Chapter 3

PTS limits and levels of concern in the environment, food and human tissues

3.1. Environment and food

A basic approach used to assess the potential risk posed to ecosystems and human health by toxic and other harmful effects of pollutants involves comparison observed concentrations of pollutants in the environment with established 'Maximum Permissible Levels' and 'Levels of Concern' (values that trigger action) in corresponding media. There are a number of guidelines and other normative documents that provide values for such levels, for various substances in different media. Among these, the following documents are of relevance to the project:

1. List of Fishery Standards: Maximum Permissible Concentrations and Approximately Permissible Levels of Harmful Substances Effects in Water of Water Bodies of Fishery Value (State Committee of the Russian Federation for Fishery, 1999).

2. List of Maximum Permissible Concentrations and Approximately Permissible Concentrations of Chemical Compounds in Soil (Ministry of Health of the USSR, 1993).

3. Neue Niederlandische Liste. Altlasten Spektrum 3/95. Rules for Building SP 11-102-97, Annex B (State Committee of the Russian Federation for Building, 1997).

4. Maximum Permissible Concentrations of Pesticides in Foods and Methods of their Analysis (Ministry of Health of the USSR, 1989).

5. Drinking Water. Hygienic Guidelines for Water Quality in Centralized Water Supply Systems. Quality Control (State Committee of the Russian Federation for Sanitary Epidemioilogical Control, 1996).

6. Provisional Method of Isomer-specific Estimation of Polychlorinated Dibenzo-n-dioxins in Water (Ministry of Health of the USSR, 1991).

7. Hygienic Limits of Pesticide Contamination of Environmental Objects (Ministry of Health, 2003).

8. Hygienic Requirements for Safety and Nutrition Value of Foodstuffs (Ministry of Health, 2001).

9. Toxic Substances and Disease Registry Update (U.S. Department of Human Health and Services, 2003).

Guideline values from these documents relevant to substances and media considered under the project are presented in Tables 3.1–3.7.

Contaminant	MPC, mg/L
Cadmium	0.005
Mercury	0.00001
Lead	0.006
Naphtalene	0.004
HCH	0.00001
DDT	0.00001
PCB	0.00001

Table 3.1. Maximum Permissible Concentrations (MPC) of selected contaminants in water, for water bodies of value to fisheries.

Contaminant	Guideline value, mg/kg dry weight
Lead	32.00
Mercury	2.10
Benzo(a)pyrene	0.02
γ-HCH	0.10
ΣHCH	0.10
Heptachlor	0.05
ΣDDT/DDE/DDD	0.10
HCB	0.03

Table 3.2. Maximum Permissible Concentrations (MPC) and Approximately Permissible Concentrations (APC) for selected contaminants in soil.

Contaminant	MPC, mg/kg dw	LOC, mg/kg dw
Lead	85.0	530
Cadmium	0.8	12
Mercury	0.3	10
ΣPAHs	1.0	40
ΣDDT/DDE/DDD	0.0025	4

Table 3.3. The Netherlands Maximum Permissible Concentrations (MPC) and Levels of Concern (LOC) for selected contaminants in soil and bottom sediments (as employed in the Russian Federation).

Pesticide	Guideline for soil, mg/kg dw	Guideline for water, mg/L
DDT	0.10	0.100
HCB	0.03	0.001
ΣHCH	0.10	0.020
Heptachlor	0.05	0.001

Table 3.4. Guideline values for pesticide concentrations in soil and water of freshwater bodies.

Food	MPC, mg/kg ww		
	Lead	Cadmium	Mercury
Meat and poultry raw	0.5	0.05	0.03
Internal organs of mammals and birds	0.6	0.3	0.1
Kidneys	1	1	0.2
Animal fat	0.1	0.03	0.03
Predatory freshwater fish raw	1	0.2	0.6
Non predatory freshwater fish raw	1	0.2	0.3
Marine fish raw	1	0.2	0.5
PTWI, μg/kg body weight	25	7	5 (total Hg)

Table 3.5. Maximum Permissible Concentrations (MPC) for heavy metals in food items, and internationally recommended Provisional Tolerable Weekly Intakes (PTWI).

3.2. Human blood and breast milk

In epidemiological studies, biological monitoring, or biomonitoring, is the assessment of exposure of a population to specific toxic substances by means of systematic or periodic measurements of these substances or their metabolites in human specimens, such as blood, urine, or breast milk, etc. Biomonitoring can be used to establish the body burden or internal dose of specific environmental contaminants through all possible routes of exposure. Population-based biomonitoring, in combination with environmental monitoring (e.g., of air, water, food, and soil), is considered to be one of the most valuable tools in providing information on spatial, temporal, ethnic and socio-economic trends in human exposure to contaminants. Biological monitoring is also becoming widely used in studies linking environmental exposure to pollution-related diseases, for general environmental health monitoring programs, and also to explore body burdens of contaminants in populations that may be at increased risk of exposure.

