6504 or 525 6564 Telex: 16460 Telefax: (020) 525 5802
	Dr R.C. Wegman	Department of Industrial Contaminants Laboratory of Organic Chemistry National Institute of Public Health and Environmental Hygiene P.O. Box 1 3720 BA Bilthoven Netherlands Tel: (030) 742871 Telex: 47215 RIUM NL Telefax: (030) 74315
New Zealand	Dr D. Hannah	Department of Scientific and Industrial Research Gracefield Road Private Bag, Petone <u>Lower Hutt</u> New Zealand Tel: (04) 666 919 Telex: PHYSICS 3814
Norway	Dr M. Oehme	Norwegian Institute for Air Research P.O. Box 64 N-2001 Lillestrom Norway Tel: (06) 814170 Telex: 74854 Telefax: (06) 819247

<u>Country</u>	<u>Contact Person</u>	<u>Institution</u>
United Kingdom	Dr J.R. Startin	Ministry of Agriculture, Fisheries and Food Food Science Laboratory Haldin House Queen Street Norwich NR2 4SX United Kingdom Tel: (0603) 611712 Telex: 97317 Telefax: (0603) 610538
USA	Professor M. Gross	University of Nebraska Dept of Chemistry Hamilton Hall Lincoln, NE 68588-0304 USA Tel: (402) 4723501
	Dr L. Needham	Center for Environmental Health Centers for Disease Control 1600 Clifton Road Atlanta, GA 30333 USA Tel: (404) 4524176 or 3293311 Telex: 549571 CDC ATL
	Dr R.D. Stephens	Hazardous Material Laboratory Department of Health Services 2151 Berkeley Way Berkeley, CA 94704 USA Tel: (415) 5403003 Telefax: (415) 5402305

ANALYTICAL FIELD STUDIES

List of participating countries and coordinators

<u>Study coordinator</u>	Dr S. Tarkowski / Dr E. Yrjänheikki WHO Regional Office for Europe 8 Scherfigsvej DK-2100 Copenhagen Ø Tel: (01) 290111 Telex: 15348 WHO DK Telefax: (01) 181120	
<u>Country</u>	<u>Coordinator</u>	<u>Institution</u>
Austria	Dr F. Haschke	Univ.-Kinderklinik Wien Währinger Gürtel 18-20 A-1097 Vienna Austria Tel: (222) 48003232
Belgium	Mr H. Beernaert	Head of Food Division Institute of Hygiene and Epidemiology 14 rue Juliette Wytsman B-1050 Brussels Tel: (02) 6425111 Telex: 21034
Canada	Dr J.J. Ryan	Food Research Division Health and Welfare Canada Health Protection Branch Tunney's Pasture Ottawa, Ontario K1A 0L2 Canada Tel: (613) 9570978 Telex: 053-3679 Telefax: (613) 9571907
Denmark	Dr N. Rosdahl	National Board of Health 13 Amaliegade, P.O. Box 2020 DK-1012 Copenhagen K Denmark Tel: (01) 911601 Telex: 31316 SERUM DK ("For Sundhedsstyrelsen")
Finland	Ms T. Vartiainen	National Public Health Institute Department of Environmental Hygiene and Toxicology P.O. Box 95 SF-70701 Kuopio Finland Tel: (71) 201346 Telex: 42218 KUY SF

<u>Country</u>	<u>Coordinator</u>	<u>Institution</u>
Germany, Federal Republic of	Dr W. Mathar	Max von Pettenkofer-Institut Federal Health Office P.O. Box 330013 1000 Berlin 33 Tel: (030) 83082665 or 83080 Telex: 187016 BGESA D Telefax: (030) 83082741
Israel	Ms E. Akstein	Ministry of Health 2 Ben Tabei Street P.O. Box 1176 <u>Jerusalem 91010</u> Israel Tel: (02) 637252 or (03) 531011 (Tel-Aviv) Telex 26137 HEAL IL
Italy	Dr A. Di Domenico	Istituto Superiore di Sanità Viale Regina Elena 299 <u>00161 Rome</u> Italy Tel: (06) 4990 Telex: 610071 ISTSAN I
Netherlands	Mr R.C.C. Wegman	Dept of Industrial Contaminants Laboratory of Organic Chemistry National Institute of Public Health P.O. Box 1 3720 BA Bilthoven Netherlands Tel: (030) 742871 Telex: 47215 RIVM NL Telefax: (030) 74315
New Zealand	Dr D. Hannah	Department of Scientific and Industrial Research Gracefield Road Private Bag, Petone <u>Lower Hutt</u> New Zealand Tel: (04) 666 919 Telex: PHYSICS 3814
Norway	Dr E. Dybing	Department of Toxicology National Institute of Public Health Geitmyrsveien 75 0462 Oslo 4 Norway Tel: (02) 356020 Telex: 72400 FOTEX N

<u>Country</u>	<u>Coordinator</u>	<u>Institution</u>
Poland	Prof. Z. Brzezinski	National Research Institute of Mother and Child Kasprzaka 17A 01/211 Warsaw Poland Tel: (22) 323965
Sweden	Mr O. Aaslander	Technical Department National Environmental Protection Board P.O. Box 1302 171 25 Solna Sweden Tel: (08) 799 1124 Telex: 11131 ENVIRON S
United Kingdom	Dr J.R. Startin	Ministry of Agriculture, Fisheries and Food Food Science Laboratory Haldin House Queen Street Norwich NR2 4SX United Kingdom Tel: (0603) 611712 Telex: 97317 Telefax: (0603) 610538
USA	Dr A. Schechter	Dept of Preventative Medicine State University of New York - Health Science Center at Syracuse Clinical Campus at Binghamton 88 Aldrich Avenue Binghamton NY 13903 USA Tel: (607) 7726255
Yugoslavia	Dr E. Reiner	Institute for Medical Research and Occupational Health M. Pijade 158 P.O. Box 291 YU-41001 Zagreb Yugoslavia Tel: (041) 434188 Telex INSTMED, Zagreb