No	Contaminant	Raw food stuffs	Russian food safety limits		MRL*	TDI
			Concentration in food, mg/kg	Maximum permissible levels of human exposure, mg/kg/day	Chronic oral exposure, mg/kg/day	µg/kg body weight
1	Chlordane	-	Not established	Not established	0.0006	0.05
2	Hexachlorocyclohexane	Fish and sea products Meat and poultry	0.1 (sum of α-, β-, γ-isomers) 0.5	0.01; 0.005 for children;	α- 0.0080 β- 0.0006** γ- 0.00001**	0.30 (total)
3	Sum of DDT	Fish and sea products Meat and poultry	0.20 0.02	0.050; 0.025 for children	0.0005	20.00
4	Hexachlorobenzene	Cereals	0.01	0.0006	0.00005	0.27
5	Heptachlor	Not specified	Not allowed		Not established	Not established
6	Toxaphene		Not established		0.00100	0.20
7	PCBs	Fish and marine mammals	2.0		0.00002 (as Arochlor)	1.00 (as Arochlor) 0.30 (as Σ PCB14)
8	Dioxins (measured as 2,3,7,8-TCDD)	Fish and sea food Meat and poultry	11.0 ng/kg ww; 88.0 ng/kg lipids 0.9 ng/kg ww 3.3 ng/kg lipids	Not established	0.000001	0.00001
9	Mirex		Not established	Not established	0.0008	0.07

Table 3.6. Russian national food safety limits and internationally recommended Minimal Risk Levels (MRL) and Tolerable Daily Intake (TDI) values for persistent organic substances. * – (ATSDR, 2004). ** – established only for intermediate (> 14-364 days) exposure duration.

Food items	ΣHCH	ΣDDT/DDE/DDD
Terrestrial animal meat (muscle)	0.1	0.1
Terrestrial animal fat	0.2	1
Meat of marine mammals (walrus, seal)	0.01	0.02
Meat of marine mammals (larga seal, bearded seal)	0.01	0.2
Marine fish	0.2	0.2
Freshwater fish	0.03	0.3
Salted, smoked and marinated fish (as recalculated for wet weight of fish)	0.2	0.4
Fish liver	1	3
Salted herring	0.2	2

Table 3.7. Maximum Permissible Concentrations (MPC) for HCH and DDTs in various species, tissues, and processed foodstuffs.

Currently, levels of individual human exposure to the most important PTS that occur in the Arctic environment are assessed by measuring their concentrations (or those of their metabolites) in blood. The development of adequate analytical instrumentation and protocols, as well as the adoption of effective quality control procedures, makes possible reliable measurement of compounds and their metabolites at very low concentrations.

In spite of numerous advances in techniques, there are still some major challenges in the field of biological monitoring. A number of difficulties have been encountered in determination of specific health effects due to contaminant exposure in humans and their indicators, which are crucial components of the risk assessment process. Production of reliable risk assessments by means of biological monitoring alone is, for certain groups of persistent toxic substances, such as pesticides, still beyond current capabilities. This is due to a lack of detailed knowledge on how to interpret observed concentrations of the substances or their metabolites in various human body fluids and tissues, in particular in the typical situation of integrated exposure to a mixture of different chemicals in combination with other relevant (stress) factors that can influence health.

The best opportunity for the developing a reliable health risk assessment process is afforded by those biological criteria which are based on 'limit values' derived from well-designed epidemiological studies and supported by relevant laboratory experiments. Limit values such as those issued by the following organizations:

- *Deutsche Forschungsgemeinschaft (biological tolerance values for occupational exposure);*
- *Human Biomonitoring Commission in Germany (human biomonitoring values; HBM-1 and HBM-2);*
- *US American Conference of Governmental Industrial Hygienists (ACGIH) (biological exposure indices (BEI));* and
- *Health Canada (Medical Service Branch – Biological Guidelines)*

help to interpret the analytical results of biological monitoring.

Limit values relating to human media, for contaminants under consideration in the project, are summarized in Table 3.8. At present, the number of such values for PTS in blood and breast milk is still very limited.

With respect to Table 3.8, it is important to note that the Health Canada Guidelines for PCBs are expressed in terms of 'Arochlor 1254' concentrations, and as such do not adequately reflect risks from contamination by the whole range of substances within the PCB group. Following discussion within the AMAP Human Health Assessment Group, it was

therefore recommended that the Health Canada Guidelines should be employed only for the purpose of general comparisons of exposure levels and potential risks.

Contaminant	Matrix	Level of Concern (declarable)	Action Level	Ref
Lead	Whole blood	0.48 µmol/L; 100 µg/L for children ≤12 years and female <45	0.96 µmol/L 150 µg/L	[1] [4]
		150 µg/L (men and women >45)	250 µg/L	[4]
Cadmium	Whole blood	5.0 nmol/L	44.5 nmol/L 5 µg/L	[1] [3]
Mercury	Whole blood	75 nmol/L	100 nmol/L for children and women <40; 500 nmol/L for all men, and women >40	[1]
		5 µg/L	15 µg/L	[4]
Selenium	Plasma	Over 2.0 µmol/L	Over 3.0 µmol/L (children)	[1]
ΣDDT	Plasma	-	200 µg/L	[2]
PCBs (as Arochlor 1254)	Plasma	5 µg/L for children and women <40; 20 µg/L for all men, and women >40	100 µg/L	[1]
	Breast milk	-	50 µg/L (1.43 mg/kg lipids)	[1]

Table 3.8. Levels of Concern (LOC), and Action Levels and Limits for selected PTS in human blood and breast milk.
[1] Health Canada, 1997 – Guidelines adopted based on (CACAR, 1997)
[2] WHO, 1989c.
[3] ACGIH, 2004.
[4] German Human Biomonitoring Commission, 1996.

In cases where biological threshold values have not yet been established, judgments regarding guideline levels of a chemical or its metabolites in biological samples can, in many instances, be facilitated by comparison to suggested reference values (RVs). These describe an (acceptable) exposure situation for a given group of the general population to a contaminant. It should be explicitly pointed out that such reference values are strictly statistically-derived values, and are of no health relevance per se. However, RVs are often the only available means by which to assess integrated human exposure to environmental contaminants entering the body through several pathways, when relevant biological limits have not yet been established.

Table 3.9. Reference values for some persistent organic pollutants in whole blood (µg/L) of children aged 9 to 11 years living in Germany.

Contaminant	Reference Value (whole blood, µg/L)
PCB 138	0.3
PCB 153	0.4
PCB 180	0.3
ΣPCB 138, 153, 180	0.9
β -HCH	0.3
HCB	0.3
Total DDT	0.7

One of the most recently updated lists of reference values for environmental toxicants, based on a series of measurements of blood and breast milk concentrations of POPs in large populations, has been produced by the German Human Biomonitoring Commission (German Human Biomonitoring Commission, 2003); Tables 3.9-3.11.

Age (years)	PCB 138	PCB 135	PCB 180	PCB (138+ 153+180)	HCH	HCB	DDE West Germany	DDE East Germany
18-19	0.4	0.6	0.3	1.1	0.3	0.4	1.5	3
10-29	0.6	0.9	0.6	2.0		0.5	2	5
30-39	0.9	1.6	1.0	3.2		1.0	4	11
40-49	1.4	2.2	1.6	5.1		2.5	7	18
50-59	1.7	2.8	2.1	6.4	0.5	3.3	8	31
60-69	2.2	3.3	2.4	7.8	0.9	5.8	11	31

Table 3.10. Reference values for some persistent organic pollutants in whole blood (µg/L) of adults aged 18 to 69 years living in Germany.

Taking into account the need to ensure harmonized study protocols, another excellent opportunity for comparison of biomonitoring data is provided by the results of comprehensive national and international (e.g. circumpolar) human health monitoring programmes, such as those summarized and assessed by AMAP (AMAP 1998; 2002, 2003a).

It should be noted that there are no existing Russian biological exposure indices (BEI) of any type. BEI for lead and some other metals have recently been proposed and tentatively approved by the Sub-committee on Sanitary and Hygienic Regulations, of the Ministry of Health. However, they have not been formally endorsed, due to the adoption by the State Duma, in 2003, of new legislation on technical regulation. According to this legislation, the the Ministy of Health has no longer power to endorce any regulatory document. In general, reorganisation of Russian governmental structures have led to changes in the process of development, endorsement and enforcement of regulative documents.

As shown in the forthcoming chapters, a lack of formally adopted values of the levels of concern, threshold values, and other indicators of health effects of contaminants creates significant difficulties for human health authorities and practical medical personnel in assessment of PTS effects in general, and on indigenous population in particular. However, this lack should not block adoption of practical measures on reduction of human health risk due to PTS intake. In this case, application of the precautionary principle can be recommended.

Contaminant	Reference Value (breast milk, mg/kg lipid)
PCB 138	0.3
PCB 153	0.3
PCB 180	0.2
ΣPCB 138,153, 180	0.8
Total PCB	1.2
β-HCH	0.1
HCB	0.3
Total DDT	0.9

Table 3.11. Reference values for some polychlorinated biphenyls (PCBs) and organochlorine pesticides in breast milk, mg/kg lipid.